Fredag 14 december 2018, Antonio F. Costa, UNED, Madrid, Spanien

Seminariet arrangeras av Pedagogiska klubben på Matematiska institutionen i samarbete med Matematiska kollokviet.

Titel: Mathematics and E-learning

Onsdag 12 december 2018, Juha Lehrbäck, Jyväskylä University, Finland

Sammanfattning: There are several possible definitions of dimension for subsets of the Euclidean space (or a more general metric space). Assouad-type dimensions reflect, in a sense, the extreme local behavior of sets. While the upper and lower Assouad dimensions of a self-similar set always agree with its Hausdorff dimension, this no longer holds for inhomogeneous self-similar sets, which are obtained from a self-similar set E by adding to E a compact condensation set C and all the iterates of C under the iterated function system defining the self-similar set E. In addition, rather delicate separation conditions are needed in order to obtain nice formulas for the Assouad dimensions of inhomogeneous self-similar sets. After a general introduction recalling some of the basic definitions and facts from fractal geometry, I will discuss the above issues together with some examples and applications. The main results of this talk are based on my joint work with Antti Käenmäki.

Onsdag 5 december 2018, Ugur Abdulla, Florida Institute of Technology, Melbourne, Florida, USA

Titel: The Wiener Criterion at $\infty$ for the Elliptic and Parabolic PDEs, and its Measure-Theoretical, Topological and Probabilistic Consequences

Sammanfattning: Norbert Wiener’s celebrated result on the boundary regularity of harmonic functions is one of the most beautiful and delicate results in XX century mathematics. It has shaped the boundary regularity theory for elliptic and parabolic PDEs, and has become a central result in the development of potential theory. In this lecture I will describe my research developments which precisely characterize the regularity of the point at $\infty$ for second order elliptic and parabolic PDEs and broadly extend the role of the Wiener test in classical analysis. The Wiener test at $\infty$ arises as a global characterization of uniqueness in boundary value problems for arbitrary unbounded open sets. From a topological point of view, the Wiener test at $\infty$ arises as a thinness criteria at $\infty$ in fine topology. In a probabilistic context, the Wiener test at $\infty$ characterizes asymptotic laws for the characteristic Markov processes whose generator is the given differential operator. The counterpart of the new Wiener test at the minimal Martin boundary point leads to uniqueness in the Dirichlet problem for a class of unbounded functions growing at a certain rate near the boundary point; a criteria for the removability of singularities, asymptotic laws for conditional Markov processes and for unique continuation at the finite boundary point.

Onsdag 28 november 2018, Cyril Tintarev, Uppsala
Titel: Functional-analytic theory of defect of compactness

Sammanfattning: There are many important embeddings of functional spaces that are not compact, but, instead, every bounded sequence has a subsequence with a well-structured defect of compactness (a difference between the sequence and its limit). The primary example is the Sobolev embeddings on Euclidean space. The structure of the defect of compactness is defined relatively to a group G of linear isometries on the space. If G is rich enough, then the defect of compactness is a countable sum of "elementary concentrations" of the form $g_k w$, $g_k \in G$, with the "blowup" sequences $g_k$ acting in a decoupled manner, $g_k^{-1} \tilde{g}_k \to 0$, which corresponds in applications to terms differently scaled or with asymptotically disjoint supports. In general, such structure exists if the embedding is co-compact relative to the group G - a non-trivial property similar to, but weaker than compactness, satisfied in particular, by embeddings of Besov and Triebel-Lizorkin spaces relative to the group of translations and dilations. Other examples include Strichartz embeddings, Moser-Trudinger-(Yudovich-Peetre) embeddings, and embeddings on Sobolev type on Riemannian and sub-Riemannian manifolds. This functional-analytic approach generalizes the concentration-compactness method developed in the 1980’s in the context of calculus of variations.

Onsdag 14 november 2018, André Raspaud, Université de Bordeaux, Frankrike

Titel: Strong edge-coloring and star edge-coloring of graphs

Sammanfattning: A proper edge-coloring of a graph $G$ is a coloring of the edges of $G$ such that every two adjacent edges receive two distinct colors.

In this talk we will give a short survey of the following different close notions of edge-coloring of graphs.

- **A strong edge-coloring** of a graph $G$ is a proper edge-coloring of $G$ such that every two edges adjacent to a same edge receive two distinct colors.

  The strong chromatic index of $G$, denoted by $\chi'_s(G)$, is the smallest integer $k$ such that $G$ admits a strong edge-coloring with $k$ colors.

- **An acyclic edge-coloring** is a proper edge-coloring of $G$ with the property that every cycle contains edges of at least three distinct colors.

  The acyclic chromatic index of $G$, denoted by $\chi'_a(G)$, is the minimum number $k$ such that $G$ admits an acyclic edge-coloring with $k$ colors.

- **A star edge-coloring** of a graph $G$ is a proper edge coloring such that every 2-colored connected subgraph of $G$ is a path of length at most 3.

  The star chromatic index of $G$, denoted by $\chi'_st(G)$, is the minimum number of colors needed for a star edge coloring of $G$.

We have the following easy inequality:

$$\chi'_a(G) \leq \chi'_st(G) \leq \chi'_s(G)$$
We will also present in this talk our results concerning the strong edge coloring and the star edge-coloring.

**Onsdag 24 oktober 2018, Vladimir Kozlov, Matematiska institutionen, Linköpings universitet**

**Titel:** Dynamical behaviour of SIR model with co-infection of two viruses

**Sammanfattning:** Co-infection with multiple strains in a single host is very common. Multiple viruses are widely studied because of their negative effect on the health of host as well as on whole population. Many mathematical models have been developed and analyzed with multiple strains. In this talk, we formulate a SIR model with co-infection and density dependence which represents a $4 \times 4$ Lotka-Volterra system.

The global dynamics of the corresponding dynamical system will be described and a special attention will be given to the dependence of the dynamics on system's parameters. Changing the parameters you can switch the system from one stable dynamics to another one. In particular it will be shown that the dynamics becomes more and more complicated when the carrying capacity of population increases. This supports the enrichment paradox for this system.

The mathematical analysis of this system is based on an interplay between the theory of linear complementarity problem from optimization theory and a global stability analysis, which uses a generalized Volterra function.

This is a joint work with Samia Gthersheen, Vladimir Tkachev and Uno Wennergren (Linköping University).

**Onsdag 17 oktober 2018, Sergey Vakulenko, St Petersburg, Ryssland**

**Titel:** How evolution can create complex phenotypes?

**Sammanfattning:** We consider evolution of a population, where fitness of each organism is defined by many phenotypical traits. These traits result from expression of N genes, where $N \gg 1$. Well adapted organism should satisfy $N_c \gg N$ environmental constraints. The fitness is defined by a random Boolean circuits, for example, K-SAT model. The well known estimates (obtained first by E. Friedgut) show then that the probability to satisfy $N_c$ constraints is exponentially small thus the evolution rate is exponentially small in $N$ (the same fact follows from the classical Fisher geometric model and the Valiant approach).

We show that this fundamental obstacle can be overcome if the evolution goes, in certain sense, step by step and it is canalized in Waddington sense, i.e., in the end of each evolution rounds, the phenotype is stabilized with respect to mutations as a result of special gene regulation mechanisms. Moreover, we show that in such evolution process the number of mutations necessary for adaptation is sharply reduced. The most of mutations are neutral, and this neutralism increases during evolution.

These results are consistent with experimental data. They show that with a few number of genes one can obtain a complex organism, and that phenotypic stability is not an obstacle to
evolution. These results also explain QTL data: evolution can involve genetic changes of relatively large effects and often the total number of changes are surprisingly small.

This is a joint work with John Reinitz, USA, Dmitry Grigoriev, France, Andreas Weber, Germany, Ovidiu Radulescu, France, and Dominik Michels, Saudi Arabia.

**Fredag 12 oktober 2018, Alexandre Karassev, Nipissing University, Kanada**

**Titel:** Dimension and decomposition complexity

**Sammanfattning:** In attempts to capture asymptotic properties of finitely generated groups, manifolds, and general metric spaces, various dimension-like properties have been introduced recently, including asymptotic dimension, asymptotic dimension growth, asymptotic property C and asymptotic property D. We prove that if X is a tree-graded space (as introduced by C. Drutu and M. Sapir) and the family of all pieces of X satisfies one of the dimension-like properties, then X satisfies the same property, with explicit control over the parameters used in the property. In particular, the free product of finitely generated groups G*H satisfies a dimension-like property if the property holds for each group G and H. This is a joint with Nikolay Brodskiy

**Onsdag 10 oktober 2018, Evgeniy Lokharu, Lunds universitet**

**Titel:** Three-dimensional steady water waves with vorticity

**Sammanfattning:** We will consider the nonlinear problem of steady gravity-driven waves on the free surface of a three-dimensional flow of an incompressible fluid. In the talk we will discuss a recent progress on three-dimensional waves with vorticity, which is a relatively new subject. The rotational nature of the flow is modeled by the assumption on the velocity field, that is proportional to its curl. Such vector fields are known in magnetohydrodynamics as Beltrami fields. We plan to give a necessary background on the topic and prove the existence of a three-dimensional doubly periodic waves with vorticity.

The talked is based on a joint work with Erik Wahlén and Douglas Svensson Seth from Lund University.

**Onsdag 3 oktober 2018, Håkan Lennerstad, Blekinge tekniska högskola, Karlskrona**

**Titel:** Distance-consistent graph labelings, the ampleness of a graph, and graph functionals

**Sammanfattning:** A natural labeling of a simple connected graph $G = (V, E)$ is a labeling $c$ of the nodes with natural numbers $1, 2, \ldots, |V|$. Such a labeling induces a labeling distance $c(u, v) = |c(u) - c(v)|$ alongside the usual graph distance $d(u, v)$. A natural labeling that realizes the minimum

$$l(G) = \min_c \sum_{u, v \in V} (c(u, v) - d(u, v))^2$$

is a distance-consistent labeling, and $l(G)$ is the ampleness of $G$. It trivial that $l(G) = 0$ iff $G$ is a path graph, and I'll give the proof that $l(G) \leq l(K_n)$ for all $G$ with $n = |V|$. The
normalized ampleness \( L(G) = \frac{l(G)}{(Kn)} \), \( 0 \leq L(G) \leq 1 \) is studied for different graph classes such as the bipartite graph \( K_{n,n} \), the star graph \( S_n \), the cycle graph \( C_n \) and a few other types, particularly for \( n \to \infty \).

The quantity

\[
\min_c \sum_{u,v \in V} (c(u,v) - d(u,v))^2
\]

is a graph functional; mapping graphs to non-negative integers. It can be thought of as the "inverse listness" of a graph - being zero for lists only (path graphs). The quantity \( c(u, v) \) can be replaced by other quantities defining the "inverse cycleness" or "inverse starness" of any graph, in which case the corresponding functional is zero if an only if the graph is \( C_n \) or \( S_n \), respectively.

**Onsdag 26 september 2018, Johan Öinert, Blekinge tekniska högskola, Karlskrona**

Titel: Epsilon-strongly group graded rings, Leavitt path algebras and crossed products by twisted partial actions

Sammanfattning: Epsilon-strongly group graded rings constitute a class of rings which contains all strongly group graded rings and all crossed products associated with unital twisted partial group actions. A result of Năstăsescu, Van den Bergh and Van Oystaeyen (1989) gives a characterization of strongly group graded rings which are separable over their canonical 'degree zero' subrings. A more recent result of Bagio, Lazzarin and Paques (2010) gives a characterization of crossed products, associated with unital twisted partial group actions, which are separable over their coefficient subrings. We are able to simultaneously generalize both of these results by giving a characterization of separable epsilon-strongly group graded rings. We also provide examples of separable epsilon-strongly group graded rings (not strongly graded!) and thereby answer a question of Le Bruyn, Van den Bergh and Van Oystaeyen (1988).

Given an arbitrary group \( G \), we will explain how to equip any Leavitt path algebra over a finite (directed) graph with an epsilon-strong \( G \)-gradation.

This talk is based on recent joint work with Patrik Nystedt (University West, Sweden) and Héctor Pinedo (Industrial University of Santander, Colombia).

**Fredag 21 september 2018, Lashi Bandara, University of Potsdam, Tyskland**

Titel: When functional calculus, harmonic analysis, and geometry party together ...

Sammanfattning: Functional calculus emerged in the latter half of last century as a convenient tool particularly in the analysis of partial differential equations. In the last thirty years, harmonic analysis has entered the picture to interact with functional calculus in an extraordinarily fruitful way. More recently, geometry has crashed the scene, with an abundance of interesting and important problems, which can be effectively dealt with using the tools coming from functional calculus and harmonic analysis. Moreover, there are
fascinating geometric interpretations associated with the latter tools, although these investigations are still in their infancy.

The goal of this talk will be to flesh out a brief narrative of the journey of functional calculus, how it came to interact with harmonic analysis, and the party they've been recently having together with geometry. It will culminate with state-of-the-art results, but the beginnings will be humble, starting with the Fourier series! For the majority of the talk, no background will be assumed beyond Hilbert spaces, self-adjoint operators, and the spectrum of an operator.

Onsdag 12 september 2018, Nikolay Kuznetsov, Russian Academy of Sciences, St. Petersburg, Ryssland

Titel: Studies of water waves: An early history and some up-to-date developments

Sammanfattning: Main results from 1687 (Newton's Principia) to 1895 (Lamb's Hydrodynamics) will be outlined with emphasis on the work of Scott Russell on solitary waves and of Stokes on the waves named after him. The influence of the early work on achievements of the last four decades will be traced.

Onsdag 5 september 2018, Tilman Bauer, KTH

Titel: Realizing Cohomology

Sammanfattning: To compute the cohomology of a given space is generally considered a tractable problem. The inverse problem, namely to construct a space with prescribed cohomology, is a much subtler problem. For the case of cohomology with coefficients modulo an (even) prime, I will discuss the classical problem posed by Steenrod in 1960 of which polynomial rings can be cohomology rings of spaces, starting from obstructions imposed by Adams's solution to the Hopf invariant one problem to the discovery and classification of p-compact groups by Dwyer-Wilkerson, Andersen-Grodal, and others. I will then address the problem of realizing certain very small cohomology rings by combining exotic p-compact groups with exotic new cohomology theories. The last part is joint work in progress with A. Baker.

Onsdag 13 juni 2018, German Zavorokhin, Steklov Math. Institute, St. Petersburg, Ryssland

Titel: Pressure drop matrix for a bifurcation of an artery with defects

Sammanfattning: We consider a bifurcation of an artery. The influence of defects of the vessel's wall near the bifurcation point on the pressure drop matrix is analyzed. The elements of this matrix are included in the modified Kirchhoff transmission conditions, which were introduced earlier in the works of V. Kozlov and S. Nazarov, and which give better approximation of 3D flow by 1D flow near the bifurcation point in comparison with the classical Kirchhoff conditions. This is joint work with V. Kozlov and S. Nazarov.

Tisdag 5 juni 2018, Vlad Bally, Université Paris-Est Marne-la-Vallée, Frankrike
Seminariet är ett samarrangemang med Seminarier i Matematisk statistik.

**Titel:** Asymptotic integration by parts formula and regularity of probability laws

**Sammanfattning:** We consider a sequence of random variables $F_n \sim p_n(x)dx$ which converge to a random variable $F$. If we know that $p_n \to p$ in some sweated sense, then we obtain $F \sim p(x)dx$. But in many interesting situations $p_n$ blows up as $n \to \infty$. Our aim is to give a criterion which says that, if there is a "good equilibrium" between $\|F - F_n\|_1 \to 0$ and $\|p_n\| \uparrow \infty$ then we are still able to obtain the absolute continuity of the law of $F$ and to study the regularity of the density $p$. Moreover we get some upper bounds for $p$. The blow up of $p_n$ is characterized in terms of integration by parts formulae.

We give two examples. The first one is about diffusion processes with Hölder coefficients. The second one concerns the solution $f_t(dv)$ of the two dimensional homogeneous Boltzmann equation. We prove that, under some conditions on the parameters of the equation, we have $f_t(dv) = f_t(v)dv$. The initial distribution $f_0(dv)$ is a general measure (except a Dirac mass) so our result says that a regularization effect is at work; moreover, if the initial distribution has exponential moments $\int e^{\lambda'v} f_0(dv) < \infty$, then we prove that $f_t(v) \leq Ct^{-\eta}e^{-|v|^{\lambda'}}$ for every $\lambda' < \lambda$. So we have exponential upper bounds in space and at most polynomial blow up in time.

**Onsdag 30 maj 2018, Nathan Reading, North Carolina State University, USA**

**Titel:** To scatter or to cluster?

**Sammanfattning:** Scattering diagrams arose in the algebraic-geometric theory of mirror symmetry. Recently, Gross, Hacking, Keel, and Kontsevich applied scattering diagrams to prove many longstanding conjectures about cluster algebras. Scattering diagrams are certain collections of codimension-1 cones, each weighted with a formal power series. In this talk, I will introduce cluster scattering diagrams and cluster algebras, and the relationship between them, focusing on rank-2 (i.e. 2-dimensional) examples. Even 2-dimensional cluster scattering diagrams are not well-understood in general. I will show how the two-dimensional "affine-type" cases can be constructed using cluster algebras and describe a surprising appearance of the Narayana numbers in the two-dimensional affine case.

**Onsdag 23 maj 2018, Xining Li, Sun Yat-Sen University, Guangzhou, Kina**

**Titel:** Characterization of $H^p$ spaces in quasiconformal mappings

**Onsdag 16 maj 2018, Nageswari Shanmugalingam, MAI och University of Cincinnati, USA**

**Titel:** Geometric and analytic aspects of infinity-Poincaré inequalities

**Sammanfattning:** The study of absolute minimizing Lipschitz extensions and infinity-harmonic functions in the Euclidean setting was initiated by Aronsson, Crandall and Evans, and is of great interest now, with optimal regularity of solutions yet open. In the metric setting, and indeed even in the weighted Euclidean setting, studies of such solutions are possible under certain conditions on the metric space. One condition is the existence of
infinity-Poincaré inequality. In this talk we will discuss this inequality, and a geometric and analytic characterizations of this inequality.

**Onsdag 9 maj 2018 Inställt**

**Onsdag 2 maj 2018, Armen Asratian, MAI**

Titel: A localization method in Hamiltonian graph theory

Sammanfattning: A finite graph G is called Hamiltonian if it has a cycle containing every vertex of G. Almost all of the existing sufficient conditions for a finite graph G to be Hamiltonian contain some global parameters of G (such as the number of vertices) and only apply to graphs with large edge density and/or small diameter.

In a series of papers we have shown that some classical sufficient conditions for Hamiltonicity of graphs that contain global parameters can be reformulated in such a way that every global parameter in those conditions is replaced by a parameter of a ball with small radius. Such results are called localization theorems and give a possibility to find new classes of Hamiltonian graphs with large diameter and small edge density.

I shall give a review of this topic and present some new results obtained with J. Granholm and N. Khachatryan. In particular, we formulate a general method for finding localization theorems and apply this method for formulating local analogues of four well-known criteria for Hamiltonicity of finite graphs. Finally we extend some of our results to infinite locally finite graphs.

**Onsdag 18 april 2018, Sergey Nazarov, MAI och St Petersburg, Ryssland**

Titel: Sharpening and smoothing near-threshold Wood anomalies in cylindrical waveguides

Sammanfattning: Gently sloped perturbation of the wall of an acoustic or elastic waveguide can lead to Wood’s anomalies which realizes as disproportionately rapid changes of the diffraction pattern near thresholds of the continuous spectrum. By means of an asymptotic analysis certain restrictions on the profile of the wall perturbations are found that provide the appearance of the anomaly, its sharpening or extinction. Several ways are found out to avoid the anomaly, namely either to keep the threshold resonance which itself provokes the anomaly, or to provide an embedded eigenvalue, both require a fine tuning of the profile of the perturbed wall. At the same time, violation of the fine tuning procedure usually leads to the anomaly.

**Onsdag 11 april 2018, Lucia Lopez de Medrano, UNAM, Mexico City, Mexiko, och Institut Mittag-Leffler**

Titel: Tropical Geometry

Sammanfattning: In this talk we will review basic aspects of tropical geometry and discuss some of its applications in classical algebraic geometry.

**Måndag 9 april 2018, Agnieszka Kalamajaska, University of Warsaw, Polen**
Titel: Dirichlet's problem for critical Hamilton-Jacobi fractional equation

Sammanfattning: Using an extended approach of Dan Henry, we study solvability of the Dirichlet problem on a bounded smooth domain for the Hamilton-Jacobi equation with critical nonlinearity posed in Sobolev spaces:

\[
\begin{cases}
    u_t + (-\Delta)^{1/2} u + H(u, \nabla u) = 0, & t > 0, x \in \Omega, \\
    u(t, x) = 0, & t > 0, x \in \partial\Omega, \\
    u(0, x) = u_0, & x \in \Omega.
\end{cases}
\]

We will also discuss the additional regularity and uniqueness of the limiting weak solution. The talk will be based on joint work with Tomasz Dlotko.

**Onsdag 4 april 2018, Panu Lahti, Jyväskylä University, Finland**

Titel: A new approximation of BV functions on metric spaces

Sammanfattning: I will discuss a new way of approximating BV functions in the so-called strict sense, and pointwise uniformly, by SBV functions, which are BV functions whose variation measure has no Cantor part. This is based on a careful analysis of capacities. I will consider this in the setting of metric spaces with a doubling measure and Poincaré inequality but the result may be new even in Euclidean spaces. Lastly I will discuss possible applications for variational problems.

**Tisdag 27 mars 2018, Lars-Erik Persson, Luleå tekniska universitet**

Titel: The Hardy inequality: Prehistory, history and current status (PDF)

Sammanfattning: First I describe shortly the dramatic around 10 years period until G.H. Hardy formulated and proved his famous inequality in 1925. After that I describe some selected steps in what today is referred to as Hardy-type inequalities (see e.g. the book [1] and references therein). Finally, I turn to shortly describe some remarkable examples of developments mostly from the really last years. See e.g. Chapter 7 of the second edition of our book [1] and also my Lecture Notes [2] from P.L. Lions seminar. In particular, some open questions are presented.


**Onsdag 21 mars 2018, Dag Nilsson, Lunds universitet**

Titel: Existence of solitary waves: A spatial dynamics approach
Sammanfattning: In 1982 Kirchgässner studied a class of semilinear elliptic boundary value problems in an infinite strip. By treating the unbounded coordinate $x$ as time he formulated his problem as a dynamical system of the form

$$u_x = Lu + F(u),$$

where $L$ is a linear operator and $F = O(|u|^2)$. Using methods from dynamical systems theory he was then able to prove existence of solutions of the system above. Today this procedure is called spatial dynamics. In 1988 Kirchgässner applied this technique to the two dimensional irrotational water wave problem and was able to prove existence of solitary wave solutions in the presence of strong surface tension. This work was later expanded upon by other researchers who considered different parameter regimes, for example weak surface tension. The method was extended to the three dimensional setting by Groves and Mielke, under the extra assumption that the waves are periodic in one spatial direction.

In my talk I will present results from three of my papers where the method of spatial dynamics is used to prove existence of solitary waves for three different physical situations: two-dimensional internal waves, waves on a cylindrical ferrofluid jet and three dimensional internal waves. In particular I will compare my findings with known results for surface waves. Parts of the talk are based on a collaboration with Mark Groves of Saarland University.

**Onsdag 14 mars 2018, Lukáš Malý, Chalmers och Göteborgs universitet**

Titel: Self-improvement of generalized Poincaré inequalities

Sammanfattning: Many parts of the theory of first-order analysis in metric spaces rely on various types of Poincaré inequalities (PI), which are indispensable ingredients of Sobolev-type and Morrey-type embeddings of Sobolev functions. It was proven by Keith and Zhong that a $p$-Poincaré inequality is an open-ended condition. Specifically, if a complete metric space endowed with a doubling measure admits a $p$-Poincaré inequality with $p > 1$, then the metric space admits a $q$-Poincaré inequality for some $q < p$. A $p$-Poincaré inequality need not be the most natural choice when constructing a refined theory of Sobolev-type spaces, where the gradients lie in an Orlicz or a Lorentz space. For instance, Tuominen applied Orlicz-type PI and Costea–Miranda applied a Lorentz-type PI to study the respective Sobolev spaces.

In my talk, I will discuss self-improvement of such more general Poincaré inequalities. I will also provide an elementary proof that Orlicz-type Poincaré inequalities are, in fact, $p$-Poincaré inequalities in disguise and undergo self-improvement by the original result of Keith and Zhong. The method serves also as an alternative proof for relating Orlicz-type Muckenhoupt weights to the standard $A_p$ weights. The situation for Lorentz-type Poincaré inequalities is however more delicate and one can construct a fairly simple metric space where the self-improvement result fails. In particular, a Lorentz-type Poincaré inequality need not be an open-ended condition.

**Onsdag 7 mars 2018, Andreas Sykora, München, Tyskland**

Titel: Fuzzy surfaces from graphs and embedding functions

**Onsdag 28 februari 2018, Rebekah Jones, University of Cincinnati, USA**
Titel: Dimension distortion of sets of finite perimeter under a quasisymmetric map in a metric space

Sammanfattning: One characterization of quasiconformal maps is that they quasi-preserve the modulus of curves, i.e. there exists $C > 0$ such that for any collection of curves $\Gamma \subset \mathbb{R}^n$, $C^{-1} \text{Mod}_n(\Gamma) \leq \text{Mod}_n(f(\Gamma)) \leq C \text{Mod}_n(\Gamma)$. In 1973, Kelly showed that also the $\frac{n}{n-1}$-modulus of surfaces is quasi-preserved. In particular, this implies that almost every surface does not increase in dimension under such a map. We show that, under the appropriate geometric assumptions, such a result is valid in a metric space. This talk is based on joint work with Panu Lahti and Nageswari Shanmugalingam.

Onsdag 21 februari 2018, Stefan Rauch, MAI

Titel: Understanding reversals of a rattleback

Sammanfattning: The rattleback is a rigid body having a boat-like shape (modelled as the bottom half of an 3-axial ellipsoid) having asymmetric (chiral) distribution of mass. When the rattleback is spun on its bottom in the “wrong” direction then it starts to rattle, it slows down and acquires rotation in the opposite, preferred sense of direction. This behavior defies our intuition about conservation of angular momentum as the force and the torque responsible for changing the angular momentum (and the direction of spinning) are not obvious.

The overwhelming majority of papers on the rattleback’s motion study the dependence of stability for spinning solutions on the sense of rotation, on the shape of the rattleback’s surface and on the distribution of mass. There has been no available simple, intuitive explanation of the rattleback’s behavior in terms of physical forces and torques.

In a joint paper with M. Przybylska, just published in Regular and Chaotic Dynamics (a journal of Steklov Mathematical Institute), we explain the motion of a toy rattleback by using frictionless Newton equations of motion for a rigid body rolling without sliding in a plane. It is the reaction force of the supporting surface that is the source of the torque turning the rattleback in the preferred sense of rotation.

The picture is, however, more subtle as it appears that the direction of the torque depends on the initial conditions and a frictionless, low energy rattleback admits reversals in both directions(!).

I will discuss how the rattleback’s motion depends on initial conditions and how it agrees with results of simulations of the rattleback’s equations for tapping and spinning initial conditions. Simulations show also that the long time behavior of such a rattleback is, for low energy initial conditions, quasi-periodic and there are infinitely many reversals in both directions.

Onsdag 14 februari 2018, Maria Przybylska, Zielona Góra, Polen

Titel: Integrability properties of certain generalisations of non-holonomic Suslov problem

Sammanfattning: One of the basic examples of nonholonomic mechanics is the Suslov system. Two its generalizations will be presented. The first one is based on the classical heavy gyrostat. Its equations of motion are restricted by the non-holonomic Suslov constraint: the projection
of the angular velocity of the body onto a vector constant in the body frame vanishes. Integrability of the obtained system is analysed. It appears that certain integrable cases of the Suslov problem have their integrable generalisation. Additionally it is proved that for a wide range of parameters of the problem, the system is not integrable in the Jacobi sense.

The second model is a Lie-Poisson system on six-dimensional class A co-algebras generated by a quadratic Hamiltonian and restricted by a nonholonomic constraint which is a generalisation of the Suslov constraint. We obtain counterparts of classical integrable cases. Moreover, in the case without a potential conditions of meromorphicity of solutions lead to cases with additional polynomial first integrals. They are constructed by means of solutions of a third order linear differential equations that in two cases appear to be generalised hypergeometric equations defining 3F2 hypergeometric function. It appears that for all class A co-algebras there exists a generalised version the Kozlov case when the system is described by a natural Hamiltonian with two degrees of freedom. It is shown that this system is not integrable except in one case.

Fredag 9 februari 2018, Yakov Krasnov, Bar-Ilan University, Ramat Gan, Israel

Titel: Methods of nonassociative algebras in differential equations

Sammanfattning: Many well-known (classes of) differential equations may be viewed as a Riccati type equation in a certain commutative nonassociative algebra. We develop further the principal idea of L. Markus for deriving algebraic properties of solutions to ODEs and PDEs directly from the equations defining them. Our main purpose is (a) to show how the algebraic formalism can be applied with great success to a remarkably elegant description of the geometry of curves being solutions to homogeneous polynomial ODEs, and, on the other hand, (b) to motivate the recent interest in applications of nonassociative algebra methods to PDEs. More precisely, given a differential equation on an algebra A, we are interested in the following two problems:
1. Which properties of the differential equation determine certain algebraic structures on A such as to be associative, unital or division algebra.
2. In the converse direction, which properties of A imply certain qualitative information about the differential equation, for example topological equivalent classes, existence of a bounded, periodic, ray solutions, ellipticity etc.
We also define and discuss syzygies between Peirce numbers which provide an effective tool for our study. (Some results here are based on a recent joint work with V. Tkachev.)

Onsdag 7 februari 2018, Salvador Rodríguez-López, Stockholms universitet

Titel: Regularity properties for solutions of hyperbolic equations in some Function spaces

Sammanfattning: Fourier analysis methods play an important role in the study of some linear and nonlinear PDEs. In this talk, we will first give a general overview of some tools of Fourier analysis, such as Littlewood-Paley decomposition, some associated function spaces, namely Besov and Triebel-Lizorkin spaces, and certain operators such as pseudo-differential and Fourier integral operators. We will also briefly discuss some recent results on the regularity for the solutions to linear hyperbolic partial differential equations, which encompasses the wave
equation. More precisely, since the solution of these equations can be written as a linear combination of the so-called Fourier integral operators, the regularity is established by obtaining some boundedness properties of these. Specifically, we will present an extension of the result of A. Seeger, C.D. Sogge and E. M. Stein on $L^p$ spaces to the scale of Besov and Triebel-Lizorkin spaces. We will finish the talk by pointing out some ongoing research and open problems.

**Onsdag 31 januari 2018, Anders Björn, MAI**

Titel: Some parts from the history of analysis in the 19th century

Sammanfattning: While preparing for the Real Analysis, honours course, (Analys överkurs) during the autumn I tried to find out some details about who invented what and when. Some of these facts don't seem to be so well known, but may be of interest to others. I will discuss things like who introduced and proved uniform continuity, and who first showed that continuous functions can be integrated. I will also discuss how the Riemann zeta function, and esp. the Riemann hypothesis, influences estimates for $\pi(x) = \text{the number of primes } \leq x$, and the history around these results.

**Onsdag 24 januari 2018, Veronica Crispin Quiñonez, Uppsala**

Titel: Hilbert series of quadratic forms in the exterior algebra

[Sammanfattning](PDF)

**Onsdag 17 januari 2018, Sylvester Eriksson-Bique, UCLA, Los Angeles, USA**

Titel: Poincaré inequalities and notions of connectivity

Sammanfattning: What does it mean for a space to be well-connected, and how can one quantify that? In this talk I will discuss a few notions of connectivity, and how they relate to Poincaré inequalities. This initial discussion revolves around the seemingly innocent question: If the gradient of a function is small, can I conclude that the function is almost constant? This can be made effective in several ways, leading to various inequalities, some of which are classical Poincaré inequalities, and one of the is a new quantitative notion of connectivity. These inequalities have appeared in various contexts and are related to many applications. Interestingly, all of these turn out to be equivalent, as long as equivalent is properly interpreted, to the classical notion of a Poincaré inequality. With time, I might discuss briefly some recent applications to non-self-similar carpets, self-similar spaces and self-improvement phenomena.
The Mathematical Colloquia held in 2017 at Linköping University

Organized by Anders Björn, Milagros Izquierdo Barrios, Vladimir Kozlov, and Hans Lundmark.

Onsdag 11 januari 2017, Visa Latvala, University of Eastern Finland, Joensuu, Finland

Weak Harnack estimates for quasisub- and quasisuperminimizers with non-standard growth
Sammanfattning: Weak Harnack estimates can be regarded as generalizations of subminimizing and superminimizing properties of classical subharmonic and superharmonic functions. These estimates are important tools in the nonlinear potential theory. For the p-Laplace type equations, weak Harnack estimates can be obtained either by Moser’s iteration method or by De Giorgi’s method. DíazBenetto and Trudinger extended the latter method in 1980’s to a very general class of quasisub- and quasisuperminimizers. The purpose of the talk is to give an overview on results related to quasisuperminimizers of the variational integrals with non-standard growth. We focus on the variable exponent growth but also comment on the recent development related to generalized Orlicz spaces.


The influence of geometry of a manifold on attainability of the norm of the Sobolev trace embedding operator
Sammanfattning: Let Ω be a smooth compact Riemannian n-dimensional manifold with smooth boundary, and let 1 < p < n. We consider the trace Sobolev embedding

\[ \mu_\lambda \equiv \inf_{u \in H^1(\Omega)} \frac{\|\nabla u\|_{L^p(\partial \Omega)}}{\|u\|_{L^n(\Omega)}} \geq 0 \] (1)

(here \(p^* = (n-1)p/(n-p)\)). Similarly to the case of conventional Sobolev embedding (see the survey [3] and references therein), the attainability of the infimum in (1) heavily depends on the geometry of the domain Ω. The following work with Alexander Reznikov.


Onsdag 25 januari 2017, Adrian Mantu, Karlstads universitet

Reactors in flow systems with distributed microstructures: well-posedness and homogenization asymptotics
Sammanfattning: The discussion will address the multiscale modeling, analysis and approximation of a class of reaction-diffusion systems posed simultaneously on both macroscopic and microscopic space scales. The coupling between the scales is done via micro-macro transmission conditions. Our target system has a typical structure for reaction-diffusion-flow problems in media with distributed microstructures (also called, double porosity materials), reminding the work of G. Barenblatt on flows through fractured media. The talk will focus on an analysis and the derivation of the two-scale structure based on formal homogenization asymptotics. We will show how the resulting structure of the system and will point out a route to justify the homogenization asymptotics rigorously. A numerical example will illustrate how the weak solution “communicates” between the space scales.

Onsdag 1 februari 2017, Clas Rydberygren, ITN, Norrköping

New sources of input data for travel demand estimation models
Sammanfattning: Forecasts of how journeys are made, from where and to where, is usually done using simple mathematical models. The results from the models are used as estimates of the traffic flow in the transport system. Estimates are made for the load today, in the future, and to estimate the change in travel demand when changes in the infrastructure are made. The model result is critical input to traffic planners. Different types of models are used depending on, among other things, if the analysis requires the results to include all modes of transport, or not, and the length of the forecast horizon. Models for long-term forecasts (several years) often contain components to describe the travelers’ values and perceptions whereas models for the current situation or with a very short forecast horizon, often is based exclusively a network model and data from dedicated traffic measurements. During this seminar, I will present an example of a traditional demand model, and exemplify how this model is used. The ongoing digitization have led to new sources of input data for this type of models. I will exemplify this by presenting inputs used in a couple of research projects ongoing at the Division of Communications and Transport System (KTS) at ITN.

Onsdag 8 februari 2017, Viktor Kolyada, Karlstads universitet

On Gagliardo-Nirenberg type inequalities
Sammanfattning: Since the 19th century the theory of Riemann surfaces has a central place in mathematics putting together complex analysis, algebraic and hyperbolic geometry, group theory and combinatorial methods. Since Riemann, Klein and Poincaré among others, we know that a compact Riemann surface is a complex curve, and also the quotient of the hyperbolic plane by a Fuchsian group. In this talk we study the connectivity of the moduli spaces of Riemann surfaces (i.e. in spaces of Fuchsian groups). Spaces of Fuchsian groups are orbifolds on the geometry of a manifold with automorphism actions is disconnected and consists of several connected components. This talk is a survey of the different methods and topics playing together in the theory of Riemann surfaces.

Onsdag 1 mars 2017, Milagros Izquierdo, MAI

On the Connectivity of Branch Locii of Spaces of Curves
Sammanfattning: Since the 19th century the theory of Riemann surfaces has a central place in mathematics putting together complex analysis, algebraic and hyperbolic geometry, group theory and combinatorial methods. Since Riemann, Klein and Poincaré among others, we know that a compact Riemann surface is a complex curve, and also the quotient of the hyperbolic plane by a Fuchsian group. In this talk we study the connectivity of the moduli spaces of Riemann surfaces (i.e. in spaces of Fuchsian groups). Spaces of Fuchsian groups are orbifolds on the geometry of a manifold with automorphism actions is disconnected and consists of several connected components. This talk is a survey of the different methods and topics playing together in the theory of Riemann surfaces.

Onsdag 8 mars 2017, Natan Kruglyak, MAI

Theory of Interpolation (review)
Sammanfattning: A year ago I gave a talk during which I have discussed what was done in interpolation theory before 1980. Now I plan to remind (shortly) what was discussed last year and will focus on some results which were obtained after 1980.

Onsdag 15 mars 2017, Håkan Hedenmalm, KTH

Bloch functions, asymptotic variance, and geometric zero packing
Sammanfattning: In connection with the study of the universal integral means spectrum for quasiconformal mapping, it turns out that the main term for small exponents and small connected components. This talk is a survey of the different methods and topics playing together in the theory of Riemann surfaces.

Onsdag 22 mars 2017, Thomas Geisser, Rikkyo University, Tokyo, Japan, och Institut Mittag-Leffler

Analytical method of spectra calculations for quantum optics systems in the Bargmann representation
Sammanfattning: Since the 19th century the theory of Riemann surfaces has a central place in mathematics putting together complex analysis, algebraic and hyperbolic geometry, group theory and combinatorial methods. Since Riemann, Klein and Poincaré among others, we know that a compact Riemann surface is a complex curve, and also the quotient of the hyperbolic plane by a Fuchsian group. In this talk we study the connectivity of the moduli spaces of Riemann surfaces (i.e. in spaces of Fuchsian groups). Spaces of Fuchsian groups are orbifolds on the geometry of a manifold with automorphism actions is disconnected and consists of several connected components. This talk is a survey of the different methods and topics playing together in the theory of Riemann surfaces.

Onsdag 29 mars 2017, Panu Lahti, MAI

Fine boundaries and Federer’s characterization of sets of finite perimeter in metric spaces
Sammanfattning: The fundamental problem of quantum mechanics is solving the eigenvalue problem for a given Hamilton operator, i.e. determination of eigenfunction called a wave function and corresponding eigenvalue called the energy spectrum. We show that for a certain class of quantum mechanics problems one can use the so-called Bargmann representation which allows one to rewrite the eigenvalue equation as a system of linear equations with one independent complex variable. Using this representation we distinguish three types of conditions determining the spectrum: local conditions around each singularity, compatibility condition taking into account the interaction of connected components, and normalization condition related to the proper growth order of solutions. A few examples of quantum optics systems describing the interaction of one mode of electromagnetic radiation with two-level atom will be considered and obstructions on solutions given by these conditions will be presented. In some cases, one can find closed form expression on spectrum formulated by means of transcendental functions of parameters of the systems such as confluent Heun functions or generalised Heun functions.

Onsdag 2 mars 2017, Alexander I. Nazarov, Idag Petersburg, Ryssland

The influence of geometry of a manifold on attainability of the norm of the Sobolev trace embedding operator
Sammanfattning: Let Ω be a smooth compact Riemannian n-dimensional manifold with smooth boundary, and let 1 < p < n. We consider the trace Sobolev embedding

\[ \mu_\lambda \equiv \inf_{u \in H^1(\Omega)} \frac{\|\nabla u\|_{L^p(\partial \Omega)}}{\|u\|_{L^n(\Omega)}} \geq 0 \] (1)

(here \(p^* = (n-1)p/(n-p)\)). Similarly to the case of conventional Sobolev embedding (see the survey [3] and references therein), the attainability of the infimum in (1) heavily depends on the geometry of the domain Ω. The following work with Alexander Reznikov.

A weighted Fourier series with signed good kernels

Sony Chan

Abstract

It is natural to try to find a kernel such that its convolution of integrable functions converges faster than that of the Fejér kernel. In this thesis, we introduce weighted Fourier partial sums which are written as the convolution of signed good kernels and prove that $L^1$ convergence of the weighted Fourier partial sums is much faster than that of the Cesàro means. In addition, we present two numerical experiments.

Abstract Hun Kanal:

Title: Probabilistic analysis of a digital search tree in compression algorithms.

Hun Kanal, Lecturer at the department of Mathematics, RUPP.

The digital search tree (ds) plays a central role in compression algorithms, of Lempel–Ziv type. This structure can be viewed as a mixing of a digital structure (the tree) with a binary search tree. The probabilistic analysis is thus involved, even in a sense when the text is produced by a simple source (as memoryless source, or a Markov chain). The analysis for memoryless sources was first performed in the paper of Flajolet and Sedgewick (1996), then Jacquemet, Looschot, Proesler Szymanski, Teng (between 1999 and 2001) deal with general memoryless sources or Markov chains, and perform the analysis of the main parameters of Digital Search Trees (DST) – namely, internal path length, profile, typical depth. This talk performs probabilistic analyses of the depth of a ds, when it is built on words emitted by a general source. We prove that for a large class of sources, the typical depth follows an asymptotic gaussian law, with an optimal speed of convergence. The finding is established by analytic and probabilistic methods (i.e. generating functions, Poisson and Mellin transform, Rice formula and asymptotics methods). The methods involve also dynamical analysis which mixes in an original setting certain free analytic nebuleries and methods (from dynamical system theory (namely transfer operators, and their spectral properties).

Abstract Ngonn Seam:

Functions of bounded variation (BV functions) are a class functions that is somewhat more general than Sobolev functions, in that they may have discontinuities and even "jumps", but are nonetheless differentiable in a very weak sense. Various minimization problems are natural to formulate for the BV class, due to its good compactness properties. In this talk I focus on sets of finite perimeter, which are sets whose characteristic functions are BV functions. In the Euclidean setting, the so-called Federer's characterization states that a set is of finite perimeter if and only if its measure theoretic boundary has finite "surface area". In the more general setting of a metric measure space, the characterization remains an open problem. In the talk I will show how we can obtain a slightly different characterization by replacing the measure theoretic boundary with a new concept, the so-called fine boundary.

Serguey Nazarov, MAI

Singularities caused by kissing balls

Sammanfattning: It will be demonstrated that the gradient of eigenfunctions of the Neumann problem for the Laplace operator at the tangency point of two balls in dimension $d > 2$ get a singularity $r^{-d/2}$. This is even more classical that the square-root singularity of stresses in the theory of cracks. At the same time, in dimension $d = 2$ all eigenfunctions are infinitely differentiable at the tangency point of two discs. Furthermore, for the Dirichlet problem, eigenfunctions are smooth in any dimension. The Steklov problem related to water-waves, will be discussed as well. This work is done in cooperation with Jari Taskinen, University of Helsinki.

Oscar Perdomo, Central Connecticut State University, New Britain, CT, USA

Embedded constant mean curvature hypersurfaces on spheres

Sammanfattning: In this talk we will discuss hypersurfaces of the $n$-dimensional unit sphere with exactly two principal curvatures and constant mean curvature $-cmc$. Besides providing an explicit construction for these hypersurfaces, we will show that for every positive integer $n$ and any $H$ between $-nm/(n+1)$ and $nm/(n+1)$, there exists an embedded hyper surface with cmc $H$ and with group of isometries invariant under the cyclic group $Z_{nm}$. When $H$ is close to $-nm/(n+1)$, the hypersurface looks like a necklace made out of $m$ spheres and $m+1$ catenoid necks attached. When $H$ is close to $nm/(n+1)$, the hypersurface resembles a ring of $m$ spheres slightly deformed and connected by $m+1$ catenoids. Finally, when $H$ is between $-nm/(n+1)$ and $nm/(n+1)$, there exists an embedded surface with cmc $H$. Andrews and Li showed that these surfaces are the only embedded tori in the sphere with cmc $H$. We will finish the talk by doing some comments on Andrews and Li's proof.
ON A NONLINEAR PSEUDO PARABOLIC PROBLEM
NGUYEN SEAM

Abstract. This work deals with the study of a nonlinear pseudo parabolic problem. Find $u \in \mathcal{D}'((0,T)\times(0,1))$ such that
\[ f(u_a) - \Delta u_a = \phi \left( (u_a)' + b(u_a) \right) \forall a \in Q \]
with the initial condition
\[ u(a,0) = u_0 \in H \]
resulting in an implicit time discretization, we would prove the existence of a solution to the problem. We would illustrate numerical solution by finite elements method.

Abstract Lin Sok:
Orthogonal group and Boolean functions
Lin Sok
Department of Math, Royal University of Phnom Penh, 12156 Phnom Penh, Cambodia, sok.lin@rupp.edu.kh
(joint work with Minjia Shi and Patrick Solé)

Abstract
In this talk, we study orthogonal group over finite fields. We show how to construct self-dual codes and linear complementary dual (LCD) codes over large finite fields from the elements in the group and explore the connections with the generalised $Z_p^*$-self-dual bent functions. We prove existence of optimal LCD codes of some certain lengths over large finite fields. We prove non-existence of the generalised $Z_p^*$-regular bent functions in odd variables and classify them in low even variables.

Onsdag 21 juni 2017, Anita Rojas, Universidad de Chile
A Sage package for equisymmetric stratification and applications
Sammanfattning: In this talk we present an algorithm running over the mathematical software Sage, which allows users to compute group actions on Riemann surfaces up to topological equivalence, in terms of generating vectors. Moreover, it allows to compute induced generating vectors when considering subgroups of a given group, hence to classify the corresponding action up to topological equivalence. The main motivation to develop this algorithm is to study the equisymmetric stratification of the moduli space of Riemann surfaces of genus $g$ defined by Broughton in 1990.

Onsdag 23 augusti 2017, Petros Petrosyan, Yerevan State University, Armenien
Number of palettes in edge-colorings of graphs
Sammanfattning: A proper edge-coloring of a graph $G$ is a mapping $\alpha : E(G) \to N$ such that $\alpha(e) \neq \alpha(e')$ for every pair of adjacent edges $e, e' \in E(G)$. If $\alpha$ is a proper edge-coloring of a graph $G$ and $v \in V(G)$, then the palette of a vertex $v$, denoted by $\alpha(v, \alpha_v)$, is the set of all colors appearing on edges incident to $v$. For a proper edge-coloring $\alpha$ of a graph $G$, we define $S(G, \alpha)$ as follows: $S(G, \alpha) = \{ \alpha(v, \alpha_v) : v \in V(G) \}$. For every graph $G$ and its proper edge-coloring $\alpha$, we have $1 \leq |S(G, \alpha)| \leq |V(G)|$. In 1997, Burris and Saks introduced the concept of vertex-distinguishing proper edge-colorings of graphs. A proper edge-coloring $\alpha$ of a graph $G$ is a vertex-distinguishing edge-coloring if for every pair of distinct vertices $u$ and $v \in V(G)$, $S(u, \alpha_u) \neq S(v, \alpha_v)$. This means that if $\alpha$ is a proper edge-coloring of a graph $G$, then $|S(G, \alpha)| = |V(G)|$. On the other hand, recently Horváth, Kalinowski, Meszka and Ważniak initiated the study of the problem of finding proper edge-colorings of graphs with the minimum number of distinct palettes. For a graph $G$, they define the palette index $\pi(G)$ of a graph $G$ as follows: $\pi(G) = \min_{\alpha} |S(G, \alpha)|$, where minimum is taken over all possible proper edge-colorings of $G$. In this talk we will give a survey of the topic and present a recent progress in the study of palette indices of graphs.

Onsdag 30 augusti 2017, Jari Taskinen, Helsingfors Universitet, Finland
Band-gap spectra of some elliptic equations and systems on waveguides
Sammanfattning: We consider the band-gap structure of the essential spectrum of some elliptic spectral problems on periodic 2- and 3-dimensional waveguides. In the recent paper with S. Nazarov [1] we study the linearized piezoelectricity system on waveguides with thin structures, which are created by thin ligaments connecting (infinitely many, translated copies of) bounded cells. We establish the existence of an arbitrary number of gaps, if the connecting ligaments of the cells are thin enough. The problem is non-selfadjoint, thus we apply a self-adjoint reduction scheme; also the mere existence of the band-gap structure for the essential spectrum needs a new proof, which we able to provide. In the work [2] with F. Bakharev we study the linearized elasticity system for waveguides, the geometry of which is similar to the above situation. We perform an asymptotic analysis to obtain quite precise information on the position of the spectral bands. Finally, in the project [3] we study the Laplace-Dirichlet problem in the plane which is perforated by a periodic lattice of discs with radial $r > 0$. Applying Floquet-Bloch-Gelfand-techniques we show that the FBG-eigenvalues depend real analytically on the geometric parameter $r$. This leads to a non-existence result for eigenvalues of infinite multiplicity.


Onsdag 6 september 2017, Ugo Gianazza, University of Pavia, Italien
A self-improving property of degenerate parabolic equations of porous medium-type
Sammanfattning: We show that the gradient of solutions to degenerate parabolic equations of porous medium-type satisfies a reverse Hölder inequality in suitable intrinsic cylinders. We modify the by-now classical Gehring lemma by introducing an intrinsic Calderón-Zygmund covering argument, and we are able to prove local higher integrability of the gradient of a proper power of the solution $u$. This is a joint work with Sebastian Schwarzacher of Charles University.

Onsdag 13 september 2017, Nikolay Kuznetsov, Russian Academy of Sciences, St. Petersburg, Ryssland
The Legacy of Vladimir Andreevich Steklov in Mathematical Physics: Work and School
Sammanfattning: Steklov's major contributions to mathematical physics will be described along with those of his students (Friedmann, Tamarkin, Smirnov, Shohat) and of students of his students. In particular, the problem of finding the essential spectrum of some elliptic operators in periodic waveguides will be described, and the results will be compared to the general theory of Steklov's students and of students of his students.

Onsdag 4 oktober 2017, Samuel Bengmark, Chalmers och Göteborgs universitet
Success-factors in Transition to University Mathematics
Sammanfattning: We search for the relative importance of different factors influencing students' performance in first year university mathematics. Characteristics of students at three universities in Sweden (n=1007) were measured twice; when entering the university and at the end of the first year. Four important constructs were found which we label Self-efficacy, Motivation type, Study habits and Views of mathematics. Together the predictive power of these four constructs, on the students' success in university mathematics, was in the same range as the grades from upper secondary school. Individually each of the constructs had little predictive power but some aspects seemed more important for students with low grades from secondary school.

Onsdag 11 oktober 2017, Mikael Hansson, MAI
A word property for twisted involutions in Coxeter groups
Sammanfattning: Coxeter groups are important objects in, e.g., combinatorics and geometry. The word property for Coxeter groups solves the problem of deciding whether two reduced words in the generators represent the same group element. In the last few years, several people have proved word properties for twisted involutions in various Coxeter groups. I will review these results, and then present a word property which holds in the general case. If there is time, I will outline the proof. This is joint work with Axel Hultman.

Onsdag 18 oktober 2017, Sergey Vakulenko, St. Petersburg, Ryssland
Biodiversity, extinction and limit evolution structures in foodwebs
Sammanfattning: This talk is devoted to the problem of large food web stability and extinctions, mass extinctions under climate changes in such webs. The foodweb model describes ecosystems, where a number of species share a few of resources. The model extends previous ones and takes into account extinctions and self-limitation effects. Under some conditions, we prove a theorem about global convergence of solutions for two cases: for models without extinctions and with ones. The main difference between those cases is that,
when extinctions are taken into account, evolution is fundamentally non-predictable. We estimate a limit level of biodiversity and obtain an explicit estimate involving system parameter, that estimate is valid for any kinds of ecosystem dynamics. The is joint work with V. Kozlov and U. Wennergren.

Onsdag 15 november 2017, Jan-Åke Larsson, ISY

Efficient simulation of some quantum computer algorithms

Sammanfattning: A long-standing aim of quantum information research is to understand what gives quantum computers their advantage. Such an understanding would be of great benefit when attempting to build a quantum computer. Here we present a framework that uses classical resources but still is able to efficiently run, for example Deutsch-Josza and Simon's algorithms, and also can run Shor's factoring algorithm with some systematic errors. We also perform an experiment factoring 15 using classical pass-transistor logic at room temperature, with smaller systematic errors than any former experimental implementation, and the same amount of resources in time and space as a scalable quantum computer. Our results give further insight into the resources needed for quantum computation, aiming for a true understanding of the subject.

Onsdag 22 november 2017, Filippo Remonato, Norges teknisk-naturvitenskapelige universitet, Trondheim

Water waves solutions of the Euler equations with affine vorticity

Sammanfattning: I will present several solutions of the Euler equations with affine vorticity. We start by reviewing the bifurcation theory for the water wave problem, following in the footsteps of Ehrnström-Escher-Wahlén, and then turn our attention to the numerical approach, where the combination of standard Finite Elements and B-splines basis functions, recently known as Isogeometric Analysis, is used to solve the Euler equations in their full free-boundary setting, without any reduction to a fixed domain. Periodic travelling waves solutions are found bifurcating from the line of trivial solutions in accordance with the theory, and we will look at several branches for both small and large amplitude waves with particular attention to the internal critical layers structure. These preliminary results are part of a joint work with the University of Pavia, Italy.

Onsdag 29 november 2017, Maarit Järvenpää, Oulu University, Finland, och Institut Mittag-Leffler

Introduction to random covering sets

Sammanfattning: Limsup sets, defined as upper limits of various sequences of sets, play an important role in different areas of mathematics. Random covering sets are a class of limsup sets defined by means of a family of randomly distributed subsets of the d-dimensional torus. We discuss various problems related to random covering sets with special emphasis to their dimensional properties.

Onsdag 6 december 2017, Esa Järvenpää, Oulu University, Finland, och Institut Mittag-Leffler

Abelian groups admitting a minimally almost periodic or a connected Hausdorff group topology

Sammanfattning: In 1934 von Neumann introduced a notion of a minimal almost periodic topological group. A topological group is minimally almost periodic if every non-trivial homomorphism from it into any compact group is discontinuous. These groups are notoriously difficult to construct, yet many classical groups (such as the permutation group of the integers or the group of isomorphisms of the universal separable metric space endowed with the pointwise convergence topology) are minimally almost periodic. In this talk, we overview the complete solutions of both the problem of the existence of minimally almost periodic group topologies and the problem of the existence of connected group topologies on abelian groups, as well as the relation of these two long-standing problems to the Markov-Zariski topology of the group in question.
The Mathematical Colloquia held in 2016 at Linköping University

Organized by Anders Björn, Milagros Izquierdo Barrios, Vladimir Kozlov, and Hans Lundmark.

1. Onsdagen 20 januari 2016, Eero Saksman, Helsingfors universitet, Finland
   On the Gaussian multiplicative chaos
   Sammanfattning: We try to explain what Gaussian multiplicative chaos is, and recall its basic properties. In addition, we revisit the uniqueness problem in the case of critical chaos, and if time permits, some of the (partly heuristic) connections to e.g. Liouville quantum gravity or the Riemann zeta function will be discussed.

2. Onsdagen 27 januari 2016, Vitalij Tjatyrko, MAI
   A compact space with non-coinciding dimensions dim and ind
   Sammanfattning: In the talk I will describe a relatively old and simple example of a compact chainable separable 1st countable space having ind = 2 at each point. All announced properties will be motivated.

   On the Zaremba-Hopf-Oleinik lemma
   Sammanfattning: We discuss the Hopf–Oleinik lemma for solutions to elliptic and parabolic equations. For the Laplace operator this property is well known for more than one hundred years, starting from a pioneer paper of Zaremba (1910), and reads as follows. Let $\Omega \subset \mathbb{R}^n$ and let $\lambda \in \Delta$. Then, if $\theta \in \partial \Omega$, we have
   \[ \frac{\partial u}{\partial \theta} < 0. \]
   For general operators of non-divergence type with bounded measurable coefficients this result was established in the elliptic case independently by E. Hopf and O.A. Oleinik (1952) and in the parabolic case by L. Nirenberg (1953). Lately, many mathematicians were aimed at the extension of the class of admissible operators and at the reduction of the boundary smoothness. We consider generalized (strong) solutions for non-divergence type equations
   \[ Lu = -\lambda u + h(x)D_j u = f(x), \quad (ND) \]
   \[ Mu = \lambda u - \mu(x)D_j u + h(x)D_j u = f(x), \quad (ND2) \]
   i.e. we assume $D(Du) \in L^p(\mathbb{R}^n)$ in (NDE) and $\partial \Omega$, $D(Du) \in L^{p+1}(\mathbb{R}^n)$ in (NDP) (in the parabolic case also some anisotropic spaces are admissible). We suppose that the operators under consideration are uniformly elliptic (parabolic). The problem of our interest is how "bad" the lower-order coefficients $\lambda$, $\mu$ may be to ensure the Hopf-Oleinik lemma to hold true. We provide new sharp counterexamples for this lemma.

4. Onsdag 10 februari 2016, Natan Kruglyak, MAI
   Real interpolation: theory and applications
   Sammanfattning: I plan to give a review of the theory of real interpolation with focus on the results in which I was involved.

5. Onsdagen 17 februari 2016, Søren Eilers, University of Copenhagen, Danmark, & Institut Mittag-Leffler
   The complete classification of Cuntz-Krieger algebras
   Sammanfattning: In 1980, Joachim Cuntz and Wolfgang Krieger showed how to associate a functional analytic object, more precisely a $C^*$-algebra, to any finite graph with no stranded vertices in a way reflecting the dynamics of the shift space associated to such a graph, and from the early days of the classification theory of $C^*$-algebras this class was under scrutiny to establish classification results by $K$-theory. Indeed, Michael Rørdam in 1995 completed the classification of those Cuntz-Krieger algebras that are simple, by employing in a groundbreaking way that the $K_0$-group of such a $C^*$-algebra is precisely the Bowen-Franks group well-known in the classification of shift spaces. I will report on how recent understanding of the larger class of graph $C^*$-algebras has recently allowed for a complete solution of the classification problem for Cuntz-Krieger algebras in a way which is not at all reflected in the dynamics. The part of the work which I have contributed is joint with Restorff, Ruiz and Sørensen.

6. Onsdag 24 februari 2016, Réamonn Ó Buachalla, Polish Academy, Warszawa, Polen
   A $C^*$-algebraic introduction to noncommutative geometry
   Sammanfattning: I begin by recalling the definition of a $C^*$-algebra, along with Gelfand and Naimark’s characterisation of commutative $C^*$-algebras as function algebras on compact Hausdorff spaces. I then explain why this motivates us to think of noncommutative $C^*$-algebras as “noncommutative topological spaces”. Building on this, I introduce Woronowicz’s notion of a compact quantum group and show that it reduces to the definition of a compact topological group in the commutative case. I will also discuss quantum-SU(2), the theory’s prototypical example. Finally, I present Connes’ notion of a spectral triple, together with his commutative classification theorem. This is the result that motivates us to think of spectral triples as noncommutative Riemannian manifolds. For an example we take the Podles sphere, a quantum homogeneous space of quantum-SU(2), and present it’s standard spectral triple which is a direct $q$-deformation of the standard Dirac operator on the $S^2$-sphere.

7. Onsdag 2 mars 2016, Jens Hoppe, KTH
   Minimal hypersurfaces
   Sammanfattning: I will discuss explicit solution techniques to obtain them, and closely related questions.

8. Fredag 4 mars 2016, Luciano Mari, Universidad Federal do Ceará, Brasilien
   A -algebraic introduction to noncommutative geometry
   Sammanfattning: The study of Riemann surfaces began in the last half of the nineteenth century and continues as a very active research area today and in the foreseeable future. During its history, the study of Riemann surfaces has used all the tools of the topic areas of the title. In this talk we will explore how Riemann surfaces interact with these topic areas. Special attention will be paid to hyperelliptic surfaces and their generalizations, super-elliptic surfaces.

9. Fredag 11 mars 2016, Juha Lehrbäck, Jyväskylä, Finland
   Whitney covers, Minkowski dimensions, and the size of the $\tau$-boundaries
   Sammanfattning: Whitney covers, Minkowski dimensions, and the size of the $\tau$-boundaries can be always covered with balls in such a way that the balls have uniformly bounded overlap and the radius of each ball is comparable from the distance of the ball to $\mathbb{E}$. These are called Whitney covers due to obvious connections with the classical Whitney cubes. In this talk, I will explain how the amount of Whitney balls (or cubes) of certain size is related to the Minkowski dimensions of $\mathbb{E}$, and how this connection can be used in the $d$-dimensional Euclidean space to obtain estimates for the $(n-1)$-dimensional Hausdorff measure (“surface measure”) of the $\tau$-boundary of $\mathbb{E}$, i.e. the set of points having distance $\tau$ to $\mathbb{E}$. In particular, I will show how the Minkowski dimensions and also the so-called spherical dimensions of $\mathbb{E}$ can be characterized using the amount of Whitney balls (under some mild conditions on $\tau$). This talk is based on my joint work with Antti Käenmäki and Matti Vuorinen (Indiana Univ. Math. J. 62 (2013), No. 6, 1861-1889).

10. Onsdag 30 mars 2016, Yuri Karlovich, Universidad Autónoma del Estado de Morelos, Mexiko
    One-sided invertibility of functional operators
    Sammanfattning: Let $R = [0, +\infty)$ and let $\phi$ be an orientation-preserving homeomorphism of $R$, onto itself with $\log \phi \in L^p(R)$ and only two fixed points $0$ and $\infty$. Given $p \in (1, \infty)$, we study Wiener’s type functional operators of the form
\[ A = \sum_{k \leq \alpha} a_k u_k^2 : U'(\mathbb{R}) \to U'(\mathbb{R}), \quad (1) \]

where the coefficients \( a_k \) are in \( L^\infty(\mathbb{R}) \), the isometric shift (composition) operator \( U_\alpha \) is given by \( U_\alpha f = (x^\alpha f(x)) \), and \( ||A||_{\infty} = \sum_{k} ||a_k||_{L^\infty(\mathbb{R})} < \infty \). Under assumption that \( x^\alpha \) and all \( a_k \) are continuous on \( \mathbb{R} \), and slowly oscillating at \( 0 \) and \( \infty \), criteria for the one-sided invertibility of the operator \( A \) on the spaces \( U'(\mathbb{R}) \) are established. First, the one-sided invertibility of the binomial functional operators \( f_1 = f_0 + f_1u^2 \) is studied on the basis of some algebraic methods, passing to discrete operators on the spaces \( P \) and applying the limit operators techniques. The study and results essentially depend on the oscillation of the shift derivative and coefficients. We then study the one-sided invertibility of operators of the form (1). The invertibility of functional operators associated with subexponential and amenable groups that act topologically freely and the one-sided invertibility of functional operators on rearrangement-invariant spaces are also discussed.

1. **Onsdag 6 april 2016, Antonio F. Costa, UNED, Madrid**
   Riemann surfaces of genus \( g \) and 4g automorphisms
   Sammanfattning: In 1895 Hurwitz showed that a hyperbolic Riemann surface of genus \( g \) has at most \( 84(g-1) \) automorphisms. The surfaces with \( 84(g-1) \) automorphisms are called Hurwitz surfaces. It is still an open problem for which genera there are Hurwitz surfaces. There's a difficult problem to identify the surfaces admitting a determined number of automorphisms. However there are very early results: In 1895 Wiman produced Riemann surfaces having an automorphism of order \( 4g+2 \) and surfaces having an automorphism of order \( 4g \). In 1968 Accola and Maclachlan (independently) gave for each genus surfaces with \( 8(g+1) \) automorphisms. In 1996 Kulkarni showed that the Accola-Maclachlan surface is the only surface with \( 8(g+1) \) automorphisms. And Wiman surfaces are, with a few exceptions, the only surfaces with an automorphism of order \( 4g+2 \) and \( 4g \) respectively. He also showed that in the second case the surface has \( 8g \) automorphisms. Riemann surfaces admitting more than \( 4g \) automorphisms are isolated in the corresponding moduli space. In this talk we talked on Riemann surfaces with 4g automorphisms.

2. **Onsdag 13 april 2016, Thomas Kragh, Uppsala universitet**
   Symplectic topology and stable homotopy
   Sammanfattning: In this talk I will outline some basic concepts in symplectic geometry, and describe how Gromov-Witten invariants of symplectic manifolds are defined by counting solutions to certain non-linear elliptic PDEs. These invariants can be used to define Quantum homology of the symplectic manifold, and I will try and describe how one might go about encoding this structure into a refined object in stable homotopy theory (i.e. a spectrum).

3. **Onsdag 20 april 2016, Mattias Jonsson, University of Michigan, Ann Arbor, USA, och Göteborg**
   Degenerations of ameoba and tropical varieties
   Sammanfattning: A collection of polynomials with complex coefficients defines a submanifold of complex Euclidean space, which in turn casts a "shadow" on Real euclidean space, under the map that takes each complex coordinate to the logarithm of the absolute value. This shadow is called the amoeba of the submanifold and shows up in various branches of mathematics. I will explain that a suitable rescaling limit of the amoeba coincides with a combinatorial object, the tropical variety associated to the submanifold. The proof involves non-Archimedean geometry, but no knowledge of this will be assumed.

4. **Onsdag 27 april 2016, Mieczysław Mastyło, University of Poznań, Polen**
   On the multilinear and polynomial inequalities
   Sammanfattning: We will present several new multilinear and polynomial inequalities. The first part of the talk is based on a joint work with Andreas Defant. We show an exact inequality between the \( L^p \)-norm of a polynomial \( P \) on the \( n \)-dimensional torus \( T^n \) and its Mahler measure \( M(P) \). Using extrapolation we transfer this estimate into a Khinchin-Kahane type inequality, which relates a certain universal ordinal norm and Mahler’s measure. In the second part we will discuss new variants of Kahane-Salem-Zygmund inequalities for the expectation of the supremum norm of homogeneous Bernoulli polynomials on the unit ball of a Banach space. We combine ideas from stochastic processes and interpolation theory to control increments of a Rademacher process in an Orlicz space via entropy integrals.

5. **Onsdag 4 maj 2016, Sergey Nazarov, MAI och St Petersburg State University, Ryssland**
   Wandering eigenvalues of the Laplacian with an improper Robin conditions
   Sammanfattning: The spectrum of the boundary value problem

6. **Onsdag 18 maj 2016, Johan Thim, MAI**
   Radlarm type asymptotics for elliptic operators
   Sammanfattning: We consider how the eigenvalues of the Neumann and Dirichlet problems for an elliptic operator (mainly the Laplacian) depend on the domain. The two problems require different notions of closeness between the reference domain and the perturbed domain and abstract frameworks in Hilbert space are presented. The main result is an asymptotic formula where the remainder is expressed in terms of the proximity quantities described above when these are relatively small. We also consider applications to the Laplacian in \( C^1 \), \( C^2 \) and Lipschitz domains. For the \( C^1 \) case, an asymptotic result for the eigenvalues is given together with estimates for the remainder. In the Neumann case, we also consider an example where \( \alpha = 0 \).

7. **Onsdag 25 maj 2016, Lukáš Malý, University of Cincinnati, USA**
   Trace and extension theorems for BV and Sobolev functions in metric spaces
   Sammanfattning: In the general Dirichlet problem, one starts with a domain, prescribes boundary values, and looks at the set of functions on the interior of the domain whose trace on the boundary matches the prescribed boundary values. For domains in metric measure spaces, we investigate the class of functions defined on the boundary that can be extended to functions of some specified regularity on the interior. Under some rather mild requirements on regularity of the boundary, we find a linear extension operator from a Besov class on the boundary to the BV class (or the Newton-Sobolev class \( N^{1,p} \)) on the interior of the domain. This operator can then be used to find BV extensions of \( L^p \) boundary data. Hence, the trace class of \( BV(\Omega) \) on \( L^p(\partial\Omega) \) provides that the ambient metric space admits a 1-Poincaré inequality. We will also look into analogous questions for domains with a thick or a thin boundary (i.e., with a boundary of Hausdorff co-dimension other than 1). This is joint work with N. Shanmugalingam and M. Snipes.

8. **Onsdag 1 juni 2016, Nikolai Nadirashvili, Aix-Marseille Université, Frankrike**
   Hessian equations and minimal cones
   Sammanfattning: We give a brief introduction to viscosity solutions of fully nonlinear elliptic equations, discuss questions of regularity of viscosity solutions. We also discuss applications of noncommutative and nonassociative algebras to classification of homogeneous solutions of fully nonlinear equations and its connections with minimal cones.

9. **Torsdag 9 juni 2016, Roy Skjelnes, KTH**
   Hilbert schemes
   Sammanfattning: In algebraic geometry the Hilbert schemes are fundamental objects. These objects are characterized by parametrizing subschemes in projective space. Moduli problems are often solved by relating them to the existence of the Hilbert schemes. Hilbert schemes that possess specific properties are of particular interest. The fact that the Hilbert...
scheme of points in the plane is itself smooth, but involves a vast of research activity, and surprising discoveries. In the talk I want to describe some of the interesting advances about Hilbert schemes, but I will also focus on their definition and their basic properties. Instead of presenting results in their most general form I will try to give simplified versions and avoid using the abstract machinery that alleles non-experts from algebraic geometry.

Onsdag 17 augusti 2016, Petrox Petroyan, Yerevan State University, Armenien

Cyclical interval edge-colorings of graphs

Sammanfattning: An edge-coloring of a graph \( G \) with colors \( 1, \ldots, \ell \) is called a cyclical interval coloring if the edge incident to each vertex of \( G \) are colored by consecutive colors, under the condition that color 1 is considered as consecutive to color \( \ell \). The concept of cyclical interval edge-coloring of graphs was introduced by de Werra and Solot in 1991 and was motivated by questions arising in flexible manufacturing systems, in particular the so-called cylindrical open shop scheduling problem. In this talk we will give a survey of the topic and present a recent progress in the study of cyclical interval edge-colorings of graphs. In particular, we will present new results on some open problems concerning cyclical interval edge-colorings of graphs. This is joint work with A.S. Arazian and C.J. Casselgren.

Tisdag 23 augusti 2016, Yasunao Hattori, Shimane University, Japan

A survey on topologies on the posets of formal balls in metric spaces - An bridge between the theory of computation and topology

Sammanfattning: The set of formal balls in a metric space was introduced by Weihrauch and Schreiber in \( \cite{2} \) to represent a metric space in a domain, and several authors studies it as a computational model for a metric space. Let \( R \) and \( \mathbb{R} \) denote the set of real numbers and non-negative real numbers, respectively. Let \( (X, d) \) be a metric space and \( B^+(X, d) = X \times R_+ \). An element of \( B^+(X, d) \) is called a (lift formal ball). In \( \cite{1} \), Tsuchi and Hattori extended the notion of formal balls to balls having negative radii, say generalized formal balls, i.e., let \( B(X, d) = X \times R \) and we call an element of \( B(X, d) \) a formalized general ball. We induce a partial order in \( B^+(X, d) (B(X, d)) \) as \( \langle x, r \rangle \leq \langle y, s \rangle \) if \( d(x, y) \leq r - s \). Then \( B^+(X, d) \) and \( B(X, d) \) are continuous posets, and they have the Scott, bi-Scott, Lawson and the Martin topologies from domain theoretical point of view. I shall discuss the topologies above in the posets of formal balls. In this talk, firstly, we introduce fundamental notions from domain theory, say, below openness, domain, continuous domain, Scott topology, bi-Scott topology, Lawson topology, and Martin topology etc. Then we shall discuss on the relations between the topological structures and the order-theoretic structures on the posets of formal balls in metric spaces from the topological point of view. References: \([1]\) H. Tsuchi and Y. Hattori, Lawson topology of the space of formal balls and the hyperbolic topology of a metric space, Theoret. Computer Sci., 405 (2008), 199-205. \([2]\) K. Weihrauch and U. Schreiber, Embedding metric spaces into cpo’s, Theoret. Computer Sci. 16 (1981), 5-24.

Onsdag 24 augusti 2016, Anita Rojas, Universidad de Chile

Completely decomposable abelian varieties, the case of Jacobians

Sammanfattning: The action of a finite group \( G \) on an abelian variety \( A \) induces a decomposition of \( A \) into \( G \)-invariant factors, called the isotypical decomposition of \( A \). It comes from the decomposition of the group algebra \( \mathbb{Q}[G] \) of \( G \) over the rationals, into simple algebras. Hence each factor corresponds to a rational irreducible representation of \( G \). A completely decomposable Abelian variety is an abelian variety which is isogenous to a product of elliptic curves. In 1993, Ekedahl and Serre asked several questions about completely decomposable Jacobian varieties, some of them are still open. In particular they asked if there are completely decomposable Jacobian varieties in any dimension \( g \geq 2 \). In the same work, the authors presented a list of dimensions in which there are completely decomposable Jacobian varieties. Nevertheless, besides stopping in dimension 199 they opened the question whether there are higher dimensional completely decomposable Jacobian varieties, their list has some gaps. These questions have motivated several articles approaching their answers through different methods. We use group actions as the main tool. In this talk we will discuss fundamental results, some recent advances, as well as some work in progress, regarding these questions.

Tisdag 30 augusti 2016, Justyna Sigerska-Rynkowska, Gdańsk University of Technology, Polen

Complex oscillations in a nonlinear neuron model with resets

Sammanfattning: We investigate complex oscillations in a class of bidimensional nonlinear hybrid dynamical systems modeling neuronal voltage dynamics with adaptation and spikes. We show that these models can generally display mixed-mode oscillations (MMOs), i.e. trajectories featuring an alternation of small oscillations with spikes or bursts (multiple consecutive spikes). The mechanism by which this behaviour is generated naturally relies on the hybrid structure of the flow: small oscillations are governed by invariant manifolds of the underlying continuous dynamical system consisting of two non-linear ODEs, while discrete resets control the emission of spikes or bursts. The decomposition into these two mechanisms reveals their geometrical origin, allowing a relatively simple classification of points at the reset line associated to specific inter-spike trajectories. Periodic and MMO patterns are thus related to the sequence of consecutive locations of the resets, that we analyze by considering these as points on the orbits of the so-called adaptation map. We demonstrate that this map can be seen as a lift of a discontinuous degree-one circle map with diverging left- and right- derivatives at the discontinuity points. Notwithstanding, in certain cases such a map falls into the framework of either the non-overlapping lifts or the so-called old heavy maps’, which can be studied in detail through the means of rotation theory, with the univocal bidirectional link between the rotation number of the trajectory and the signature of the generated MMOs. In contrast to more classical frameworks in which MMOs were evidenced, the present geometric mechanism neither requires more than two dimensions nor necessitates a separation of timescales and complex return mechanism. The talk is based on a joint work with J. Rubin (University of Pittsburgh), J. Touboul (College de France & INRIA) and A. Vidal (Université d’Evry-Val-d’Essonne & INRIA).

Onsdag 31 augusti 2016, Tomas Sjödin, MAI

Stationary boundary points for a Laplacian growth problem in higher dimensions

Sammanfattning: This talk will concern the behaviour of corners for certain Laplacian growth processes driven by source terms in higher dimensions. In two dimensions this process corresponds to Hele-Shaw flow, and it is known that corners of interior angle less than \( \pi / 2 \) in the boundary of a plane domain are initially stationary for such growth processes. The aim here is to present analogous results in higher dimensions.

Onsdag 7 september 2016, Mikko Parviainen, Jyväskylä, Finland

Nonlinear stochastic games and normalized p-Laplacian

Sammanfattning: In this colloquium, we discuss a class of stochastic games. A particular example of such a stochastic game is the tug-of-war with noise. Passing to the limit with the step size, this game gives rise to the normalized or game theoretic \( p \)-laplace equation and \( p \)-parabolic equation. After the introduction, we consider regularity for value functions for these stochastic games. We also discuss these equations from the PDE point of view.

Fredag 9 september 2016, Maria Przybylska, Zielona Góra, Polen

Applications of Darboux polynomials to integrability studies

Sammanfattning: In the theory of ordinary differential equations first integrals play a crucial role. Constant values of these functions are invariant with respect to the flow generated by the considered system. However there exist also functions such that only their zero level is invariant. Polynomial functions with this property for polynomial vector fields are called Darboux polynomials. Darboux for construction of first integrals of planar polynomial differential systems in \( \mathbb{R}^2 \) and \( \mathbb{C}^2 \) and later generalised and analysed by many authors. In the talk, properties of Darboux polynomials and their applications to integrability studies will be presented. Detailed construction of first integrals using Darboux polynomials for non-linear 3-dimensional stretch-twist-fold (STF) flow depending on nine parameters will be shown. In addition to presentation of some integrable cases also the non-integrability proof for a four-parameter family of STF flows by means of differential Galois approach will be given. Also the application of Darboux polynomials for proving non-integrability in the class of polynomial first integrals for the Helmholtz system will be explained.

Onsdag 14 september 2016, Klav Markström, Umeå universitet

Voting and Condorcet voters

Sammanfattning: From the earliest days of the mathematical study of voting and democracy it has been known that there are “paradoxical” situations in which all candidates of an election lose a majority vote. In this talk I will give an introduction to some of the theory of voting and the study of so called Condorcet domain. The latter are collections of preferences which avoid voting paradoxes in a specific sense. Condorcet domains have connections to combinatorics, order theory, group theory and geometry and I will introduce some of these, including some of my own recent work in this area.

Onsdag 21 september 2016, Nikolay Kuznetsov, Russian Academy of Sciences, St Petersburg, Ryssland

Direct and inverse spectral problems for sloshing of a two-layer fluid

Sammanfattning: Direct and inverse eigenvalue problems for a pair of harmonic functions with a spectral parameter in boundary and coupling conditions will be considered. The direct problem is relevant to sloshing frequencies of free oscillations of a two-layer fluid in an open container. The upper fluid occupies a layer bounded above by a free surface and below by a layer of fluid of greater density. Both fluids are assumed to be inviscid, incompressible and heavy, whereas the free surface and the interface between fluids are supposed to be bounded. The inverse problem deals with recovering of the densities ratio and the interface’s depth.

Onsdag 28 september 2016, Michel Chipot, Universität Zürich, Schweiz

Asymptotic Issues in Cylinders

Sammanfattning: We demonstrate that this map can be seen as a lift of a discontinuous degree-one circle map with diverging left- and right- derivatives at the discontinuity points. Notwithstanding, in certain cases such a map falls into the framework of either the non-overlapping lifts or the so-called old heavy maps’, which can be studied in detail through the means of rotation theory, with the univocal bidirectional link between the rotation number of the trajectory and the signature of the generated MMOs. In contrast to more classical frameworks in which MMOs were evidenced, the present geometric mechanism neither requires more than two dimensions nor necessitates a separation of timescales and complex return mechanism. The talk is based on a joint work with J. Rubin (University of Pittsburgh), J. Touboul (College de France & INRIA) and A. Vidal (Université d’Evry-Val-d’Essonne & INRIA).

References: 
is solution of the corresponding homogeneous problem. Our goal is to explain the selection process of the solution for different problems of this type when \( \ell \to \infty \).

**Onsdag 5 oktober 2016, Jürgen Rossmann, Universität Rostock, Tyskland**

On the instationary Stokes system in an angle

Sammanfattning: The talk deals with the first initial-boundary value problem for the Stokes System

\[
\nu - \Delta \nu + \nabla p = f, \quad -\nabla \cdot \nu = g
\]

in a (2-dimensional) angle \( \Omega \). The goal is to obtain existence and uniqueness results for solutions in weighted Sobolev spaces. To this end, the parameter-dependent problem

\[
(s - \Delta)U + \nabla P = F, \quad -\nabla \cdot U = G \text{ in } K, \quad U = 0 \text{ on } \partial K
\]

for the Laplace transforms \( \mathcal{L}[U, x] = \mathcal{L} \) and \( \mathcal{L}[P, x] = \mathcal{P} \) is studied, where \( y \) is an arbitrary complex number with nonnegative real part. Solvability and regularity results are presented both for weak and strong solutions of the parameter-dependent problem.

**Måndag 5 december 2016, Zelnab Badreddine, University of Nice, Frankrike**

Mass transportation on sub-Riemannian manifolds of rank two in dimension four

Sammanfattning: This talk is concerned with the study of the Monge optimal transport problem in sub-Riemannian manifolds where the cost is given by the square of the sub-Riemannian distance. Our aim is to extend previous results on existence and uniqueness of optimal transport maps to cases of sub-Riemannian structures which admit many singular minimizing geodesics. We treat here the case of sub-Riemannian structures of rank two in dimension four.

Sammanfattning: Let \( X \) be a set, \( \tau_1, \tau_2 \) topologies on \( X \) and \( \mathcal{D}_1(X, \tau_1) \) the family of all subsets of \( X \) possessing the Baire property in \( (X, \tau_1) \), \( i = 1, 2 \). We study conditions on \( \tau_1 \) and \( \tau_2 \) that imply a relationship (for example, inclusion or equality) between the families \( \mathcal{D}_1(X, \tau_1) \) and \( \mathcal{D}_2(X, \tau_2) \). We are mostly interested in the case where the topology \( \tau_2 \) is formed with the help of a local function defined by the topology \( \tau_1 \) and an ideal of sets on \( X \).

**Fredagen 14 oktober 2016, Alexandre Karassev, Nipissing University, Kanada**

Infinite-dimensional and continuous spaces

Sammanfattning: This talk is an overview of several results relating dimension theory and the theory of continuous selections. The focus will be on those results pertaining to infinite-dimensional spaces. In particular, several important theorems involving \( C \)-spaces, weakly infinite-dimensional spaces, and Ernest Michael's \( G_\delta \)-problem, will be discussed.
Monodromy of Milnor fibers of hyperplane arrangements

Sammanfattning: First I will recall some geometrical and combinatorial objects associated to a hyperplane arrangement such as complement, Milnor fiber, Orlik-Solomon algebra and Aomoto complex. Then I will talk about local system cohomology of complements, cohomology of Milnor fibers and monodromy. Finally, I will introduce a graph which is determined by the arrangement’s combinatorics and whose connectivity implies the vanishing of the monodromy eigenspaces for certain eigenvalues. We will end up by some open questions and directions of research in the vein of the latter graph.

Fredag 16 december 2016, Leslie Jiménez, MAI

Non-topologically equivalent actions of dihedral groups on Riemann surfaces and their Jacobians

Sammanfattning: Given a compact Riemann surface $X$, we define the group of automorphisms $Aut(X)$ of $X$ as the analytical automorphism group of $X$. We say that a finite group $G$ acts on $X$ if there is a monomorphism $G \rightarrow Aut(X)$. Any curve $X$ of genus $g$ has associated a principally polarized abelian variety $JX := H^{1,0}(X, \mathbb{C})^*/H_1(X, \mathbb{Z})$, where $H^{1,0}(X, \mathbb{C})^*$ is the dual of the complex vector space of holomorphic forms of $X$, and $H_1(X, \mathbb{Z})$ is the first homology group of $X$. This variety is called the Jacobian variety of $X$ and has complex dimension $g$. In this talk, we will classify actions of certain dihedral groups on a Riemann surface $X$ using topological equivalence. We use this classification to study the group algebra decomposition of $JX$. 

Fredag 16 december 2016, Leslie Jiménez, MAI
The Mathematical Colloquia held in 2015 at Linköping University

Organized by Anders Björn, Milagros Izquierdo Barrios, Vladimir Kozlov, and Hans Lundmark.

Onsdag 14 januari 2015, Mitsuru Wilson, Western University, London, Ontario, Kanada
Noncommutative geometry and curvature
Sammanfattning: In the celebrated 1943 paper, Gelfand and Naimark proved the contravariant equivalence between the category of compact Hausdorff spaces $\mathcal{X}$ and the category of commutative $\mathcal{C}^*$-algebras $\mathcal{A}$. In the construction, $\mathcal{A}$ is nothing but the algebra $\mathcal{C}^*(\mathcal{X})$ of continuous functions on $\mathcal{X}$. This correspondence can be used to lift the notion of spaces by replacing the spaces by not necessarily commutative $\mathcal{C}^*$-algebras, which generalizes the algebra $\mathcal{C}^*(\mathcal{X})$ of continuous functions. Alain Connes introduced a more potent idea in order to implement geometry into noncommutative spaces. It is a very fruitful and beautiful subject where many fields of mathematics merge together in sophistication. In my talk, I will introduce the basic ideas of Noncommutative Geometry and discuss key examples briefly to present our joint work with Joakim Arnlind on the computation of curvatures for noncommutative spaces.

Onsdag 21 januari 2015, Kristian Björklund, KTH
Strange attractors arising from linear difference equations
Sammanfattning: The intriguing computer generated pictures of so-called strange attractors, for example the Lorenz attractor, have popularized the field of dynamical systems. Linear difference equations do not seem to have much in common with such pictures. We all know how to solve linear difference equations with constant coefficients. However, if we move away from the constant case, things easily turn very difficult. One important case is when the coefficients of the equation are so-called quasi-periodic, that is, they are not periodic, but in some sense “close” to being periodic. In this talk we will focus on the most studied class of such an equation: the discrete Schrödinger equation with a quasi-periodic potential. Recent results, as well as open problems, will be presented. In particular we will see that a special type of strange attractor actually dwells deep inside this equation.

Onsdag 28 januari 2015, George Baravdish, ITM, LjU, Norrköping
Inversa problem för blodförrättsning

Måndag 2 februari 2015, Petros Petrosyan, Yerevan State University, Armenien
Interval edge-colorings of graphs
Sammanfattning: An edge-coloring of a graph $G$ with colors 1, ..., $k$ is called an interval $k$-coloring if all colors are used and the colors of edges incident to each vertex of $G$ are distinct and form an interval of integers. The concept of interval edge-coloring of graphs was introduced by Asratian and Kamalian in 1987 and was motivated by the problems in scheduling theory. For example, it is known that the problem of finding an interval edge-coloring of bipartite graph corresponds to the problem of constructing a timetable without a "gap", in which every class and (or) every teacher conducts lessons in a continuous period of time. In this talk we give a survey of the topic and present a recent progress in the study of interval edge-colorings of graphs. In particular, we present new bounds for the number of colors in interval edge-colorings of some classes of graphs.

Onsdag 4 februari 2015, Agnieszka Kalamajka, University of Warsaw, Poland
On one variant of an interpolation inequality and its applications to nonlinear eigenvalue problems
Sammanfattning: We are interested in a certain type of interpolation inequality, estimating the term $\int \int |f(x)|^2 |\bar{f}(x)| dx$ by a quantity which involves the function $f$, its gradient $\Delta f$ and second order of the right hand side of the equation. The function $k$ is supposed to be continuous. Such inequalities imply the classical Gagliardo-Nirenberg interpolation inequalities. In the case $k = 1$, while in the case of general $k$ they seem to be unknown. The problem when the function $f$ depends on one variable is essentially simpler than the one in $n$ dimensions. To construct such inequalities we apply Hardy inequalities with best constants, as well as knowledge about constants in inequalities which involve the vectorial Riesz transforms. Applications to PDEs will also be discussed. The lecture will be based on a series of recent joint works with Tomasz Choczewski, Jan Peszek and Katarzyna Miazgicka.

Onsdag 11 februari 2015, Egmont Porten, Mittuniversitetet
Polynomial hulls on analytic varieties
Sammanfattning: Polynomial hulls and polynomial convexity of compact subsets of $\mathbb{C}^n$ are among the fundamental concepts of complex analysis. Whereas their relevance for polynomial approximation is not always explicitly mentioned in one complex variable (since polynomial hull admit a topological description), polynomial convexity becomes pivotal for the development of pseudocovexity theory in several variables. After a general introduction, we will consider the thickening problem, raised by John Erik Fornaess in the seventies. If $K$ and $L$ are compact subsets of $\mathbb{C}^n$ such $K$ is the first is contained in the interior of the second, then the same relation holds for their polynomial hulls. Now the problem is whether this thickening property generalizes to compacts contained in a complex subvariety $X$ of $\mathbb{C}^n$. One encounters serious additional difficulties if $X$ has singularities. Even for isolated singularities the problem is still wide open. The talk will present recent progress obtained jointly with Andreas Lind. The main topics are an affirmative result for isolated singularities of quasihyperbolic type and a result on thickening of hulls with holomorphic structure, which rules out “algebraic” counter-examples.

Onsdag 18 februari 2015, Lydie Mpinganzima, University of Rwanda
Robin-Dirichlet algorithms for the Cauchy problem for the Helmholtz equation
Sammanfattning: We consider the Cauchy problem for the Helmholtz equation. It was demonstrated in our previous paper that the alternating algorithm suggested by V.A. Kozlov and V.G. Maz’ya does not converge to large wavenumbers $k$ in the Helmholtz equation. We present some modifications of the algorithm that may restore the convergence. They consist of the replacement of the Neumann-Dirichlet iterations by the Robin-Dirichlet ones and they repair the convergence for $k$ less than the first Dirichlet-Laplacian eigenvalue. In order to treat large wavenumbers, we present an algorithm based on iterative solution of Robin-Dirichlet boundary value problems in a sufficiently narrow strip. Numerical implementations obtained using the finite difference method are presented. The numerical results illustrate that these algorithms, produce a convergent iterative sequences.

Onsdag 25 februari 2015, Eljah Liflyand, Bar-Ilan University, Israel
Fourier transform versus Hilbert transform
1. In the ’50s (Kahane, Ivić-Tschikura, Bos, etc.), the following problem in Fourier Analysis attracted much attention: Let $\{a_n\}$ ($k = 0, 1, 2, ...$) be the sequence of the Fourier coefficients of the absolutely convergent sine (cosine). Fourier series of a function $f : T = [-\pi, \pi] \to C$, that is $\sum_{k = -\infty}^{\infty} a_k \in C$. Under which conditions on $\{a_k\}$ will the re-expansion of $f(t) = f(t) - (f(0))$ converge?
2. For what functions on the real axis and their Fourier transforms: Do the re-expansion of a function with integrable cosine ( sine) Fourier transform in the ( sine) cosine Fourier transform is integrable if and only if the initial Fourier Transform is integrable but also the Hilbert transform of the initial Fourier transform is integrable. The 2. following result is due to Hardy and Littlewood: If a (periodic) function $f$ and its conjugate $\tilde{f}$ are both of bounded variation, their Fourier series converge absolutely. We generalize the Hardy-Littlewood theorem (Joint work with U. Stadtmüller) to the fourth transform of a function on the real axis and its modified Hilbert transform. The initial Hardy-Littlewood theorem is a partial case of this extension, when the function is taken to be with compact support.

Fredag 27 februari 2015, Antonio F. Costa, UNED, Spanien
Limit points of equisymmetric 1-dimensional families of Riemann surfaces
Sammanfattning: We describe the limit surfaces of some special types of 1-dimensional equisymmetric families of Riemann surfaces in the Deligne-Mumford compactification of moduli space. We provide a description of such nodal Riemann surfaces in terms of the deck group of the coverings defining the family. We apply our method to some well known examples. This is joint work with Victor Gonzalez-Aguilera.

Onsdag 4 mars 2015, Fredrik Viklund, Uppsala universitet och KTH
Self-avoiding walks
Sammanfattning: A self-avoiding random walk is a random walk with no self-intersections. The Self-Avoiding Walk (SAW) model is the uniform measure of self-avoiding walks of a given length. It was introduced by Flory in the 1940s as a model for polymers. Since then, it has been studied intensely by physicists and mathematicians and there are many beautiful predictions and conjectures. Despite much effort, however, there are few rigorous results. Loop-erased random walk (LERW) is another probability measure on self-avoiding walks about which more is known. In the talk I will explain some of the natural questions about these models, along with corresponding predictions and (in a few cases) answers.

Onsdag 11 mars 2015, Pär Kirurib, KTH

Nodal length statistics for arithmetic random waves

Sammanfattning: The Laplacian acting on the standard two dimensional torus has spectral multiplicities related to the number of ways an integer can be written as a sum of two integers, and we can use these multiplicities to encode the eigenvalues of the Laplacian on the torus, and we study the statistics of the lengths of nodal sets (i.e., the zero set) of the eigenfunctions in the "high energy limit". In particular, we determine the variance for a generic sequence of energy levels, and also find that the variance can be different for certain "degenerate" subsequences; these degenerate subsequences are closely related to the circle on which lattice points are very badly distributed. Time permitting we will discuss which probability measures on the unit circle that "come from" lattice points on circles.

Onsdag 18 mars 2015, Hojoo Lee, Seoul, Sydkorea

Swapping out minimal cones in Euclidean space

Sammanfattning: The theory of minimal submanifolds has its origin in the theory of calculus of variations developed by Euler and Lagrange in the 18th century and in later investigations by Schwarz, Riemann and Weierstrass in the 19th century. It has very recently seen remarkable advances that have solved lots of long standing open problems. We explicitly construct generalized helicoids in odd dimensional Euclidean spaces, and minimal cones in even dimensional Euclidean spaces. Our minimal varieties unify various interesting examples: classical helicoids foliated by straight lines, Choe-Hopper's minimal hypersurfaces foliated by Clifford's minimal cones, Barbara-Dajczer-Jorge's ruled minimal submanifolds, and Harvey-Lawson's twisted normal cone over Clifford torus. This work is joint with E. Lee.

Onsdag 25 mars 2015, Berkant Savas, ITN

Clustering based low rank matrix approximations

Sammanfattning: In this talk we will present, discuss, and motivate clustering based low rank matrix approximation methods. These methods are particularly suited for problems with large scale data sets that represent graphs and/or bipartite graphs from information science applications. Our approach has a number of benefits: (1) the approximation preserves important structure present in the original matrix (graph); (2) the approximation contains both global-scale and local-scale information; (3) the procedure is efficient both in computational speed and memory usage; (4) the obtained low rank approximations are highly accurate; and (5) the method outperforms regular low rank approximations in various application problems. Our approach is quite flexible and may be combined with different clustering methods and different algorithms for low rank approximations, e.g. the singular value decomposition, stochastic methods for matrix approximations, negative matrix factorizations. We will show deterministic and probabilistic approximation error bounds obtained by our method, and a number of experiments that exemplify various benefits in our approach.

Onsdag 8 april 2015, Evgeniy Lokharu, MAI

Uniqueness and stability results on steady water waves with vorticity

Sammanfattning: We consider the two-dimensional nonlinear problem describing steady gravity water waves with vorticity in a channel of finite depth. The water motion is assumed to be unidirectional and the surface tension is neglected. It is well known that among small-amplitude waves only Stokes and solitary waves exist which the Bernoulli constant is close to its critical value. We complete this result by proving that all near-critical waves are necessarily small. Furthermore, we prove a stability estimate that implies uniqueness for small-amplitude waves with a prescribed Cauchy data at the profile at some point and provide a parametrization by the amplitude for the family of waves with near-critical values of the Bernoulli constant. Using similar methods, we study solitary-type waves for arbitrary Bernoulli constants and prove that they are necessarily supported by sub-critical shear flows. In particular, this means that there are no waves that oscillate and decay at the same time. This is joint work with Vladimir Kostov and Nikolay Kuznetsov.

Onsdag 15 april 2015, Valov Vesko, Nipissing University, North Bay, Kanada

Homogenous AR(1) compacta

Onsdag 22 april 2015, Sergey Nazarov, MAI / Russian Academy of Sciences, Sankt Petersbourg, Ryssland

Stabilizing solutions at a threshold of the continuous spectrum and scattering anomalies in a wave guide

Sammanfattning: A criterion for the existence of stabilizing solutions of the homogeneous Dirichlet and Neumann spectral problems at thresholds of the continuous spectrum in a perturbed cylindrical or periodic wave guide will be presented on the base of the energy radiation conditions. The relationship of these solutions with the following spectral anomalies will be explained:

- the appearance of near-threshold eigenvalues, isolated in the discrete spectrum and embedded into the continuous spectrum;
- classical Weyl's anomalies of the diffusion patterns;
- almost full transmission and reflection at above-threshold frequencies;
- failure of the limit absorption principle at the threshold frequencies.

Some open questions, especially in elasticity, will be formulated.

Onsdag 29 april 2015, Emílio Buultjens, UNED, Spanien

Pseudo-real Riemann surfaces

Sammanfattning: A Riemann surface is called pseudo-real if it admits anticonformal automorphisms but no anticonformal involution. Pseudo-real Riemann surfaces appear in a natural way in the study of the moduli space $M_{g}^{\text{pl}}$ of Riemann surfaces considered as Klein surfaces. If $M_{g}$ is the moduli space of Riemann surfaces of genus $g$, then there is a two fold covering $g: M_{g} \to M_{g}^{\text{pl}}$, and the preimage of the branch locus consists of the Riemann surfaces admitting anticonformal automorphisms, which are either real Riemann surfaces admitting anticonformal involutions, or pseudo-real Riemann surfaces. So pseudo-real Riemann surfaces are Riemann surfaces that are equivalent to their conjugate but the equivalence is not realized by an involution. In this talk we will study some results known about these Riemann surfaces.

Onsdag 13 maj 2015, Lars Andersson, KTH och Albert Einstein Institut, Potsdam, Tyskland

Geometry and analysis in black hole spacetimes

Sammanfattning: The dynamical stability of the Kerr rotating black hole spacetime is one of the central open problems in general relativity. The Carter constant plays a key role in understanding the stability problem. I will explain how the Carter constant arises and discuss how it and related symmetry operators enters in the analysis of the dynamics of geodesics, waves and Maxwell fields on the Kerr background.

Onsdagen 20 maj 2015, Dewey Estep, University of Cincinnati, USA

Prime Ends on Metric Spaces and the Dirichlet Problem

Sammanfattning: Examples of Hamiltonian systems with Arnold diffusion

Onsdagen 27 maj 2015, Maria Saprykina, Sweden

On delusive nodes of free oscillations

Sammanfattning: Two theorems and one conjecture about nodal sets of eigenfunctions arising in various spectral problems for the Laplacian will be reviewed. It occurs that all these assertions are either incorrect or only partly correct, but their analysis has brought better understanding of the corresponding area of mathematical physics. The contribution made by V. I. Arnold will be emphasized.

Måndagen 1 augusti 2015, Xingli Li, Aalto University, Helsingfors, Finland

Preservation of bounded geometry under spherization and flattening: quasi-convexity and $\varphi$-Poincare inequality

Sammanfattning: This is a joint work with Estibalitz Durand-Cartagena. In this work we explore the preservation of quasi-convexity and $\varphi$-Poincare inequality under spherization and flattening in the metric setting. The results developed in our previous work show the preservation of Ahlfors regularity, doubling property and the $\varphi$-Poincare inequality for $\varphi \in \mathcal{A}_{\infty}$ under spherization. Limiting properties of the envelopes provided the underlying metric space has a singular quasiconvexity in this work, we propose a weaker assumption to still preserve quasi-convexity and $\varphi$-Poincare inequality, called radial starlike quasi-convexity and meridian starlike quasi-convexity extending in particular a result by Buckley, Herron and Xie to a wider class of metric spaces and covering the case $\varphi \equiv \infty$ in our previous work.

Onsdagen 2 september 2015, Maria Przybylska, University of Zielona Góra, Polen

Hunting for integrable systems in curved spaces

Sammanfattning: The differential Galois theory has been created as a tool for checking that a given linear differential equation has a closed form solution. Quite recently it was obtained that it can be also used for investigation of the integrability of Hamiltonian systems. Namely, if a Hamiltonian system is integrable in the Liouville sense, then the differential Galois group of linear equations obtained from the linear part of the Hamiltonian vector field's expansion along a particular solution has abelian identity component. In the case of
Hamiltonians depending on parameters this implication can be used for searching for new integrable systems. Analysis of the differential Galois group enables one to distinguish values of these parameters such that necessary integrability conditions are satisfied and the system can be integrable. This procedure has appeared very effective in the case of natural Hamiltonian systems with standard kinetic energy and potentials that are homogeneous functions of coordinates. Then integrability obstructions are expressible by means of restrictions on eigenvalues of the Hessien matrix calculated for the potential at the singular points, called Darbouz points. It means that calculations of differential Galois integrability conditions reduce to linear algebra operations and this method really gave new, previously unknown, integrable cases. In this lecture we will define a class of Hamiltonian systems in curved spaces for which one can also formulate differential Galois integrability obstructions in such a nice form. This is the class of natural Hamiltonian systems with two degrees of freedom with kinetic energy depending on coordinates and appropriate form of potentials. The obtained integrability conditions gave new integrable and superintegrable systems which will be presented.

Onsdag 9 september 2015, Ugo Gianazzza, University of Pavia, Italien
The expansion of positivity: old and new
Sammanfattning: The so-called Expansion of Positivity (also known in the literature as Growth Lemma) is an important tool in the proof of regularity results for elliptic and parabolic equations, both in divergence and non-divergence form. After reviewing some well known examples and their applications, I will present and discuss a recent result about singular parabolic equations, both of p-Laplacian and porous medium type.

Fredag 11 september 2015, Francesco Calogero, University of Rome “La Sapienza”, Italien
On the generation of monic polynomials obtained by replacing the coefficients of the polynomials of the next generation with the zeros of a polynomial of the previous generation
Sammanfattning: Generations of monic polynomials all of arbitrary degree N are obtained from a seed polynomial of degree N by identifying the coefficients of the polynomials of the next generation with the zeros of a polynomial of the previous generation; and Diophantine properties are reported of the zeros of the polynomials thereby obtained when the seed polynomial is the Hermite polynomial of degree N. This is joint work in progress with Oksana Bihun.

Onsdag 23 september 2015, Ralf Fröberg, Stockholm universitet
Something about numerical semigroups
Sammanfattning: A numerical semigroup is a subset of the natural numbers which is closed under summation, contains 0, and contains all but finitely many natural numbers. The theory about numerical semigroups has applications to algebraic geometry and coding theory. I will talk about the main definitions and properties, and some applications to algebraic curves. The best reference to the pure theory of numerical semigroups is a book by Garcia-Sanchez and Rosales with the title Numerical Semigroups.

Onsdag 30 september 2015, Jürgen Rossmann, Universität Rostock, Tyskland
Asymptotics of solutions of the Neumann problem for the Poisson equation near edges
Sammanfattning: We study the behavior of solutions of the Neumann problem for the Poisson equation near a straight (n−m)-dimensional edge in the n-dimensional space. More precisely, we consider the problem

\[ \Delta u = f \text{ in } \mathbb{R}^n, \quad u = 0 \text{ on } \partial \mathbb{R}^n, \]

where \( \mathbb{R}^n \) is a cone in \( \mathbb{R}^n \), \( 2 \leq m < n \), with vertex at the origin, \( \Omega \) denotes a subdomain of the unit sphere with smooth boundary \( \partial \Omega \). First, we consider the Green function of this problem. We obtain the asymptotics of the Green function near the edge. Here, precisely, we formulate the main results and examples.

Onsdagen 4 november 2015, Irina Asekritova, MAI
The main result is as follows. If \( N \) is sufficiently large, then the system is stable with a probability close to 1. Such stability is possible even when for standard models (without species parameters: mortality rates, self-limitation coefficients, and resource abundances), but also on an additional parameter \( N \) (“ecological potential”, or the number of non-occupied ecological niches).

Onsdagen 7 oktober 2015, Thomas Vogel, Ludwig-Maximilians-Universität München & Inst Mittag-Leffler
Approximation of foliations by contact structures
Sammanfattning: In dimension three, foliations (except foliations by spheres) of codimension one can be approximated by contact structures. We will discuss this theorem together with some question about the relationship between properties of these structures (taut foliations, fiberable contact structures, etc.) and applications.

Onsdagen 14 oktober 2015, German Zavorokhin, Steklov Math. Institute, St. Petersburg, Ryssland
A fractal graph model of capillary type systems
Sammanfattning: The capillary system is modelled by a fractal graph attached to a blood vessel. It is supplied with differential equations obtained from three-dimensional model by the dimension-reduction procedure. The geometry and physical parameters of this system are described by a finite number of scaling parameters which allows the system to have self-reproducing solutions, solutions which are determined by their values on a certain finite piece of the fractal graph and are continued on the remaining part by using these scaling factors. We describe all self-reproducing solutions, and as a result we obtain a connection between the pressure and the flux at the junction point between the capillary system and blood vessel. This connection gives an artificial boundary condition at the junction in the blood vessel and allows us to solve the problem for the flow in the blood vessel without solving it in the capillary system. This is joint work with Vladimir Kozlov and Sergei Nazarov.

Torsdagen 15 oktober 2015, Alex Karassev, Nielsoling University, North Bay, Kanada
Inductive dimension with respect to normal base
Sammanfattning: The dimension-like invariant \( \text{Ind}_\beta \), introduced by Illities, is a generalization of large inductive dimension Ind. It is defined with respect to a normal base \( \mathcal{F} \), which is a base of closed sets with special properties. We will discuss the definition and some properties of this invariant. Further, we briefly discuss applications of \( \text{Ind}_\beta \) to estimate dimensions of some topological spaces. The second part of this talk will be devoted to the dimension \( \text{Ind}_F \) of n-dimensional cubes. In particular, we show that, under the appropriate choice of the normal base \( \mathcal{F} \), the values \( \text{Ind}_F \) of n-cube form the set \( \{n, n+1, n+2, \ldots, \infty\} \).

Onsdagen 21 oktober 2015, Mark Groves, Universität des Saarlandes, Saarbrücken och Lunds universitet
Three-dimensional solitary water waves
Sammanfattning: The existence of solitary-wave solutions to the three-dimensional water-wave problem is predicted by the Kadomtsev-Petviashvili (KP) equation in the case of strong surface tension and the Davey-Stewartson (DS) system in the case of weak surface tension. The term "solitary wave" describes any solution which has a pulse-like profile in its direct vicinity and, more generally, the equations admit three types of solitary waves: a line solitary wave is spatially homogeneous in the direction transverse to its direction of propagation, while a periodically modulated solitary wave is periodic in the transverse direction. A fully localised solitary wave on the other hand decays to zero in all spatial directions. In this talk I will outline mathematical results which confirm the existence of the three-dimensional solitary waves for the full gravity-capillary-water-wave problem in its usual formulation as a free-boundary problem for the Euler equations; both strong and weak surface tension are treated.

Onsdagen 28 oktober 2015, Sergey Vakulenko, St Petersburg, Russia
Replicator stability of ecological systems
Sammanfattning: We propose a new approach to the problem of stability of large ecological systems. This approach develops some ideas of M. Gromov for cell and molecular biology, and uses the known Kolmogorov system for population dynamics. The model takes into account species extinctions and mass-extinctions. We show that stability depends not only on the usual parameters (mortality rates, self-limiting coefficients, and resource abundances), but also on an additional parameter \( N \) ("ecological potential", or the number of non-occupied ecological niches). The main result is as follows. If \( N \) is sufficiently large, then the system is stable with a probability close to 1. Such stability is possible even when for standard models (without species emergence) an ecological equilibrium does not exist and all species are extinct. This is joint work with Vladimir Kozlov and Unn Wennergren.

Onsdagen 4 november 2015, Irina Asekritova, MAI
Integrability of Fredholm operators
Sammanfattning: It is well known that the class of Fredholm operators is very important for several areas of mathematics including spectral theory of operators on Banach spaces and PDEs. The study of interpolation properties of Fredholm operators was initiated by I. Steinberg in 1974 and continued in works by M. Zafran, Y. Sagerh, W. Cao, N. Kalton, M. Mitrea and others. In the talk we will discuss some recent results on interpolation of Fredholm operators and their applications to the famous Lions-Magenes problem on interpolation of closed subspaces.

Fredagen 6 november 2015, Tilahun Abebaw, Addis Ababa University, Ethipion
Decomposition factors of D-modules over a hyperplane arrangement in the plane
Sammanfattning: Let \( a_1, a_2, \ldots, a_n \) be linear forms defined on \( \mathbb{C}^2 \) and \( X = C \cap V(a_1) \cap \cdots \cap V(a_n) \). The coordinate ring \( \mathcal{O}_X \) of \( X \) is a holonomic \( A_n \)-module. This is joint work in progress with Oksana Bihun.

Fredagen 11 november 2015, Johan Björklund, Uppsala universitet
Real algebraic knots and knot diagrams
Sammanfattning: Hilbert’s 16th problem concerns possible topological configurations of real algebraic curves (that is, what can a curve be if the zero set of some real polynomial look like?) in the plane (for some given degree). A natural generalization is to examine the same situation in space. Here the real algebraic curves can form knots, and so we need some form of real algebraic knot theory to understand the situation. During the talk I will discuss how to "translate" the classical smooth knot theory to a real algebraic setting (knot
diagrams, invariants, etc.) and in particular describe some new phenomena which appear.

Onsdagen 18 november 2015, Alexander Khudnev, Russian Academy of Sciences, Novosibirsk, Ryssland
On the hierarchy of thin inclusions in elastic bodies
Sammanfattning: In this talk, we consider equilibrium problems for elastic bodies with thin inclusions of different rigidity. It is assumed that a delamination of inclusions takes place, therefore forming a crack between the inclusions and the elastic body. We justify passages to zero and infinity of rigidity parameters and discuss limit problems. A full hierarchy of thin inclusions in elastic bodies is established.

Onsdagen 25 november 2015, Venuste Nyagahakwa, MAI
Topology of Vitali selectors on the real line
Sammanfattning:

Onsdagen 2 december 2015, Eric Setterqvist, MAI
Taut strings and real interpolation
Sammanfattning: The notion of taut string was introduced by G.B. Dantzig in 1971 and has since then appeared in a broad range of applications including statistics, image processing, stochastic processes and communication theory. In this talk, we present an approach based on the K-functional of real interpolation that provides a unifying framework of existing theories and extend the range of applications of taut strings. More precisely, we introduce the notion of invariant K-minimal sets, explain their connection to taut strings and characterize all bounded, closed and convex sets in \( \mathbb{R}^n \) that are invariant K-minimal with respect to the couple \((L^1, L^\infty)\). Different examples of invariant K-minimal sets with respect to the couple \((L^1, L^\infty)\) will also be discussed. In particular, the L^1-closure of the image of the L^1-ball of smooth vector fields with compact support in \( \mathbb{R}^n \) under the divergence operator is an invariant K-minimal set with respect to \((L^1, L^\infty)\).

Onsdagen 9 december 2015, Hans Jürgen Engelbert, Friedrich Schiller-University, Jena, Tyskland
Stochastic Differential Equations for Sticky Reflecting Brownian Motion
Sammanfattning: We study the ‘ordinary’ stochastic differential equation (SDE) with irregular drift and diffusion coefficients

\[
X_t = x_0 + \int_0^t \sigma(X_u) \, dB_u + \int_0^t \mu(X_u) \, du, \quad t \geq 0,
\]

where \( x_0 \in \mathbb{R}_+ \) is the initial state and \( (B_t) \) is a standard Brownian motion. It turns out that the equation above is equivalent to a system of equations involving local time at state 0 and the occupation time of the solution at state 0, and a solution \( (X_t) \) will be called \( \text{textit{stiffly reflecting Brownian motion}} \) with stickiness parameter \( \mu \in (0, \infty) \). The limiting cases \( \mu = 0 \) and \( \mu = \infty \) correspond to an absorbing Brownian motion and an immediately reflecting Brownian motion, respectively. We prove that the SDE has a jointly unique weak solution but no strong solution. The latter fact verifies Skorokhod’s conjecture on sticky reflecting Brownian motion and provides alternative arguments to those given in the literature.

Onsdagen 16 december 2015, Jonas Sjöstrand, KTH
Integer-valued games
Sammanfattning: I will give an introduction to Conway’s beautiful theory of combinatorial games and surreal numbers. Then I will present a new class of integer-valued partizan games called element-removal games. In general, these games are PSPACE-hard to play, but in some instances there is a simple optimal strategy. One example is the leaf-removal game, played on a tree whose vertices are colored black or white. The players are called Black and White and in each move the player removes any leaf of their own color. If this is impossible the game is lost.

References


Venuste Nyagahakwa
Linköping University
Onsdag 29 januari 2014, Jan van den Heuvel, London School of Economics and Political Science, UK

The complexity of change

Sammanfattning: Many combinatorial puzzles and problems can be formulated as “Can I transform configuration 1 into configuration 2, if certain transformations only are allowed?”.

An example of such a question is: given a certain position of the Rubik’s Cube, is it possible to go back to the position with all sides of one colour (and without taking the cube apart)?

A more mathematical example is: given two valid assignments of a logical expression, can I transform the first assignment into the second one, by changing the truth value one variable at a time, and always maintaining a solution of the SAT-instance? A final example is: given two $k$-colourings of a graph, can I transform the first $k$-colouring into the second one, by recolouring one vertex at a time, and always maintaining a proper $k$-colouring? In this talk we shall give an overview of some older and more recent work on this type of problem. The emphasis will be on the computational complexity of the problems: how hard is it to decide if a certain transformation is possible or not?

Onsdag 5 februari 2014, Alexander I. Nazarov, Steklov Institute and Saint Petersburg State University, Russia

On monotonicity of integral functionals under monotone and symmetric rearrangements

Sammanfattning: We will discuss some recent work with Maria J. Carro and Luis Rodríguez-Piazza, concerning the fundamental problem of Fourier analysis related to almost everywhere convergent Fourier series.

Onsdag 12 februari 2014, Mieczysław Mastyło, University of Poznan, Polen

On almost everywhere convergent Fourier series

Sammanfattning: We will discuss some recent work with Maria J. Carro and Luis Rodríguez-Piazza, concerning the fundamental problem of Fourier analysis related to almost everywhere convergent Fourier series.

Onsdag 5 mars 2014, Alexandr Kostochka, University of Illinois at Urbana-Champaign, USA

Coloring sparse graphs

Sammanfattning: Graph coloring is assigning colors to vertices of a graph in such a way that adjacent vertices always have different colors. The problem of coloring vertices of a graph with fewest colors is NP-hard and attracted a lot of attention. Among the most known results are the Four Color Theorem claiming that every planar graph is 4-colorable and Grötzsch’s Theorem stating that every planar graph without 3-cycles is 3-colorable. A graph $G$ is $k$-critical if $G$ cannot be colored with $k-1$ colors but each of its proper subgraphs can. In order to understand why some graphs need many colors to be colored, one needs to understand the structure of $k$-critical graphs. The first main result of the talk is a new lower bound on the number of edges in $n$-vertex $k$-critical graphs proving a conjecture of Gallai from 1963 (joint with Yancey). On the base of this, we give a very simple proof of Grötzsch’s Theorem above and describe the planar graphs with exactly four triangles that are not 3-colorable (joint result with Borodin, Dvorak, Lidicky and Yancey). This answers a question of Erdős from 1990.

Onsdag 12 mars 2014, Vicenç Torra, IIIA-CSIC, Barcelona, Spanien

Non-additive measures and integrals

Sammanfattning: In this talk I will present some results on non-additive measures and integrals. I will review the Choquet integral, a generalization of the Lebesgue integral for non-additive measures, review distorted Lebesgue measures and distorted probabilities, and describe the definition of the f-divergence and Hellinger distance for this type of measures. I will also discuss applications of non-additive measures and integrals, specially in decision making.

Onsdag 19 mars 2014, Krzysztof Marciniak, ITN

Flat coordinates for Stäckel systems

Sammanfattning: Stäckel separable systems, i.e., a class of quadratic in momenta Hamiltonian systems separable (in the sense of HamiltonJacobi theory) in orthogonal coordinates, are most conveniently obtained from appropriate separation relations. In this talk I use this fact to show how to explicitly construct flat coordinates for those Stäckel systems of the so called Benenti type that are flat from a single generating function. Our construction encompasses the already known cases of flat coordinates for Benenti systems, namely Jacobi elliptic coordinates, Jacobi parabolic coordinates and (in certain cases) coordinates recently discovered by A. Sergeyev and M. Blaszak. Moreover, I will demonstrate the explicit form
Onsdag 26 mars 2014, Mats Andersson, Chalmers och Göteborgs universitet

Generalized cycles in projective space and local intersection numbers

Sammanfattning: Let $Z$ and $W$ be two varieties in projective space. Some years ago, Tworzewski, and independently Gaffney and Gasder, introduced for each point on the set-theoretical intersection of $Z$ and $W$, a list of non-negative integers, called the local intersection numbers, that generalize the classical Hilbert-Samuel multiplicity. We introduce a class of generalized cycles, that contains all analytic cycles. Each generalized cycle has well-defined multiplicity at each point and a well-defined degree. Given two (generalized) cycles $Z$ and $W$ we define a product $Z \cdot W$, that is a generalized cycle with the property that its multiplicities at each point is precisely the local intersection numbers. Moreover, the product respects Bezout's identity. We also discuss the relation to the classical non-proper intersection product. In particular, from $Z \cdot W$ one can get the associated cohomology class on the set-theoretical intersection of $Z$ and $W$. This is a joint work in progress with D Eriksson, H Samuelsson, E Wulcan and A Yger.

Onsdag 2 aprill 2014, Henke Holden, Norges teknisk-naturvitenskapelige universitet, Trondheim, Norge

On the initial-value problem for the Camassa-Holm equation

Sammanfattning: The Camassa-Holm (CH) equation reads $u_t - u_{txx} + 2uu_x - 2u_xu_{xx} - uu_{xxx} = 0$ where $u$ is a real parameter. We are interested in the Cauchy problem on the line initial data in $H^n$. There is a well-known and well-studied dichotomy between two distinct classes of solutions of the CH equation. The two classes appear exactly at wave breaking where the spatial derivative of the solution becomes unbounded while its $H^n$ norm remains finite. We here survey this problem and introduce a novel solution concept gauged by a continuous parameter $\lambda$ in such a way that each $\lambda = \lambda_0$ corresponds to conservative solutions and $\lambda = 1$ gives the dissipative solutions. This allows us to consider the difference between the two classes of solutions and their behavior at wave breaking. We also extend the analysis to a two-component Camassa-Holm system. This is joint work with Jóhann Björk (NTNU) and Xavier Raynaud (SINTF).

Onsdag 9 aprill 2014, Alain Albouy, Observatoire de Paris, Frankrike

An extension of Beltrami's theorem about spaces which are geodesically equivalent to the affine space

Sammanfattning: The central projection from a plane to a sphere maps geodesics on geodesics without respecting the time parameter. Beltrami's theorem is a characterization of the surfaces of constant curvature by such a property. We will present an extension of this theorem to the case of a geodesic symmetric bilinear form on the tangent space, instead of the surface. We will consider the question of when is a totally geodesic in the sphere is also a totally geodesic in the plane, i.e. when does a surface have a different geodesic structure on the plane that has the same geodesics on the sphere. This is an open problem, and we will review the available results.

Onsdag 16 april 2014, German Zavorokhin, Steklov Math. Institute, St. Petersburg, Ryssland

The wave field of a point source that acts on the permeable free boundary of a Biot half-plane

Sammanfattning: The initial boundary value problem of wave propagation in a half-plane filled with a fluid-saturated porous solid is considered. The Biot medium is isotropic, homogeneous, and with open pores on the boundary. Using complex analysis techniques, explicit formulas for the components of displacement vectors in elastic and fluid phases are obtained.

Tisdag 22 april 2014, Alexandre Karassev, Nipissing University, Kanada

Homogeneous compacta and the Bing-Borsuk conjecture

Sammanfattning: An absolute neighbourhood retract (ANR) is a topological space which is a retract of some open neighbourhood for any embedding of it into another space. It is well-known that all polyhedra are ANRs, but there are many examples of compact ANRs that exhibit some extraordinary properties different from that of polyhedra. One of the most intriguing open questions about compact ANRs is the following problem, known as the Bing-Borsuk conjecture: is every finite-dimensional compact homogeneous ANR a manifold? Here a space is called homogeneous if for any points $x$ and $y$ in $X$ there is a homeomorphism of the space onto itself that moves $x$ to $y$. It has been shown that the Bing-Borsuk conjecture is valid for the 2-dimensional case. In my talk, I will give an overview of various results related to the Bing-Borsuk conjecture and homogeneous ANRs.

Onsdag 23 april 2014, Magnus Herbstritsen, MAI

The Physical optics approximation for the scattering of a metallic sphere

Sammanfattning: In electromagnetics, when an incoming wave interacts with and is scattered from an object, the scattered field is often calculated from the induced (surface) currents. For complicated objects, which are also many wavelengths in size, the problem of determining these currents often gets unmanageable, and one way around this is to use the so-called Physical Optics approximation. This approximation roughly says that the incoming field potics approximation. The surface current which would result if the wave instead was reflected from an infinite tangent plane at the point in question. Although widely used, there are few (if any) situations where this approximation has been formally validated. I will discuss what this approximation says in the simplest case, i.e., scattering from a sphere. I also claim that the approximation in this case is valid, and I will discuss some parts of the proof.

Onsdag 7 maj 2014, Juhaan Siljander, Helsingfors universitet, Finland

A parabolic Harnack inequality for a nonlocal in time diffusion equation

Sammanfattning: Nonlocal PDEs have gathered a lot of interest during the last years. In particular, the fractional Laplacian and its generalizations have been studied extensively recently. In this talk we will discuss a different kind of nonlocal equation: namely a parabolic diffusion model where the nonlocal operator is in time instead of space. This kind of equations arise in physics as a random walk model for anomalous diffusion. They have also been used to model diffusion on fractals as well as heat conduction with memory. The talk will consider a recent result concerning the Harnack inequality for weak solutions of the so called time-fractional heat equation.

Onsdag 14 maj 2014, Bas Michielsen, ONERA, Toulouse, Frankrike

Stochastic boundary integral equations in electromagnetic scattering

Sammanfattning: In electromagnetic theory, the scattering of electromagnetic waves by obstacles plays an important role. This scattering process is characterised by a set of "scattering poles", i.e., the scattering coefficients. Each describable is defined by the evaluation of a current distribution on a regular electromagnetic field. The numerical construction of the current distributions and fields needs the solution of boundary value problems for the Maxwell equations. The practical value of a numerical computation of such scattering coefficients depends, of course, on the correspondence between the numerical representation of the obstacle's geometry. Modelling errors can be due to deviations between the nominal geometry and the actual realisation of the obstacle or lack of precision in its discretised representation. It is important to be able to characterise the variability of the observed results due to modelling errors. One strategy for finding such characterisations consists of replacing a deterministic model by a probabilistic model. A probability measure is chosen to parameterise the uncertainty in the geometry of the scattering object. This leads to boundary value problems with stochastic boundaries. Such problems can be solved numerically in many different ways. In this talk, we study the consequences of uncertainties when solving a boundary value problem by means of an equivalent integral equation on the boundary. A standard boundary integral equation is then replaced by a boundary integral equation on a stochastic surface. In the analysis of this problem, we benefit from the exterior differential calculus. In the first part of the talk, we present some essential relations of this calculus in the context of boundary integral equations in electromagnetic scattering. In the second part, we will focus on how to solve such stochastic boundary integral equations numerically. In particular, we will present a practical algorithm for solving the stochastic integral equation which gives important estimates of its solution.

Onsdag 21 maj 2014, Johann Engelbrecht, University of Pretoria, Sydafrika

Visualising complex zeros with sibbling curves

Sammanfattning: A parabola such as $y = x^2 + 1$ is said to have "imaginary" zeros. Through centuries, many people have attempted to explain these illusive zeros. In this talk we trace the development of complex zeros including the notion of complex numbers and subsequent graphical representation thereof. We show that by restricting the domain to those complex numbers that map onto real numbers, representations of functions other than the ones in the real plane are obtained. In other words, the well-known curves in the real plane only depict part of a bigger whole, e.g. the graph that we normally use for the parabola above is one of a pair the other sibling up to now totally hidden! This expanded representation brings new insight into visualising complex roots and the graphs of complex functions. In fact, the question immediately arises: when is a linear map from a space of vectors to another space of vectors which sends decomposable vectors on decomposable vectors? This expanded representation brings new insight into visualising complex roots and the graphs of complex functions. In fact, the question immediately arises: when is a linear map from a space of vectors to another space of vectors which sends decomposable vectors on decomposable vectors? In 1980, Jaak Vilms used some results on this question to solve problems of local embedding of Riemannian manifolds.

Måndag 26 maj, Luboš Pick, Prag, Tjeckien

Sharp iteration principle for higher-order Sobolev embeddings

Sammanfattning: We survey results from the paper [CPS, arXiv:1311.0153] in which we developed a new sharp iteration method and applied it to show that the optimal Sobolev embeddings of any order can be derived from isoperimetric inequalities. We prove thereby that the well-known link between first-order Sobolev embeddings and isoperimetric inequalities is best possible. In particular, we show that if $\Omega$ is a bounded domain containing an open subset $\mathcal{O}$, then any order Sobolev embedding on regular (John) domains, on Maz'ya classes of (possibly irregular) Euclidean domains described in terms of their isoperimetric function, and on families of product probability spaces, of which the Gauss space and the exponential measure space are classical instances. This is a joint work with Andrea Cianchi of Florence and Lenka Slavíková of Prague.

Måndag 26 maj, Andrea Cianchi, Florens, Italien

Gradient regularity in elliptic boundary value problems via rearrangements

Sammanfattning: This talk is devoted to some results in collaboration with V. Maz'ya, on global integrability properties of the gradient of solutions to boundary value problems for nonlinear elliptic equations (or systems, in some cases) in divergence form. Minimal assumptions on the regularity of the ground domain and of the prescribed data for a certain gradient bound are pursued. A distinctive feature of our approach is in the derivation of estimates which are flexible enough to be applied in the proof of gradient bounds for a wide choice of norms. Most of the relevant estimates are formulated in terms of pointwise inequalities for the distribution function of the length of the gradient, or, equivalently, for its
decreasing rearrangement. With this tool at disposal, global bounds for any rearrangement invariant norm of the gradient of solutions to either Dirichlet or Neumann boundary value problems are simply reduced to one-dimensional inequalities for Hardy type operators.

Onsdag 28 maj 2014, Pekka Koskela, Jyväskylä, Finland

Intrinsic Hardy-Orlicz spaces of conformal maps.

Sammanfattning: The theory of Hardy spaces of analytic functions goes back to F. Riesz and G.H. Hardy. In the definition, one considers boundedness of the integrals of the p-th power of the modulus of \( f(z) \) over circles centered at the origin. The very same definition has also been used for injective analytic functions, that is for conformal maps. However, a conformal map is simply a conformal change of the metric and hence the modulus of \( f(z) \) is not a natural quantity to consider. A much more natural choice is the intrinsic distance to \( f(0) \) in the image domain, i.e., the distance between \( 0 \) and \( y \) induced by the conformal density associated to the conformal map. Assuming that \( f(0) = 0 \), this intrinsic distance is at least the modulus of \( f(z) \) and can well be substantially larger. Somewhat surprisingly, the conformal map belongs to the Hardy class \( H^p \) if and only if it belongs to the corresponding space associated to the intrinsic distance. This is not anymore true for the case of Hardy-Orlicz classes.

Måndag 9 juni 2014, Helen Doerr, Syracuse University, USA

Engaging students in the Calculus class.

Sammanfattning: How can asking good questions help students learn Calculus? In this talk, I will show how the use of "student response systems" (also known as "clickers") can engage students in making conjectures and arguing about their validity. Good clicker questions can also provide both students and instructors with insights into prior knowledge and misconceptions that can be addressed through peer interactions and feedback. The development of "good" questions and the management of the class discussion will be demonstrated as well.

Onsdag 11 juni 2014, Jacob Sniatycki, University of Saskatchewan, Kanada

An introduction to G-functions and some of their applications

Sammanfattning: In the first part of the talk I will introduce in a very elementary way Meijer G-functions. This remarkable class of special functions of the hypergeometric type appears in a variety of applications as well as being modern on-line depositories of integral formulas and integral identities. In a slightly more technical second part of the talk I will discuss the origin of my own interest in these functions: random two-matrix models of Cauchy-Laguerre type. For these models many probabilistic questions can be reduced to statements involving a subclass of Meijer G-functions. This talk is based on joint work with M. Bertola, M. Gekhtman and, Independently, R. Beals.

Fredag 13 juni 2014, Jonatan Lenells, Baylor University, USA

Riemann-Hilbert problems and long-time asymptotics for the Degasperis-Procesi equation

Sammanfattning: I will introduce a theory of matrix Riemann-Hilbert problems for a class of jump contours of very irregularity. As an application, the long-time asymptotics for the Degasperis-Procesi equation on the line and on the half-line will be determined.

Onsdag 20 augusti 2014, Visa Latvala, University of Eastern Finland, Joensuu, Finland

Weak Cartan and Cartan properties of the fine topology on metric spaces

Sammanfattning: We consider the fine topology on a complete metric space equipped with a doubling measure supporting a \( p \)-Poincare inequality. We focus on two versions of the Cartan property and discuss their applications to the non-linear potential theory as well as to the theory of Sobolev functions on metric spaces.

Onsdag 27 augusti 2014, Axel Hultman, MAI

Inversion graphs and root theory on permutations diagrams

Sammanfattning: The diagram of a permutation \( \pi \in S_n \) is the subset of the \( n \times n \) grid consisting of the points that are above and to the right of \( \pi \) entries in the permutation matrix of \( \pi \). Let \( B(\pi) \) be the number of permutations \( \sigma \) such that the permutation matrix of \( \sigma \) has only \( N \) entries on the diagonal. The inversion graph of \( \sigma \) has vertices \( 1, \ldots, n \) and an edge \( e_{ij} \) is inverted \( i < j \) if \( e_{ij} > e_{ji} \). Let \( A(\pi) \) be the number of ways to direct the edges of the inversion graph without introducing directed cycles. Remarkably, \( A(\pi) = B(\pi) \) for all \( \pi \). This was independently proven by Lewis and Morris and by myself. It is an instance of a more general conjecture due to Klein, Lewis and Morris, where it is now known.

Onsdag 10 september 2014, Maria Przybylska, University of Zielona Góra, Polen

A differential Galois framework for searching for new integrable systems

Sammanfattning: The problem of detection of new integrable systems has a long history, but it is only quite recently that some new methods for its (more or less) systematic investigation have been proposed. Strong necessary conditions for integrability were formulated in terms of properties of the differential Galois group of equations obtained from linearisation of the investigated system along a non-equilibrium particular solution. As an example, the efficiency of these conditions will be demonstrated on the famous problem of the heavy rigid top. It will be shown that there are no other meromorphically integrable cases apart from those already known: the Euler case, the Lagrange case and the most complicated Kovalevskaya case. A programme for systematic research of integrable homogeneous potentials will be sketched. For this class of systems, integrability conditions obtained from local differential Galois analysis along particular solutions are complemented by other conditions due to some global analysis. These conditions are expressible by means of some Diophantine equations. These equations give the basis for systematic research of integrable homogeneous potentials. Examples of such analysis for potentials with two and three degrees of freedom will be shown.

Onsdag 17 september 2014, Cornelia Schiebold, Mittuniversitetet

Soliton equations and operator theory

Sammanfattning: Soliton equations are an important class of nonlinear partial differential equations, which contain physically relevant equations like the Korteweg-de Vries (KdV) equation, the sine-Gordon equation, and the Nonlinear Schrödinger equation. While these equations govern very different physical phenomena, they have striking common structural properties like the existence of particle-like solutions (solitons) interacting in elastic collisions. The struggle to find a mathematical explanation has led to substantial progress in mathematical physics. Today it is known that the theory of soliton equations is linked to several major branches of mathematics. Our talk will be an introduction to an operator theoretic approach to soliton equations, which may be traced back to work of Marchenko and enables us to apply Banach geometry in the study of solution families. As a motivation, we will carefully explain this in the most accessible case of the KdV equation. Then we will discuss further developments of the method in the study of matrix equations and hierarchies. In the applications part, we will talk on the asymptotic description of multiple pole solutions, the construction of matrix solitons and countable nonlinear superposition. We will illustrate our results by Mathemtica plots.

Onsdag 24 september 2014, Pencho Petrushev, University of South Carolina, USA

Spaces of distributions associated with non-negative self-adjoint operators

Sammanfattning: Classical and nonclassical Besov and Triebel-Lizorkin spaces are developed in the setting of a metric measure space with the doubling property and in presence of a non-negative self-adjoint operator whose heat kernel has Gaussian localization and the Markov property. Sub-exponentially localized and compactly supported frames are constructed and utilized for decomposition of Besov and Triebel-Lizorkin spaces. The frames are also used for Littlewood-Paley decomposition of Hardy spaces. Furthermore, atomic decomposition of Hardy spaces is established in this general setting. This theory allows, in particular, to develop the Littlewood-Paley theory and spaces of distributions on the sphere, cube, ball, and simplex with weights as well as in the context of Lipschitz, Riemannian, and Carnot-Caratheodory spaces.

Torsdag 25 september 2014, Sebastian Reyes Carocca, Universidad Autonoma Madrid, Spanien

Arithmeticity of Kodaira fibrations

Sammanfattning: Let \( X \) be an algebraic variety and \( k \) a subfield of field of the complex numbers. We say that \( k \) is a field of definition for \( X \) if there exist polynomials with coefficients in \( k \) and an algebraic variety \( Y \) over \( k \) that defines isomorphic to \( X \). If \( k \) is a field of numbers we shall say that the variety is arithmetic. Let \( S \rightarrow C \) be a Kodaira fibration, i.e., a non-trivial holomorphic family of algebraic curves over an algebraic curve \( C \). In this talk we shall show that whether or not the algebraic surface \( S \) is arithmetic depends only on the biholomorphic class of its universal cover.

Onsdag 8 oktober 2014, Leif Melkerson, MAI

Mittag-Leffler Modules

Sammanfattning: I will present a class of modules which lies between the projective modules and the flat ones, namely the locally projective modules, also called flat strict Mittag-Leffler modules by Raynaud and Gruson, who introduced Mittag-Leffler modules in their famous and difficult paper in Inventiones Mathematicae 13 (1971). In particular I will study certain linear operators on such modules.

Onsdag 15 oktober 2014, Milagros Izquierdo, MAI

Engaging students in the Calculus class.

Sammanfattning: How can asking good questions help students learn Calculus? In this talk, I will show how the use of "student response systems" (also known as "clickers") can engage students in making conjectures and arguing about their validity. Good clicker questions can also provide both students and instructors with insights into prior knowledge and misconceptions that can be addressed through peer interactions and feedback. The development of "good" questions and the management of the class discussion will be demonstrated as well.
Cyclic Trigonal Maps

Sammanfattning: A complex algebraic curve (or Riemann surface) $X$ of genus at least two will be considered, following Poincaré's uniformization, as the quotient of the hyperbolic plane by a Fuchsian group. The curve/Riemann surface $X$ is defined over a number field if and only if there is a meromorphic function $f$ on the Riemann sphere ramified on at most three points, that is the (torsion-free) uniformizing group of $X$ is a subgroup of a triangle group. The lifting by $f$ of the segment $[0,1]$ is a graph embedded in the surface $X$: a map or Grothendieck "dessin d'enfant". The map determines the analytical/birational structure of $X$. In this talk we will give an introduction to the theory of maps and focus on maps admitting an automorphism of prime order $p$ whose quotient by $f$ is an automorphism of the Riemann sphere, so called $p$-gonal maps.

Onsdag 5 november 2014, Klara Stokes, Högskolan i Skövde

Geometric Point-circle Geometries from Moore graphs

Sammanfattning: The study of configurations in projective real or complex plane is a classical subject in geometry. Configurations appear naturally as certain arrangements of lines, planes or circles in a geometric plane or space. A map is a drawing of a graph on a compact Riemann surface such that the complement of the drawing is the disjoint union of finitely many topological discs called faces. It will be explained how to construct geometric point-circle configurations embedded on Riemann surfaces from uniform maps. In particular, geometric realizations of all pentagonal geometries with $k$ lines through each point and either $k$ or $k-1$ points on each line can be obtained in this way. All these pentagonal geometries come from Moore graphs. Therefore this work involves a study of maps of Moore graphs. In particular we give the minimum genus of the Hoffman-Singleton graph.

Onsdag 12 november 2014, Tomas Persson, Matematikcentrum, Lunds universitet

Random limsup-sets

Sammanfattning: Suppose that we have a sequence of arcs on a circle. We rotate these arcs randomly and form the union $A$ of the arcs. A classical problem, originating from Dvoretzky, is when almost surely $A$ is the entire circle. A classical problem, originating from Dvoretzky, is when almost surely $A$ is the entire circle. Similarly, one may consider the limsup-set $B$ of the randomly rotated arcs, that is $B$ is the set of points that are covered by infinitely many arcs. In fact, when $A$ is the entire circle, then almost surely $B$ is the entire circle. Recently, there has been some interest in determining the almost sure Hausdorff dimension of the limsup-set $B$ as well as other fractal properties. These kind of problems have also been considered in higher dimension. I will talk about old and new results in this area. Necessary concepts such as Hausdorff dimension will be explained.

Onsdag 19 november 2014, Sergey Vakulenko, St Petersburg, Russia

Mechanisms of catastrophic phenomena in complex ecological webs via Hamiltonian dynamics

Sammanfattning: We investigate global stability and dynamics of large bipartite ecological networks by classical methods of dynamical systems theory, including Hamiltonian methods and averaging. Our analysis exploits the network topological structure, namely, existence of strongly connected nodes (hubs) in the networks. We reveal new relations between topology, interaction structure and network dynamics. We describe mechanisms of catastrophic phenomena leading to sharp changes of dynamics and investigate how these phenomena depend on ecological interaction structure. This is joint work with Vladimir Kozlov and Uno Wennergren.

Onsdag 26 november 2014, Anders Björn, MAI

Boundary regularity, barriers and Petrovskii’s condition for $p$-parabolic equations

Sammanfattning: Consider the Dirichlet (boundary value) problem for the Laplacian, i.e. take a domain $G$ in $\mathbb{R}^d$ and a continuous function $f$ on the boundary $\partial G$ and find the harmonic function $u$ which has $f$ as boundary values. For general domains this problem can’t always be solved, and for existence of a solution we have to allow the boundary values to be taken in some weak sense (e.g. using Perron solutions). A boundary point $x \in \partial G$ is regular if

$$\lim_{G \ni y \to x} u(y) = f(x) \quad \text{for all } f \in C(G).$$

One can similarly define regularity for other equations, e.g. the (elliptic nonlinear) $p$-harmonic equation $\Delta u := \text{div}(|\nabla u|^{p-2}\nabla u) = 0$, the (parabolic linear) heat equation $\partial_t u = \Delta u$, and the (parabolic nonlinear) $p$-parabolic equation $\partial_t u = |\nabla u|^p$. In the first three cases, boundary regularity can be characterized by the existence of a barrier, whereas in the last case one can use the existence of a barrier family. An open problem for 20 years has been whether the existence of a single barrier can be used to characterize regularity for the $p$-parabolic equation. I will show that this is not possible. Petrovskii (1935) showed that the origin is regular for the heat equation with respect to

$$\{(x,t) : |x| < A\sqrt{t} \log |\log(-t)| \quad \text{and} \quad 1 \leq t < 0\},$$

if $A = 2$, while it is irregular if $A > 2$. I will discuss nonlinear $p$-parabolic analogs of this result. This talk is based on joint work with Jana Björn and Ugo Gianazza.
The Mathematical Colloquia held in 2013 at Linköping University

Organized by Anders Björn, Milagros Izquierdo Barrios, Vladimir Kozlov and Hans Lundmark.

Wednesday 23 January 2013, Elizabeth Vulcan, Chalmers On the effective membership problem for polynomial ideals
Abstract: 1 will discuss how analytic tools, such as multivariable residue theory, can be used to obtain bounds for the degrees of solutions to polynomial ideal membership problems. I will present some extensions of classical results to the setting of singular varieties – in particular a global version of Huneke’s singular Briançon-Skoda theorem. This is based on joint work with Mats Andersson.

Wednesday 30 January 2013, Hugo Parlier, University of Fribourg, Switzerland Kissing numbers for surfaces
Abstract: The classical kissing number problem for sphere packings is the search for an optimal upper bound on the number of n-dimensional euclidean unit spheres, pairwise disjoint in their interior, that can be tangent to a fixed unit sphere. In the case of lattice sphere packings, one asks that the centers of the spheres be points lying on a lattice. Another classical problem for lattices is the study of Hermite constants which is the problem of finding optimal bounds on the length of a shortest non-trivial vector of a unit volume lattice of dimension n. Schmutz Schaller introduced a nice parallel between these problems and problems related to systoles on closed hyperbolic surface of genus g. A systole of a surface is a homotopically non-trivial curve of shortest length and the parallel problems focus on the maximum number of systoles and their maximum length in function of genus. In this talk I’ll explain this parallel and why a hyperbolic surface of genus g cannot have more than roughly $g^2$ systoles.

Wednesday 6 February 2013, Annemarie Luger, Stockholms universitet On Nevanlinna functions
Abstract: Nevanlinna functions (those are functions mapping the upper half plane analytically into itself) and their generalizations appear in different areas of analysis as well as in many applications. In this talk I am going to introduce these functions (from my point of view) and present two examples where they play an important role. The first comes from spectral theory of quantum graphs, the second one is connected with applications in the theory of antennas.

Wednesday 13 February 2013, Jens Jonasson, Försvarsmakten How to keep data secret using a small permutation
Abstract: I will present a modern approach to the problem of obtaining data confidentiality, the most classical goal of cryptography. Keeping data confidential for a long time means protecting against future adversaries with more knowledge and more computational power, placing high demands on the design of new cryptosystems. One way to increase the confidence in the design is to build provable secure constructions, relying only on a few well-studied primitives. During the talk we will see examples of how different branches of mathematics and computer science play a central role in modern cryptography.

Wednesday 20 February 2013, Sergio Benenti, Università di Torino, Italy Analytical cosmology (How a mathematician can understand cosmology: a personal viewpoint)
Abstract: The aim is to make a well-ordered list of Principles, Definitions and Theorems. In most of the books and papers on cosmology there is not a clear distinction between these three kinds of statements. In this way we get economy, simplicity, and a very nice landscape of the matter.

Wednesday 27 February 2013, Tudor Ratiu, EPFL, Lausanne, Switzerland The Weil–Petersson geodesics on the universal Teichmüller space
Abstract: The talk will begin with a quick review, from a geometrical point of view, of the classical theory of the universal Teichmüller space. Then, the Nag–Verjovsky formula for the Weil–Petersson metric will be presented. This then motivates the introduction of the Takhtajan–Teo Hilbert manifold structure on which this formula is given by a convergent integral. Properties of the geodesic spray will be discussed as well as questions about the diffeomorphism group on the circle at critical Sobolev index. Time permitting, some comments on the image recognition problem will be also presented and linked to the geodesic spray of the Weil–Petersson metric.

Wednesday 6 March 2013, Jacok Szemigielski, University of Saskatchewan, Canada The life of peaks
Abstract: Peakons are non-smooth solutions to a class of nonlinear partial differential equations. They were first discussed by R. Camassa and D. Holm (then both at the Los Alamos National Lab) in the early nineties of the last century. Peakons represent non-smooth nonlinear waves, yet one can think of them as interacting particles. The mathematical theory of peakons, as it turned out, goes back to T. Stieltjes. In particular the first complete construction of peakons was done by adapting Stieltjes’ method of continued fractions. In this sense the theory of peakons is intimately connected with the theory of orthogonal polynomials and their generalizations. One such generalization suggested by the theory of peakons is a family of Cauchy biorthogonal polynomials. In this talk I will retrace the main steps in the story of peakons with an emphasis on the connection with orthogonal and biorthogonal polynomials.

Wednesday 13 March 2013, Klas Nordberg, ISY Symmetries in P3P
Abstract: P3P is classical problem in geometry, in which we want to determine the position and orientation (the pose) of a camera that is observing 3 known 3D points, given the projections of these points in the camera image. The literature offers multiple proposals for how to solve P3P, in most cases based on finding the roots of a quadric polynomial since there are up to 4 poses of the camera that solve the problem. In the talk, some of these methods will be described briefly, but the focus is on a novel method that combines two earlier approaches: (1) a direct parametrisation of the camera pose in terms of a rotation matrix R and a translation vector t, and (2) a reduction of the computational cost of P3P to that of finding a single real root of a cubic polynomial with real coefficients. On the way to the cubic, we will stumble across a conjugate reciprocal quadric and also notice that there are several instances of symmetries involved in the proposed method that allow us to reach the cubic.

Wednesday 10 April 2013, Yuri Safarov, King’s College, London Almost commuting operators
Abstract: The talk will review recent results on the following well known problem: if the commutator of two bounded operators is small, are they close to a commuting pair?

Wednesday 24 April 2013, Sergey Nazarov, Russian Academy of Sciences, Saint Petersburg, Russia The spectrum of the Dirichlet Laplacian of quantum waveguides
Abstract: The spectrum of the Dirichlet Laplacian in the union of double-periodically posed thin strips is investigated by means of asymptotic analysis. Position and sizes of spectral gaps are described. In the case of local perturbations the appearance of eigenvalues in the discrete spectrum is verified, either below the essential spectrum, or in gaps. The influence of open subwaveguides is studied, too.

Wednesday 15 May 2013, Grigori Rozenblioum, Chalmers Finite rank Toeplitz operators and related problems in Analysis
Abstract: A Bergman type space $H^2$ is a subspace in $L^2$ in a domain, consisting of solutions of an elliptic equation or system. The leading example is the classical Bergman space of square integrable functions, analytical in the unit disk. If $P$ denotes the projection from $L^2$ onto the disk, the Toeplitz operator $T$ acts in $H^2$ and maps $u$ to $P^*Pu$, where $P^*$ is a function called the symbol. We consider the following problem. Suppose that the operator $T$ has finite rank. What can be said about $P^*$? We describe some recent result concerning this problem, related questions in real and complex analysis, and some applications of the finite rank results.

Wednesday 22 May 2013, Klara Stokes, IDA An alternative way to generalise the pentagon
Abstract: A generalised polygon is a partial linear space such that its bipartite incidence graph has girth twice its diameter, just as ordinary polygons - the incidence graph of the ordinary n-gon is the cyclic graph on 2n vertices. Generalised polygons were introduced by Jacques Tits in order to describe geometric properties of simple groups of Lie type. By the Feit-Higman Theorem, the only finite examples of generalised polygons are thin (having two points on each line or two lines on each point) or the diameter n is either 3, 4, 6, or 8. In particular there are no (thin and finite) generalised pentagons or generalised hexagons. In this talk I will describe an alternative way of generalising the pentagon: the pentagonal geometry. A pentagonal geometry is a partial linear space in which for all points x, the points not collinear with the point x form a line. Bounds for their parameters will be given, different constructions and some non-existence results will be presented, and a connection with distance-regular graphs will be described. This is joint work with Simeon Ball, John Bamberg and Alice Devillers.

Friday 31 May 2013, Francesco Calogero, Physics Department, University of Rome “La Sapienza”, Italy
Isochronous systems are not rare
Abstract: A survey will be given of isochronous systems, i.e. systems that oscillate with a fixed period (for a particular Hamiltonian structure). In particular, a fairly general technique will be described to modify fairly general models describing a time evolution so that the modified models are isochronous (with period $T$) yet mimic closely (or even exactly) the behavior of the unmodified system for a time interval $T$ much smaller (or just smaller) than $T$.

As a particularly remarkable example (joint work with F. Leyvraz), it will be shown how – given the (autonomous) Hamiltonian $H$ describing the most general (standard) nonrelativistic many-body problem (arbitrary number $N$ of particles, arbitrary masses, arbitrary dimensions of ambient space, forces depending arbitrarily from all the particle coordinates, with the only restriction that the system be overall translation-invariant, i.e. no external forces) – it is possible to construct another (also autonomous) Hamiltonian $H'$ (in fact, an infinity of such Hamiltonians) featuring the same dynamical variables and parameters as $H$ and in addition two arbitrary positive parameters $T$ and $T'$ with $T' > T$, and having the following two properties. (i) The new Hamiltonian $H'$ yields, over the (arbitrarily long!) time interval $T'$, a dynamical evolution identical to that yielded by $H$. (ii) The Hamiltonian $H'$ is isochronous: all its solutions (for arbitrary initial data) are completely periodic with period $T$.

This finding raises (interesting?) questions about the difference among nonintegrable and integrable dynamics (all isochronous systems are integrable, indeed more than superintegrable), about the definition of chaotic behavior (including the apparent need to invent some such notion for a finite time interval), about the validity (say, for $N \approx 10^{30}$) of statistical mechanics and of the second principle of thermodynamics, about cosmology (say, for $N \approx 10^{80}$). It also demonstrates the impossibility to ascertain which dynamical theory is the correct one, out of an infinity of different theories predicting the same (exactly the same) evolution over an arbitrarily long time interval, but being qualitatively different (isochronous versus chaotic, integrable versus nonintegrable).

result of small, slight modifications, then the evolution theory "absolutely breaks down". To shed a light on this problem, we use an analogy between these evolution processes and hard-combinatorial problems, which have received great attention from mathematicians and theoretical physicists.

The main result is that a genetic redundancy, when K different genes encode the same trait, provides an exponential effectiveness of organism morphogenesis and evolution: with n genes one can obtain approximately \(2^{K^2}n^K\) traits. We also show, analytically and numerically, that special genes (capacitors) can turn on or turn off evolution, and stabilize trait pattern when the environment is stable, and engines evolution when the environment is unstable. They are hubs in genetic networks.

(With work of D. Grigoriev, J. Reinitz, and A. Weber.)

**Wednesday 20 November 2013, Paul Andrews, Stockholms universitet Coorganized with Åmnesdidaktiskt seminarium.**

**The cultural construction of school mathematics and student achievement**

**Abstract:** In this talk I will consider the extent to which school mathematics is a cultural construction. Curricula may be similar, at least as far as their content is concerned, but the underlying expectations and the extent to which systems mandate particular didactics vary considerably. Schools are located in cultural contexts that determine the ways in which they are structured and participate. Teachers themselves are, typically, products of the system in which they teach. Consequently their actions tend to be governed by hidden assumptions and beliefs about what constitutes good practice. Students also are conditioned to behave in ways that identify them with their cultural backgrounds. Drawing on a range of sources, but mostly my own research and video-recordings of European mathematics lessons, I will show how mathematics teaching is conceptualised in different cultural contexts and ask the question: can analyses of classroom practice explain students' performance on international tests of achievement like TIMSS and PISA?

**Wednesday 27 November 2013, Estibalitz Durand Cartagena, National University of Distance Education (UNED), Spain and Institut Mittag-Leffler**

**Rectifiable curves in Sierpiński carpets**

**Abstract:** In the last years, there has been an intensive research on the setting of metric measure spaces, where a first order differential calculus has been developed. In this talk we focus our attention on a particular case of doubling metric measure space: the Sierpiński carpet endowed with its associated Hausdorff measure. We will first review some of the latest results which have contributed to understanding the geometrical structure of metric measure spaces supporting a p-Poincaré inequality and motivate why the families of curves that live in the Sierpiński carpet are not enough for our purposes; that is, in terms of Poincaré inequalities. In the second part, we will characterize the slopes of nontrivial line segments contained in self-similar Sierpiński carpets. The set of slopes will be related to Farey sequences and the dynamics of punctured square toral billiards.

**Wednesday 4 December 2013, Leslie Jimenez, Universidad de Chile**

**On Jacobian varieties with group action**

**Abstract:** Given a compact Riemann surface \(X\) (curve), we study its Jacobian variety \(JX\). The action of a finite group \(G\) on \(X\) induces an action of \(G\) on \(JX\). Using the irreducible rational representations of \(G\) we obtain a decomposition of \(JX\) in lower dimension subvarieties (factors). In fact, we have the isogeny (epimorphism with finite kernel denoted by \(-\))

\[
B_r^G \times \cdots \times B_r^G \sim JX
\]

where \(r\) is the number of irreducible rational representations of \(G\) and the \(B_r^G\)'s values are well known. It is called the isogeny decomposition of \(JX\) with respect to \(G\). In this talk we will see how to get geometric information of the factors in this decomposition. We will give examples of it for some family of curves and different groups \(G\).

**Wednesday 11 December 2013, Maciej Blaszak, Adam Mickiewicz University, Poznań, Poland**

**Classical and quantum separability of Stackel systems**

**Abstract:** The Stäckel separability of a Hamiltonian system is well known to ensure existence of a complete set of Poisson commuting integrals of motion quadratic in the momenta. I consider a class of Stäckel separable systems where the entries of the Stäckel matrix are monomials in the separation variables. I also show that the only systems in this class for which the integrals of motion arising from the Stäckel construction keep commuting after quantization are, up to natural equivalence transformations, the so-called Benenti systems. Moreover, it turns out that the latter are the only quantum separable systems in the class under study. Some discussion about admissible quantization procedures will also be presented.

**Monday 16 December 2013, Vince Geiger, Australian Catholic University, Brisbane, Australia**

**Numeracy across the curriculum: An Australian curriculum perspective on mathematics on preparing students to use mathematics in the world of work and for participatory citizenship**

**Coorganized with**

**Monday 16 December 2013, Maciej Blaszak, Adam Mickiewicz University, Poznań, Poland**

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**Wednesday 18 December 2013, Bruce Sagan, Michigan State University, USA**

**Factoring rook polynomials**

**Abstract:** A board \(B\) is a subset of the squares of an \(n \times n\) chess board. Let \(r_k(B)\) denote the number of ways of placing \(k\) nonattacking rooks on \(B\) which means that every row and column has at most one rook. Various specializations of \(r_k(B)\) count permutations, derangements, and set partitions. One nice set of boards are the Ferrers boards \(B = \{b_1, \ldots, b_n\}\) where the \(b_j\) are a weakly increasing sequence of nonnegative integers and the corresponding board is obtained by choosing the lowest \(b_j\) squares in column \(j\) of the chess board for \(1 \leq j \leq n\). In a landmark paper, Goldman, Joichi, and White showed that if \(B\) is a Ferrers board then an appropriately chosen generating function for the \(r_k(B)\) factors over the integers. They also gave various applications of this result, such as a new proof of a theorem of Foata and Schützenberger. In the first half of this lecture we will provide an introduction to these beautiful results. The second half will be devoted to recent research concerning a generalization of rook placements where the rows of a board are grouped into levels and one can have at most one rook in any level or any column. This part is joint work with Kenneth Barrese, Nicholas Loehr and Jeffrey Remmel.
Wednesday 7 March 2012, Sergey Vakulenko, Institute of Mechanical Engineering Problems and University of Technology and Design, Saint Petersburg, Russia

 bounded inverses. This condition does not imply that the restriction of the operator to the real interpolation space has a bounded inverse for all values of the parameters.

Wednesday 5 March 2012, Per Enflo, Kent State University, USA

Abstract: Let be a linear bounded operator from a Banach couple to a Banach couple such that the restrictions of to the spaces and have bounded inverses. This condition does not imply that the restriction of the operator to the real interpolation space has a bounded inverse for all values of the parameters and . I plan to discuss the following problem: how can we describe all spaces such that the operator is invertible? The talk is based on joint work with N. Kruglyak.

Wednesday 29 February 2012, Niklas Lundström, Umeå universitet

Estimates for -harmonic functions vanishing on a flat

Abstract: We study -harmonic functions in a domain near an -dimensional plane (at -flat) such that the restrictions of to the spaces and have bounded inverses. This condition does not imply that the restriction of the operator to the real interpolation space has a bounded inverse for all values of the parameters and . I plan to discuss the following problem: how can we describe all spaces such that the operator is invertible? The talk is based on joint work with N. Kruglyak.

The lower bound holds also in the range

Monday 5 March 2012, Per Enflo, Kent State University, USA

Orbits of diagonal operators

Abstract: We will discuss hyperbolic orbits of operators, i.e. orbits where every subsequent step of the orbit spans the whole space. A cyclic vector is a vector whose orbit spans the whole space. Among other things we will show that for diagonal operators on Hilbert space either every cyclic vector has a hyperbolic orbit or no cyclic vector has a hyperbolic orbit.

Wednesday 7 March 2012, Sergey Vakulenko, Institute of Mechanical Engineering Problems and University of Technology and Design, Saint Petersburg, Russia

Flexibility and robustness under fluctuations of genetic networks

Abstract: We consider two types of nodes. The v-nodes, called centers, are hyperconnected and interact one to another via u-nodes, called satellites. This centralized Poissonian networks with two types of nodes. The -nodes, called centers, are hyperconnected and interact one to another via -nodes, called satellites. This centralized connection architecture realizes a bow-tie scheme and possesses interesting properties. Namely, this organization creates feedback loops that are capable to generate any prescribed pattern and dynamics, chaotic or periodic, and create a number of equilibrium states. We show that activation or silencing of a node can sharply switch the network attractor, even if the activated or silenced node is weakly connected. Centralized networks can keep their flexibility, and still be protected against environmental noise. Finding an optimized network that is both robust and flexible is a computationally hard problem in general, but nonetheless this problem is feasible when the number of satellites is large. This finding reduces to a minimization of some glass Hamiltonian. This is a joint work with Ovidiu Radulescu (Montpellier, France).

Wednesday 14 March 2012, Andrés Navas, Universidad de Santiago de Chile

On groups generated by elements near rotations

Abstract: We will show that a group of circle diffeomorphisms, having a system of generators close (in the - topology) to rotations imposes several dynamical restrictions. The most important one goes back to Duminin: such a group cannot be of "second kind" (it cannot admit a minimal invariant Cantor set). We will see that among subgroups of the Möbius group, the critical case corresponds to the classical (2,3,2) group.

Wednesday 21 March 2012, Rönnauldr G. Möller, University of Iceland

Symmetry in the theory of infinite graphs

Abstract: We consider networks with two types of nodes. The -nodes, called centers, are hyperconnected and interact one to another via -nodes, called satellites. This centralized connection architecture realizes a bow-tie scheme and possesses interesting properties. Namely, this organization creates feedback loops that are capable to generate any prescribed pattern and dynamics, chaotic or periodic, and create a number of equilibrium states. We show that activation or silencing of a node can sharply switch the network attractor, even if the activated or silenced node is weakly connected. Centralized networks can keep their flexibility, and still be protected against environmental noise. Finding an optimized network that is both robust and flexible is a computationally hard problem in general, but nonetheless this problem is feasible when the number of satellites is large. This finding reduces to a minimization of some glass Hamiltonian. This is a joint work with Ovidiu Radulescu (Montpellier, France).

Wednesday 28 March 2012, Ryszard Rubinsztein, Uppsala universitet

Knots, quandles and connections

Abstract: Quandles are spaces acting on themselves according to certain rules. Examples are given by symmetric manifolds and conjugacy classes in groups. I shall explain how one can use quandles to construct invariants of knots. I shall then discuss how, on the other hand, these invariants can, in some cases, be interpreted in terms of moduli spaces of flat connections on a punctured 2-dimensional sphere.

Wednesday 4 April 2012, Michelle Bucher, University of Geneva, Switzerland

Title: Volumes in geometry and topology

Abstract: The simplicial volume of manifolds was introduced by Gromov in the beginning of the 80's to give a topological description of the volume of (families of) Riemannian manifolds. Applied to hyperbolic manifolds, this led Gromov to a new proof of Mostow rigidity. In fact the simplicial volume of any Riemannian manifold is proportional to its Riemannian volume by a constant depending only on the universal cover. This phenomenon is reminiscent of the Hirzebruch proportionality principle between Euler characteristic and Riemannian volume, and in fact Euler characteristic and simplicial volume share important properties such as that their positivity implies the positivity of the minimal volume. In this talk, I will review positivity results for the simplicial volume and its relations to Riemannian volume and Euler characteristic.

Wednesday 11 April 2012, Sergey Nazarov, Russian Academy of Sciences, Saint Petersburg, Russia

Spectral gaps for periodically perturbed cylindrical waveguides

Abstract: The band-gap structure of the spectrum in a periodic waveguide permits for the opening of a spectral gap that is an interval of the real positive semi-axis which is free of the spectrum but has both the endpoints in it. The simplest way to indicate spectral gaps is to consider periodic perturbations of a cylindrical waveguide and to apply asymptotic methods
Wednesday 18 April 2012, Martin Bridson, University of Oxford, UK
Rigidity, mapping class groups and automorphism groups of free groups
Abstract: I shall begin with a discussion about the universe of discrete groups and explain why lattices in semisimple Lie groups, mapping class groups of surfaces, and automorphism groups of free groups have a special place in it. Then, developing the deep analogy between these three types of groups, I shall describe several results that extend ideas of rigidity (à la Mostow and Margulis) from the classical setting to the setting of mapping class groups and automorphism groups of free groups. For example, if is at least 3, the SL(2,R) cannot act by homeomorphisms on a sphere of dimension less than n-1.

Wednesday 25 April 2012, Montserrat Casals-Ruiz, University of Oxford, UK
First-order theories and Tarski problems
Abstract: Equations are present, implicitly or explicitly, in most branches of mathematics. The first ones to be formalised were the diophantine equations – equations with integer coefficients and integer solutions. Hilbert's tenth problem asks to construct an algorithm to decide whether or not a diophantine equation is compatible. In 1970, combined work of Davis, Putnam, Robinson and Matiyasevich culminated in a proof of the algorithmic undecidability of this problem, called the Davis-Putnam-Robinson-Matiyasevich theorem.

Wednesday 2 May 2012, Sebastian Hensel, Universität Bonn, Germany
Geometry of mapping class groups
Abstract: The mapping class group of a surface is one of the central objects in low dimensional topology and geometry. As a finitely generated group, it carries a natural metric whose geometry is by now well-understood. The geometry of other mapping class groups, however, is much less studied. In this talk we present joint work with Ursula Hamenstädt on the mapping class groups of handlebodies and doubled handlebodies and their relations.

Wednesday 9 May 2012, Ruth Kellerhals, University of Fribourg, Switzerland
Minimal volume tessellations in hyperbolic space
Abstract: After a short introduction to hyperbolic tessellations, orbifolds, simple constructions and properties, we consider those with many symmetries and try to rank them by means of their volumes. We discuss known results in dimensions five before five and present then new developments in hyperbolic 5-space by restricting ourselves to the arithmetic, oriented case. This is joint work with Vincent Emery (MPI Bonn).

Friday 11 May 2012, Maria del Carmen Reguera Rodriguez, Lunds universitet
Weights that avoid the cancellative properties of singular integrals
(Abstract with the Analysis seminar series.)

Abstract: It will be shown that both, the Dirichlet and the Neumann problems for the Laplace operator in the plane perforated with the double periodic family of circular holes may have spectral gaps in their spectra. The method of investigation has, necessarily, crucial difference with the case of a waveguide. The famous golden section appears in applications to another question of Muckenhoupt and Wheeden in the two weight setting.

Wednesday 16 May 2012, Sergey Nazarov, Russian Academy of Sciences, Saint Petersburg, Russia
Three-coloured chessboards
Abstract: I will discuss some mathematics and physics related to what I call three-coloured chessboards. These seemingly simple combinatorial objects turn out to have intriguing connections to other topics such as elliptic functions and modular forms, solvable models of statistical mechanics, affine Lie algebras and Painlevé equations. The lecture should be accessible to a wide audience.

Wednesday 29 August 2012, Anders Björn, MAI
The Perron method for p-harmonic functions: New resolutivity and invariance results
Abstract: In the Dirichlet problem one looks for a p-harmonic function which takes prescribed boundary values f. A p-harmonic function u is a continuous weak solution of the equation

\[ \text{div}(|\nabla u|^p \nabla u) = 0. \]

(And thus for p < 2 we obtain the usual harmonic functions.) Here 1 < p < \infty is fixed.

If f is not continuous, then there usually is no p-harmonic function which takes the boundary values as limits (i.e. such that \lim_{x \to \partial \Omega} u(x) = f(x) for all \Omega \subset \partial D). Even for continuous f this is not always possible. One therefore needs some other precise definition of what is a solution to the Dirichlet problem. For p-harmonic functions there are at least four different definitions, of which the Perron method is the most general.

For any boundary function f : \partial D \to [-\infty, \infty], the Perron method produces an upper and a lower Perron solution. When these coincide it gives a reasonable solution to the Dirichlet problem, called the Perron solution PF, and f is said to be resolutive.

In 2003 Björn-Björn-Shamrugalingam showed the following invariance result: If f \in C(\partial D) and h = f outside a set of p-capacity zero, then h is resolutive and PF = Pf.

We will look at recent improvements of this result. Some of these will be related to the prime end boundary, in the sense of the recent definition of prime ends introduced by Adamowicz-Björn-Björn-Shamrugalingam. Note that for our results we cannot use Carathéodory's classical definition, not even in simply connected planar domains.

Wednesday 12 September 2012, Nikolay Kuznetsov, Russian Academy of Sciences, St. Petersburg, Russia
No steady water waves of small amplitude are supported by a shear flow with still free surface
Abstract: The two-dimensional free-boundary problem describing steady gravity waves with vorticity on water of finite depth is considered. It is proved that no small-amplitude waves are supported by a horizontal shear flow whose free surface is not a coordinate frame such that the vorticity is time-independent in it. The class of vorticity distributions, for which shear flows with still free surface exist, includes any positive constant vorticity, as well as linear and quadratic vorticity with arbitrary positive coefficients.

Wednesday 19 September 2012, Pekka Koskela, University of Jyväskylä, Finland
Gromov hyperbolicity and quasihyperbolic geodesics
Abstract: We find explicit necessary and sufficient conditions for a Hankel operator to be positive. In view of the Hamburger theorem, this yields necessary and sufficient conditions for the solvability of a moment problem. A generalization of Bernstein's theorem on exponentially convex functions to distributions is established.

Wednesday 3 October 2012, Vladimir Tkachenko, MAI
Minimal cones, Jordan algebras and isoparametric hypersurfaces
Abstract: By exploiting equivariant properties of quadratic Clifford-Simons cones, Bombieri, De Giorgi and Giusti were able to construct in 1969 non-affine entire minimal graphs over \( \mathbb{R}^n \), thereby settling the celebrated Bernstein problem. The construction and understanding of the inner structure of minimal cones of degree higher than 2 remains a long-standing difficult problem. We give an excursion into the first non-trivial case, the cubic minimal cones, which is shown to be very related to Jordan algebras and isoparametric hypersurfaces.

We will also discuss some connections of this to recent progress in construction of non-classical solutions of certain elliptic PDEs.

Friday 5 October 2012, Britt-Marie Stolcke, Umeå universitet
Matematikerna – ett broderskap? (Seminarium inom Kvinnor inom matematik.)

Sammanfattning: Genom tiderna har kvinnor haft mycket skiftnade tillgång till studier, akademisk undervisning och yrkesverksamhet. Under vissa tider och i vissa kulturer tillåts inte kvinnor att lära sig läsa, skriva och räkna. Men det finns en obrunten tradition av kvinnor i matematiken, från kvinnorna i Pythagoras akademi till vår första kvinnliga professor i
Wednesday 10 October 2012, Yuri Brudnyi, Technion, Haifa, Israel
Interpolation of compact operators (Joint with the Analysis seminar series.)
Abstract: We begin with the still unsolved Calderón problem (1964) on preserving compactness of linear operators under the complex interpolation method. The presented partial solution for a more general problem deals with quasi-Banach lattices as target spaces, arbitrary interpolation methods and Lipschitz (in particular linear) operators. The key point of the proof is a new compactness criterion for Fréchet lattices that will be presented as well.

Wednesday 17 October 2012, Qimh Xantcha, Uppsala universitet
Binomial rings: axiomatisation, transfer and classification
Abstract: The topic of the talk is binomial rings, rings with binomial co-efficients, which were introduced by Hall in 1954 in connexion with his ground-breaking work on nilpotent groups. We show how binomial rings admit an elegant axiomatisation, implying their equivalence with the class of numerical rings studied by Ekedahl. A binomial transfer principle is described, enabling combinatorial proofs of algebraical identities. Finally, we provide a complete classification of the finitely generated binomial rings.

Wednesday 24 October 2012, Peter Hästö, Uleåborgs universitet, Finland
The strong minimum principle for quasipermeamizers of non-standard growth
Abstract: I will discuss the strong minimum principle for non-negative quasipermeamizers of the variable exponent Dirichlet energy integral. With Harjulehto, Latvala and Toivainen, we proved the SMP under the assumption that the exponent has modulus of continuity slightly more general than Lipschitz. The proof is based on a new version of the weak Harnack estimate.

Friday 26 October 2012, Alex Karassev, Nipissing University, North Bay, Canada
Spans of continua (Joint with the Analysis seminar series.)
Abstract: The concept of span was introduced by Andrew Lelek in 1964 and played a substantial role in continuum theory since then. Roughly speaking, the span of a space is the largest distance two travelers can keep between them while traversing the whole space. The talk will be an overview of various versions of span and relations between them, as well as other results in continuum theory, related to the concept of span. Most of the spaces under consideration will be graphs. Some open problems will be posed.

Wednesday 7 November 2012, Carl Johan Casselgren, MAI
Coloring graphs from random lists
Abstract: The topic of this talk is list colorings of graphs. In this model each vertex of a graph is assigned a list (set) of colors and the task is then to construct a proper coloring of the graph such that each vertex gets a color from its list. Usually, for a given graph, one is interested in determining the minimum number $\ell_v$ such that if each vertex gets a list of size $\ell_v$ then this is always possible. I will review some basic facts about list coloring and then discuss a variation on list coloring where each vertex receives a random list: let $G = G(\ell) = (V,G(\ell),\ell)$ be a graph on $n$ vertices and assign to each vertex $v$ of $G$ a list $\ell(v)$ of colors, by choosing each list uniformly at random from all $k$-subsets of a color set of size $\ell(n)$. I will discuss various conditions which imply that with probability tending to $1$ as $n \to \infty$, $G$ has a proper coloring from the random lists.

Wednesday 14 November 2012, Juha Lehrbäck, Jyväskylä University, Finland
Hardy inequalities and uniform fatness
Abstract: There is a well-known connection between the validity of the $p$-Hardy inequality in a domain and the uniform $p$-fatness of the complement of the domain, due to Ancona, Lewis, and Wannebo. However, when the $p$-Hardy inequality is replaced by a pointwise variant of the inequality, we even obtain an equivalence between the two concepts. I will discuss this and related results in the setting of metric spaces, based mainly on joint work with Riikka Korte and Heli Tuominen.

Wednesday 21 November 2012, Sergei Vakulenko, Russian Academy of Sciences, St. Petersburg, Russia
Chaos for infinite-dimensional dissipative systems
Abstract: In the 1990s, P. Polacik proposed the method of realization of vector fields (RVF). This method allows us to find infinite-dimensional dissipative dynamical systems with Chaos for infinite-dimensional dissipative systems.

Wednesday 28 November 2012, David Rule, MAI
Weighted norm inequalities for linear and multi-linear pseudo-differential operators
Abstract: I will give an overview of some boundedness results for pseudo-differential operators on weighted Lebesgue spaces. We will start by trying to understand linear operators $T(f)(x) = \int a(x,\xi)\hat{f}(\xi)e^{im\xi}d\xi$
whose symbols $a(x,\xi)$ are only assumed to be measurable in the $\xi$-variable. We will then see that this knowledge can help us understand other operators, for example, multi-linear versions of $T$. If there is time we will also consider operators where we replace the oscillatory factor $e^{im\xi}$ with the more general factor $e^{m|\xi|}$, and then this is always possible. I will review some basic facts about list coloring and then discuss a variation on list coloring where each vertex receives a random list: let $G = G(\ell) = (V,G(\ell),\ell)$ be a graph on $n$ vertices and assign to each vertex $v$ of $G$ a list $\ell(v)$ of colors, by choosing each list uniformly at random from all $k$-subsets of a color set of size $\ell(n)$. I will discuss various conditions which imply that with probability tending to $1$ as $n \to \infty$, $G$ has a proper coloring from the random lists.

Tuesday 18 December 2012, Antonio F. Costa, UNED, Madrid, Spain
Klein Doubles
Abstract: A Klein surface is a (real) surface with (dimension one) dianalytic structure, i.e. the changes of coordinates between different charts are analytic or anti-analytic. Klein surfaces can be non-orientable and have boundary. The term Klein surface goes back to Felix Klein and the modern concept appeared in a Lecture Notes by Alling and Greenleaf in 1971. A double of a Klein surface $X$ is a Klein surface $\hat{X}$ such that there is a degree 2 morphism $\hat{X} \to X$. When the genus of the Klein surface or the number of boundary connected are large, there are many possible doubles of a given Klein surface. We shall study the most important ones by historical, algebraic or geometrical reasons, including the complex double, the orienting double or the Schottky double.
The Mathematical Colloquia held in 2011 at Linköping University

Organized by Anders Björn, Milagros Izquierdo Barrios, Vladimir Kozlov and Hans Lundmark.

Wednesday 19 January 2011, Jana Björn, MAI
Quasiminimizers – pros and cons
Abstract: We define quasiminimizers of the $p$-energy integral as more robust generalizations of $p$-harmonic and harmonic functions. They share many useful properties with $p$-harmonic functions, such as maximum principle, Harnack inequality and some regularity. Other properties are much less understood or even fail, as shown by some counterexamples.

Wednesday 26 January 2011, Pär Kurlberg, KTH, Stockholm
Point count statistics for families of curves over finite fields
Abstract: We investigate the distribution of the number of $F_q$-points of curves in various families. (Here $F_q$ is the finite field with $p$ elements.) If we consider a family of curves having fixed genus and let $q$ tend to infinity the situation is fairly well understood – the distribution of the point count fluctuations are given by the (generalized) Sato–Tate distribution, which in turn is closely related to random matrix theory. On the other hand, if $p$ is fixed and we let $q$ tend to infinity (or taking $p$, $q$ to infinity in some arbitrary way), the situation is less clear, e.g., since the number of points on a curve cannot be negative, the random matrix theory model is not valid in this setting. However, for certain families of curves, certain "coin flip models" can be used to describe the fluctuations; using this we can show that the point count fluctuations are Gaussian in the large genus limit.

Wednesday 2 February 2011, Rosa M. Miró-Roig, Universitat de Barcelona, Spain
Cohomological characterization of vector bundles
Abstract: In my talk, I will address the problem of giving a cohomological characterization of vector bundles on algebraic varieties. This is a longstanding problem in Algebraic geometry which has its roots in an old paper by Horrocks where he gave a cohomological characterization of line bundles on projective spaces $\mathbb{P}^n$. In my talk, I will give a cohomological characterization of the bundle of p-differential forms on projective spaces $\mathbb{P}^n, \ldots, \mathbb{P}^m$ and a cohomological characterization of Steiner bundles on algebraic varieties. As a main tool I will use a generalized version of Bellinson's spectral sequence.

Wednesday 9 February 2011, Bernd Sturmfels, University of California, Berkeley, USA
Quartic curves and their bitangents
This is a joint arrangement with The Royal Swedish Academy of Sciences (Kungliga Vetenskapsakademien, KVA); see p. 7 of their Spring Programme 2011 (pdf file).

Wednesday 2 March 2011, Andreas Nilsson, SAAB, Linköping
Invariance multipliers
Abstract: Multipliers correspond to translation invariant operators. Sometimes they can satisfy more invariance conditions and this talk will be about such multipliers. For example Stein has shown that the Riesz transforms can be characterized as being invariant under dilations and satisfying a certain invariance condition under rotations. In this talk I will give a survey on this topic.

Wednesday 9 March 2011, Erik Wahlén, Lunds universitet
Existence and stability of solitary water waves with surface tension
Abstract: Solitary water waves with surface tension on water of infinite depth are constructed by minimising the energy subject to the constraint of fixed momentum. The stability of the set of minimisers follows by a standard principle since the energy and momentum are conserved quantities. The stability must however be understood in a qualified sense due to the lack of a global well-posedness theory for the initial value problem. The variational method relies on the concentration-compactness principle and a penalisation argument, which is needed because of the quasilinear structure. To leading order the solitary waves take the form of a periodic wave train modulated by a small-amplitude decaying envelope described by the focusing nonlinear Schrödinger equation.

Wednesday 16 March 2011, Prof. Giorgio Ottaviani, University of Firenze, Italy
On the rank of real polynomials
Abstract: A Waring decomposition of a polynomial is a sum of powers of polynomials of degree one expressing it. The rank of a polynomial is the minimal number of summands in a Waring decomposition. For example the rank of $x^2 - y^2$ is 2. The interest on this notion is motivated by applications to communication theory and other fields. We discuss about joint work with P. Comon about the rank of real polynomials in one variable.

Wednesday 23 March 2011, Nageswari Shanmugalingam, University of Cincinnati
A geometric characterization of planar BV extension domains
Abstract: The class of functions of bounded variation (BV) embodies the geometry of hypersurfaces and of boundaries of sets. It is therefore interesting to know whether a Euclidean domain is a BV extension domain, that is, a domain whose BV functions extend as BV functions to the entire Euclidean space with controlled BV energy. Burago and Maz'ya gave a characterization of BV extension domains in terms of extendability of sets of finite perimeter in the domain. In this talk we will discuss a very simple geometric characterization of bounded simply connected planar BV extension domains. The results pertinent to this talk are based on joint work with Pekka Koskela and Michele Miranda.

Wednesday 30 March 2011, Zohro Farnana, Aalto University, Helsinki, and MAI
Stability of solutions of the double obstacle problem on metric spaces
Abstract: We study the regularity properties of solutions to the double obstacle problem in metric spaces. Our main results are a global reverse Hölder inequality and stability of solutions. We assume that the space supports a weak Poincaré inequality and a doubling measure. Furthermore we assume that the complement of the domain is uniformly thick in the capacitary sense.

Wednesday 6 April 2011, Prof. Bharath Sriraman, The University of Montana
Mathematical Giftedness and Models of Talent Development – Issues, Practices and Challenges
Abstract: In recent years, gifted education/ giftedness has become an object of focus in Sweden. There is a tendency for researchers to transpose models and/or theories situated in different (national) contexts. i.e. from elsewhere, into their local context. However this creates conflict of these models clash with the local culture and the larger ideology that forms the basis of the educational system. In this lecture, an overview of issues and practices in gifted education will be presented with an emphasis on cultural norms and a focus on "mathematical" giftedness. Political, sociological and cultural issues in gifted education in the U.S and elsewhere is provided. Finally, different techniques and programs devised for identification and meeting the needs of mathematically gifted students are addressed.

Wednesday 27 April 2011, Prof. Sergey Nazarov, Institute of Mechanical Engineering Problems, St. Petersburg
On spectra of water-waves problems: Trapped modes and comparison principles
Abstract: A new approach in the linear theory of water-waves is described. It is based on the notion of a trace operator and elementary issues in the theory of self-adjoint operators in Hilbert space. By means of simple calculations and arguments, it gives direct proofs of many known facts and also new sufficient conditions for the existence of trapped modes that are eigenfunctions, solutions to the homogeneous problem with a finite energy in unbounded basins.

Wednesday 4 Maj 2011, Axel Hultman, MAI
Schubert varieties and inversion hyperplane arrangements
Abstract: In this talk I will discuss some current research on Schubert varieties and their inversion hyperplane arrangements.
Abstract: With a permutation of a finite set, we can associate an arrangement of hyperplanes called the inversion arrangement. In the real setting, it cuts the ambient space into two pieces.

Wednesday 11 Maj 2011, Johan Andersson, Uppsala University
On the power sum problem
Abstract: I will discuss for what choices of n and m the quantity
\[
\min_{|\alpha|_1=1} \max_{|\sigma|=n} \sum_{i=1}^n |\alpha_i|^m
\]
can be exactly determined, when asymptotic estimates can be found and when the right order of magnitude can be obtained. Methods used include the non negativity of the Fejér kernel, the Newton–Girard identities, as well as estimates for character sums. I will also mention recent applications of these results on the explicit construction of RNP-matrices, which are useful for compressed sensing.

Wednesday 18 Maj 2011, Dustin Cartwright, University of California, Berkeley
Interference alignment
Abstract: Interference alignment is a technique in wireless communications for allowing increased capacity across a wireless channel. In order to realize these gains it is necessary to find vector spaces satisfying certain containment conditions. I will explain how these solutions can be investigated using both elementary linear algebra techniques and the more sophisticated machinery of Schubert calculus.

Wednesday 25 Maj 2011, Prof. Joseph Landsberg, Texas A&M University, College Station
The geometry of tensors
Abstract: I will begin by reviewing basic results from linear algebra and discuss the corresponding issues in multilinear algebra – many of them translate to open questions! Even a notion as simple as the rank of a matrix becomes a subtle concept when discussing higher dimensional matrices, i.e., tensors. Some of these open questions are central to issues in areas such as computer science (complexity theory), engineering (signal processing) and physics (quantum information theory). The second part of my talk will discuss questions arising in these application areas. Recently many researchers in geometry have become interested in these open questions and I will conclude with a survey of recent progress.

Wednesday 8 June 2011, Henrik Branden, MAI (Joint Seminar with the Didactics Group)
Teaching Higher Order Thinking Skills in Scientific Computing
Abstract: In this talk I will present a teaching project that I did during the fall of 2011. The goal was to encourage students in scientific computing courses to train higher order thinking skills and to increase both the number of students with a passing grade and the number of students with higher grades. The main tool for this was constructive alignment, which required a major revision of the courses. The new versions was given with good outcome on three different programs.

Thursday 9 June 2011, K. Kozlov, Moscow State University, Russia
Compacts as equivariant compact extension of rationals
Abstract: The question what compact spaces can be equivariant extensions of the space of rational numbers Q with transitive action of some group G will be discussed. Let K be a homogeneous CDH (countable dense homogeneous) metrizable compactum. Then there is a Polish group G which acts transitively on Q with K a unique equivariant compact extension of Q.

Wednesday 31 August 2011, Hans Lundmark, MAI
Cauchy biorthogonal polynomials
Abstract: The theory of Cauchy biorthogonal polynomials was developed recently by M. Bertola, M. Gekhtman and J. Szmigielski as a general framework for understanding certain formulas that appear in so-called peakon solutions to some integrable PDEs (in particular the Degasperis–Procesi equation that I have studied together with J. Szmigielski). In this talk I will concentrate on these polynomials, and not say very much about the PDEs. After reviewing the basic facts about ordinary orthogonal polynomials, I will describe Cauchy biorthogonal polynomials and explain differences and similarities to the classical theory. Previous acquaintance with orthogonal polynomials might be helpful, but shouldn’t really be necessary.

Wednesday 7 September 2011, David Singerman, University of Southampton, UK
The Geometry of Galois’ final theorem
Abstract: In Galois’ last letter he found the values of the primes p for which the group PSL(2,p) acts transitively on less than p+1 points. (It always acts transitively on the p+1 points of the projective line.) He found that these values of p are 2, 3, 5, 7, 11. The cases p=7, p=11 have much geometric interest. PSL(2,7) is the automorphism group of the simplest projective plane, the Fano plane on 7 points. The simplest biplane is on 11 points, and PSL(2,11) is its automorphism group. The Fano plane can be embedded in Klein’s Riemann surface of genus 3. We find an interesting surface of genus 70, in which we can embed the biplane on 11 points. This surface also contains truncated icosahedra or buckyballs and so is called the buckyball curve.

Wednesday 14 September 2011, Ignacio Uriarte-Tuero, Michigan State University, USA
The full automorphism group of a family of generalized Fermat curves
Abstract: In this talk we will be concerned with a certain family of closed Riemann surfaces which are the highest (branched) abelian covers of orbitfolds with signature (0;k,k,...,k). We will provide simple algebraic curves of these surfaces and discuss the group of conformal automorphisms of them. In the particular case that the signature is (0;k,k,k,k) we will be able to obtain the full group of automorphisms as a consequence of Singerman’s list of maximal signatures and also to compute the field of moduli. We also obtained that the field of moduli is in fact a field of definition.

Wednesday 21 September 2011, Alexander Vasiliev, Universitetet i Bergen
Evolution of smooth shapes and integrable systems
Abstract: We consider a homotopic evolution in the space of smooth shapes starting from the unit circle. Based on the Loewner–Kufarev equation we give a Hamiltonian formulation of this evolution and provide conservation laws. The symmetries of the evolution are given by the Virasoro algebra. The positive Virasov at s > 0 := t - t of p := \frac{t}{t} + t of t of p := \frac{t}{t} + t of the corresponding t of the canonical Poisson structure. We study an embedding of the Loewner–Kufarev trajectories into the Segal–Wilson Grassmannian, construct the tau-function, the Baker–Akhiezer function, and finally, give a class of solutions to the KP equation. Joint work with Irina Markina.

Wednesday 28 September 2011, Magnus Jacobsson, Uppsala University
New Invariants in Knot Theory
Abstract: New invariants in knot theory have been found in the last decades which generalize and enlight the well-known Jones polynomial and its associated polynomials. I will describe the simplest of the new invariants, Khovanov homology, together with some of its properties.

Wednesday 5 October 2011, John Lewis, University of Kentucky, Lexington
Harmonic measure and p-harmonic measure
Abstract: Let Ω ⊂ R^n, n ≥ 2, be a bounded domain. The Dirichlet problem for Laplace’s equation in Ω can be stated as follows: Given a continuous function f on ∂Ω, find a harmonic function u in Ω with continuous boundary values equal to f. If f is smooth and ∂u ∈ C1 then one can use the Riesz representation theorem to show the existence of a measure μ := μ(f, Ω) on ∂Ω satisfying
$u(x_0) = \int_0^1 f \, dw(x, x_0)$. 

$\omega$ is called harmonic measure with respect to $\partial \Omega$. During the first part of my talk I will give an outline of some of the many results for harmonic measure which have been of interest to me during my career. During the second part of the talk I will indicate some recent results of myself and coauthors which generalize results for harmonic measure to measures associated with a positive solution to a nonlinear partial differential equation (called the p-Laplacian) that vanishes on a portion of $\partial \Omega$.

**Wednesday 10 December 2011, Andreas Rosén, MAI, N.B. This talk was a joint seminar with the didactics group.**

**Riemann eller Lebesgue?**


Jag planerar att tala i 30–45 minuter med en efterföljande diskussion. Dels kommer jag att förklara uppbyggnaden av pre-Lebesgueintegralen, och dels kommer jag att gå igenom ett pedagogiskt experiment som är inblandat i envariabel- och flervariabelanalysundervisningen bör ha befallning av att delta.

**Wednesday 19 October 2011, Nikolay Kuznetsov, Russian Academy of Sciences, St. Petersburg**

**Loads on marine structures in extreme waves**

Abstract: The impact of extreme waves (also referred to as freak waves) on ships and off-shore structures is an important question from different points of view (environmental, engineering etc.). The aim of this talk is to present heuristic considerations on how to simplify calculations of loads due to freak waves. One way of doing this is to combine a nonlinear model of such waves (Zakharov et al.) with an asymptotic approach to brief wave disturbances developed in the framework of the linear theory of water waves (Kuznetsov & Maz’ya).

**Wednesday 9 November 2011, Olli Martio, Helsingfors universitet och Finnish Academy of Science and Letters**

**Riccati equations**

Abstract: In the classical sense a solution to a differential equation is well understood. However, modern mathematics has created solution classes that considerably extend the classical concept. These generalized solutions also play an important role in applications. Riccati type second order partial differential equations

$$-\nabla \cdot (|\nabla u|^p \nabla u) = |\nabla u|^q, \quad p > 1, \quad q > 0,$$

and their solutions offer an interesting platform for various solution classes.

In the talk the classes of ordinary, weak, very weak and superharmonic solutions of the Riccati equation and some of their properties are considered and the effects of the exponents $p$ and $q$ are discussed.

**Wednesday 16 November 2011, Kristian Seip, Norges teknisk-naturvitenskapelige universitet, Trondheim**

**The Bohnenblust–Hille inequality**

Abstract: The Bohnenblust–Hille inequality, proved in 1931, says that the $\|P_m\|_{h_\infty^n}$-norm of the coefficients of an $m$-homogeneous holomorphic polynomial $P$ on $\mathbb{C}^n$ is bounded by $\|P_m\|_{h_\infty^n}$ times a constant independent of $m$, where $\|P_m\|_{h_\infty^n}$ denotes the supremum norm on the polydisc $\mathbb{D}^n$. The result is sharp in the sense that the independence of $m$ fails if the exponent $2m/(m-1)$ is replaced by a smaller number. The talk will present the historical background for this result, a few applications, the notion of polarization (the basic idea of proving independence) and the hunt for the best constant which was essentially completed in 2011.

**Wednesday 23 November 2011, James Brennan, University of Kentucky, Lexington**

**The Cauchy integral and certain of its applications**

Abstract: The Cauchy integral plays a fundamental role in almost every area of complex analysis. In this talk it is my intention to describe, in outline, the manner in which the Cauchy integral enters into certain problems in approximation theory. In the process, I will also give an introduction to three seemingly disparate but, nevertheless, interrelated topics:

1. The invariant subspace problem for normal operators on a Hilbert space;
2. Thomson’s theorem on mean-square polynomial approximation;
3. Tsirlin’s work on the semiaadditivity of analytic capacity.

**Wednesday 30 November 2011, Irina Markina, Universitetet i Bergen**

**Sub-Riemannian geometry and principal bundles**

Abstract: It will be an introductory talk to the subject that in the last decade received the name sub-Riemannian geometry. All necessary definitions and examples will be presented. We also illustrate how the geometry of principal bundles and sub-Riemannian geometry are related. In particular, we give the description of sub-Riemannian geodesics on principal bundles and their interesting properties.

**Wednesday 7 December 2011, Leif Melkersson, MAI**

**Problems on local cohomology – solved and unsolved**

Abstract: Local cohomology modules are in general not finitely generated. However under certain conditions on the ring, the ideal or the module, they can satisfy other finiteness conditions. In particular I will consider the question of cofiniteness. I have now solved a longstanding problem, namely that the modules cofinite with respect to a one-dimensional ideal in an arbitrary noetherian ring form a full abelian subcategory of the category of modules, i.e. they behave well under exact sequences.

**Wednesday 14 December 2011, Benjamin Young, KTH**

**Combinatorics of Donaldson–Thomas and Pandharipande–Thomas invariants**

Abstract: I will discuss a combinatorial problem which comes from algebraic geometry. The problem, in general, is to show that two theories for “counting” curves in a complex three-dimensional space $X$ (Pandharipande–Thomas theory and reduced Donaldson–Thomas theory) give the same answer. I will prove this in a special case (X is toric Calabi–Yau), where the difficult geometry reduces to elementary combinatorics. Though this approach is still difficult, it can be handled with a novel use of Eric Kuo’s “graphical condensation” technique. There will be many pictures. This is a combinatorics talk, so no algebraic geometry will be used once I explain where the problem is coming from.
The Mathematical Colloquia held in 2010 at Linköping University

Organized by Anders Björn, Milagros Izquierdo Barrios, Vladimir Kozlov and Hans Lundmark.

Wednesday 20 January 2010, Prof. Vladimir Kozlov, MAI
Complete description of water waves in a canal of finite depth for near-critical values of Bernoulli's constant

Wednesday 27 January 2010, Prof. Åke Björck, MAI
LTH – från plan till verklighet


Friday 5 March 2010, Margaret Beck, Boston University
Understanding metastability using invariant manifolds

Abstract: Metastability refers to transient dynamics that persist for long times. More precisely, suppose a PDE has a globally attracting state, meaning that, for any initial condition, the solution will asymptotically approach that state. It can happen that, on its way to the state, the solution spends a long period of time near another, possibly unstable, state. This happens, for example, in the Navier–Stokes equation in two spatial dimensions and Burgers equation in one spatial dimension, both with small viscosity. I will explain how, in the context of Burgers equations, this behavior can be understood using certain global invariant manifolds in the phase space of the PDE.

Wednesday 10 March 2010, Prof. Sergey Nazarov, Institute of Mechanical Engineering Problems, Saint Petersburg
Spectral peculiarities of T-shaped waveguides and the Dirichlet ladder

Abstract: It will be shown that the discrete spectrum of a 2d T-shaped waveguide with soft walls, composed from a strip of unit width and a semi-strip of width H > 0, is empty in the case H > Hc, but consists of the only eigenvalue in the case H ∈ [0, Hc], where Hc ∈ (1, 2] is the critical width (its explicit value is still unknown). The effect of opening gaps in the essential spectrum of the infinite 1-periodic Dirichlet ladder, composed from two parallel strips of the small width h and cleats (crossbeams) with length l and thickness Hh, is caused by the above-mentioned eigenvalue. Several unsolved homogenization problems will be formulated.

Thursday 11 March 2010, Prof. Bharath Sriraman, The University of Montana
On identities and theories of mathematics education: A critical view of the field

Abstract: In this talk a critical view of mathematics education is presented by examining its connections to psychology, social sciences, the history and philosophy of mathematics/science and design sciences. The identity of “our” field is questioned even though it offers multitudes of paradigms, methodologies and the possibilities for innovative research.

Wednesday 17 March 2010, Prof. Viviane Baladi, ENS, Paris
Linear response for generic smooth unimodal maps

Abstract: Many interesting dynamical systems admit a “natural” or “physical” measure, which describes the asymptotic time averages of a positive Lebesgue measure set of initial conditions. This measure is called the SRB measure, for Sinai–Ruelle–Bowen. When a smooth one-parameter family fj of dynamical systems admits for all (or many) small parameters t a unique SRB measure μj, it is natural to ask if the map f → μj is also smooth (possibly in the sense of Whitney). In 1997, David Ruelle solved the case when the fj are smooth and uniformly hyperbolic, obtaining a formula for the derivative: the linear response formula. Ten years later, Daniel Smania and I discovered by studying a “toy model” (piecewise expanding maps) that the presence of critical points (which destroy structural stability) may cause obstructions to linear response. We proved that the condition of “tangency” of the family to the topological class was necessary and sufficient for linear response to hold. For smooth nonuniformly hyperbolic unimodal maps, the situation is much more difficult, and for expanding maps) that the presence of critical points (which destroy structural stability) may cause obstructions to linear response. We proved that the condition of “tangency” of the family to the topological class was necessary and sufficient for linear response to hold. For smooth nonuniformly hyperbolic unimodal maps, the situation is much more difficult, and for

Wednesday 24 March 2010, Prof. Mikael Patriksson, Chalmers, Göteborg, and MAI
Current research topics and trends in the Optimization group at Mathematics Sciences, Chalmers

Abstract: The optimization group at Chalmers/Mathematical Sciences perform both basic and applied research; often the two inspires each other. The presentation covers especially two such research topics, one being the price-winning research on combinatorial optimization in maintenance planning, the other being investigations into a stochastic hierarchical decision model that has immediate applications both in traffic control and in the cure of cancer. We might also comment on how the group has responded to the recent emergence of the “Areas of advance” (”Styrkområden”), in particular in transportation and energy, following the recent substantial strategic grants given by the Swedish government.

Wednesday 28 April 2010, Mikael Olofsson, ISY
Matrix representations of Finite Extension Fields

Abstract: In 1905 G. Vitali presented first examples of non-Lebesgue measurable sets on the real line. They were called Vitali sets. In this talk I will consider some properties of the Vitali sets and their unions.

Wednesday 28 April 2010, Michael Olofsson, ISY
Matrix representations of Finite Extension Fields

Abstract: In 1905 G. Vitali presented first examples of non-Lebesgue measurable sets on the real line. They were called Vitali sets. In this talk I will consider some properties of the Vitali sets and their unions.
Abstract: A finite extension field can be viewed as a vector space over any of its subfields, with the additional property that there also is a multiplication of the elements. The elements of the field can therefore be represented as vectors over that subfield with respect to some basis. The choice of the basis affects how the arithmetic operations can be done, and thus also the complexity of the operations. Moreover, the elements of the field can be represented as matrices over that subfield with respect to two bases, which can help the implementation of arithmetic operations in the field. In this seminar, we introduce vector and matrix representations of finite extension fields and investigate structural properties of some of those matrix representations.

Tuesday 4 May 2010, Prof. Svante Linusson, KTH
Random orientations in graphs and the bunkbed conjecture
Abstract: I will describe some results from recent investigations (mostly with coauthors Sven Erick Alm and Svante Janson) on the probabilities for directed paths in randomly oriented graphs. In particular we study correlations, i.e. how the existence of a path between two vertices of a graph influences the probability of the existence of another path. The underlying graph can either be fixed or be a random graph. The talk will be self-contained and should be understandable to all PhD-student. My starting point for all these questions comes from an old conjecture by Kasteleyn (1985) on probabilities of paths in random graphs (a.k.a. percolation) which seems intuitively obvious, but no one has found a proof yet. This conjecture was named the BunkBed conjecture and presented by Olle Häggström at PASCAL’03 organized by Linköpings universitet, were he also presented proofs for a related problem. The talk is strongly related to the Master theorem of Erik As, which is presented earlier the same day.

Wednesday 5 May 2010, Prof. Claire Tomlin, UC Berkeley. Automatic Control–Mathematics Joint Colloquium
Verification and Control of Hybrid Systems using Reachability Analysis
Abstract: This talk will present reachability analysis as a method for model checking and controller synthesis for hybrid systems. We will consider the problem of guaranteeing reachability to a given closed subset of the state space. We allow for nonlinear dynamics in each dimension, and possibly non-linear state constraints. We make use of techniques from hybrid system verification to compute reachable sets, under bounded model disturbances that vary continuously. We also consider the effects of sampling and quantization. The resulting control policy is an explicit feedback law involving both a selection of continuous inputs and discrete switching commands at each time instant, based upon measurement of system state. We discuss real time implementations of this, and present several examples from multiple UAV control.

Wednesday 12 May 2010, Reiner Lenz, ITN
Don’t think twice it’s all right

Wednesday 19 May 2010, Prof. Olof Heden, KTH
On vector space partition problems, a survey of different types
Abstract: A vector space partition will here be a collection $F$ of subspaces of a finite vector space $V(n,q)$, of dimension $n$ over a finite field with $q$ elements, with the property that every non zero vector is contained in a unique member of $F$. Vector space partitions relate to finite projective planes, design theory and error correcting codes. After a few historical remarks, I will discuss the relations to the other branches of math- ematics mentioned above. The other part of the talk will contain a survey of the known results on the type of a vector space partition, more precisely: the theorem of Beutelspacher and Heden on T-partitions, rather recent results of ElZanati et al. on the different types that appear in the spaces $V(n,2)$, for $n \leq 8$, a result of Heden and Lehmann on vector space partitions and maximal partial splits including a new necessary condition, a theorem of Heden on the length of the tail of a vector space partition, and finally, a result of Alman and Pissinou on the lattice of vector space partitions of a finite vector space.

Monday 24 May 2010, Prof. Peter Leach, University of Wkazu-Natal, South Africa
Complete symmetry groups

Wednesday 2 June 2010, Prof. Göran Bergqvist, MAI
Tensor rank
Abstract: We give an elementary introduction to the concept of rank for multi-way arrays or tensors, emphasizing the differences between general arrays and two-way arrays (matrices). While the same variable size decomposition solves the problem of low-rank approximations of matrices, the corresponding problem for tensors is much more complicated. We also sketch a proof of how some exact probabilities of so-called typical ranks of tensors can be determined, these are the first such exact values known.

Wednesday 25 August 2010, Mikael Vejdemo-Johansson, Stanford University
Politeknisk topologi
Abstract: Principaldimensionen (PCA) och andra verktyg från modern dataanalys har varit stapelvara inom politikvetenskapen det senaste decenniet. Man kan läsa ut en hel del Politikens topologi

Wednesday 1 September 2010, Mikael Langer, MAI
Asymptotics of solutions of a perturbed heat equation
Abstract: Solutions of a second order parabolic differential equation in a cylinder are studied and their asymptotic properties as the time variable tends to infinity are presented.

Wednesday 8 September 2010, Prof. Nikolay Kuznetsov, Russian Academy of Sciences, Saint Petersburg
On the problem of time-harmonic water waves in the presence of a freely floating structure
Abstract: The two-dimensional problem of time-harmonic water waves in the presence of a freely floating structure (it consists of a finite number of infinitely long surface-piercing cylinders) is considered. The coupled spectral boundary value problem modelling the small-amplitude motion of this mechanical system involves the spectral parameter – the frequency of oscillations – which appears in the boundary conditions as well as in the equations governing the structure’s motion. It is proved that any value of the frequency turns out to be an eigenvalue of the problem for a particular structure obtained with the help of the so-called inverse procedure.

Wednesday 15 September 2010, Prof. Milagros Izquierdo, MAI
On the (dis)connectedness of the branch locus of moduli spaces of Riemann surfaces
Abstract: The moduli space $\mathcal{M}_g$ of compact Riemann surfaces of genus $g$ has the structure of an orbifold and the set of singular points of such orbifold is the branch locus $\mathcal{B}_g$. In this talk we study the (dis)connectedness of $\mathcal{B}_g$. More concretely, $\mathcal{B}_2$ is disconnected for $g \geq 26$. Finally we present the known information about this issue for genera $< 26$.

Wednesday 6 October 2010, Prof. Jan Nordström, MAI
Weak Boundary and Interface Conditions with Multi-Physics Applications
Abstract: By reusing the main ideas behind the recent development of stable high order finite difference methods (summation-by-parts operators, weak boundary conditions, the energy-method) new coupling procedures have been developed. We will present the theory by analysing simple examples and apply to very complex multi-physics problems.

Wednesday 13 October 2010, Prof. Anders Björner, KTH & Mittag-Leffler Institute
A q-analogue of the FKG inequality and some applications
Abstract: The FKG inequality of Fortuin, Kasteleyn and Ginibre (1971) originated as a correlation inequality in statistical mechanics. It has many applications in discrete probability and extremal combinatorics.

In this talk we present a polynomial coefficient-wise inequality that refines the original FKG inequality. This polynomial FKG inequality has applications to $f$-vectors of joins of simplicial complexes, to Betti numbers of intersection of Schubert varieties, and to power series weighted by Young tableaux. The latter case includes a correlation-type inequality for the polarization of Plancherel measure on symmetric groups, a probability measure on the set of all integer partitions. The talk will be quite elementary and no previous familiarity with these topics will be assumed.

Wednesday 20 October 2010, Tomasz Adamowicz, MAI
On $\Delta_p$-Laplacian, variable exponent and image processing
Abstract: The purpose of the talk is to introduce the fundamental object of nonlinear potential theory the $p$-harmonic operator and related $p(x)$-harmonic equation, the so-called variable exponent $p(x)$-Laplacian. If $p = \text{const}$ we have the well-known $\Delta_p$-harmonic case, but in general the geometry of the $p(x)$-harmonic world is much more complicated than the harmonic one. The basic properties of the nonlinear Laplacian and $p(x)$-Laplacian and show the unexpected and fruitful interplay between planar quasilinear PDEs and the class of mappings of finite distortion. If time permits we will discuss some of the applications of variable exponent PDEs in image processing. The talk will be accessible to graduate students and a general audience of mathematicians.

Wednesday 27 October 2010, Prof. Tudor Ratiu, EPFL, Lausanne
The variational structure of conservative complex fluids
Abstract: The goal of the talk is to present the geometry and variational principle that gives rise to Eringen’s conservative micropolar liquid crystal equations. To get there, the basic Euler–Poincaré equations and variational principle will be presented, as well as the examples of the free rigid body, ideal incompressible homogeneous Euler flow, and the Korteweg–de Vries equation. Then it will be explained how the affine Euler–Poincaré reduction gives rise to the conservative micropolar liquid crystal equations.

Wednesday 3 November 2010, Tomas Sjödin, MAI
Integrability properties of positive harmonic functions
Abstract: Positive harmonic functions on a bounded domain in n-dimensional Euclidean space have many special properties. For instance on a ball they are precisely those functions representable as a Poisson integral of a positive measure on the boundary of the ball. On some domains, in fact on a square in two dimensions, this is not true. The aim of this talk will be to sketch a proof of the fact that on a quadrature domain (where a
ball is an example of such) they are always integrable. The proof builds on blow-up arguments from the theory of free boundaries and Martin boundary techniques.

Wednesday 10 November 2010, No Colloquium. (Seminar on Intercultural Communication with Nigel Musk, IKK.)

Wednesday 17 November 2010, Tatiana Shaposhnikova, MAI

Regularity properties of solutions to the Dirichlet problem for higher order elliptic systems with rough coefficients and the boundary

Abstract: Given a bounded Lipschitz domain, we consider the Dirichlet problem with boundary data in Besov spaces for divergence form strongly elliptic systems of arbitrary order with bounded complex-valued coefficients. The main result gives a condition on the local mean oscillation of the coefficients of the differential operator and the unit normal to the boundary which guarantee that the solution operator associated with this problem is an isomorphism. This is a joint work with Vladimir Maz'ya and Marius Mitrea. I also describe higher regularity results in a subclass of Lipschitz domains characterized in terms of Sobolev multipliers, following the recent book by Vladimir Maz'ya, Tatiana Shaposhnikova “Theory of Sobolev Multipliers with Applications to Differential and Integral Operators”, Springer, Grundlehren der Mathematischen Wissenschaften, 2009. I'll pay much attention to classes of functions used in these results.

Friday 26 November 2010, Prof. Bernt Wennberg, Chalmers Tekniska Högskola

Propagation of chaos in many-particle systems

Abstract: Boltzmann's and Maxwell's kinetic theory aims at explaining the behavior of gases from an atomistic point of view. When Boltzmann's famous paper was published in 1872, the concept of atoms was not generally accepted, and the kinetic theory was much criticized. Poincaré and Zermelo gave examples that pointed at the apparently paradoxical fact that the Boltzmann equation is irreversible, while the microscopic dynamics is reversible. While this paradox is now resolved, there is still no complete, rigorous derivation of the Boltzmann equation. A key concept is "propagation of chaos". In my talk I will explain what this means, and discuss some simplified cases where propagation of chaos can be proven to hold, and hence the Boltzmann equation to be valid.

Wednesday 1 December 2010, Peter Basarab-Horwath, MAI

Some aspects of classifying evolution equations

Abstract: The problem of classifying evolution equations is presented from a systematic symmetry point of view. Using standard techniques from Lie symmetry theory allied with representation theory and the equivalence group of a differential equation (also known as the covariance group), we are able to give a complete classification of third-order evolution equations in terms of symmetry properties.

Wednesday 8 December 2010, Lukáš Malý, MAI

Calderón-type theorems for operators with nonstandard endpoint behavior

Abstract: Calderón's theorem states that every quasilinear operator, which is bounded both from $L^{p_1}$ to $L^{q_1}$, and from $L^{p_2}$ to $L^{q_2}$ for properly ordered values of $p_1, p_2, q_1, q_2$, is bounded on some rearrangement-invariant space if and only if the so-called Calderón operator is bounded on the corresponding representation space. We will establish a Calderón-type theorem for nonstandard endpoint behavior, where Lorentz $A$ and $M$ spaces will be the endpoints of an interpolation segment. Two distinctive types of nonstandard behavior are to be discussed; first, we'll explore the operators bounded simultaneously from $A(X_1)$ to $M(Y_1)$, and from $M(X_2)$ to $A(Y_2)$, next, operators bounded simultaneously from $A(X_1)$ to $A(Y_1)$, and from $M(X_2)$ to $M(Y_2)$. For that purpose, we evaluate Peetre’s $K$-functional for varied pairs of Lorentz spaces.
The Mathematical Colloquia held in 2009 at Linköping University

Organized by Anders Björn, Milagros Izquierdo Barrios, Vladimir Kostr, Hans Lundmark and Stefan Rauch-Wojciechowski.

Tuesday 13 January 2009, Jonas Bergman Arlebäck, MAI (Joint Seminar with Mathematics Education)

Title: Introducing mathematical modelling using Fermi problems in upper secondary school.

Abstract: In the documents governing the Swedish upper secondary mathematics education more and more emphasis is put on mathematical modelling. However, research suggests that the explicit teaching of mathematical modelling is not part of the implemented curricula in the classrooms. In this background, I report on and discuss a study aiming to investigate the potential of using Fermi problems to introduce mathematical modelling to Swedish upper secondary school students. The work of three groups of students engaged in solving realistic Fermi problems was analysed using an analytic tool referred to as the MAD framework, providing ‘modelling activity diagrams’ of the groups’ problem solving processes. Using these diagrams, I conclude that the processes involved in a mathematical modelling were richly represented in the problem solving processes of the groups.

Wednesday 14 January 2009, Magnus Herbertsson, MAI

Title: On the potential method for calculating radar cross sections.

Abstract: Under some natural conditions, the problem of determining the radar cross section of a body with boundary surface S results in a vector valued integral equation over S, which involves only quantities tangential to S. Using Hodge decomposition theorem, this equation can be formulated in terms of scalar functions. I will describe some recent developments using this technique.

Friday 30 January 2009, Ewa Kozlowska-Walania, University of Gdansk, Poland

Title: On the potential method for calculating radar cross sections.

Abstract: The inclusion/exclusion principle (or more generally the Möbius inversion formula) can be used very efficiently to count the number of points of a finite set covered by subsets. There are situations however which are not covered by the principle. Examples are when we have a group acting on the set permuting the elements of the cover and one is interested in computing not just the cardinality but the permutation character. I will give a general abstract setup which allows us to get inversion formulas covering these more general situations.

Monday 2 February 2009, Presentation of Maple TA

See http://www.maplesoft.com/products/mapleta

Wednesday 4 February 2009, Prof. Thomas Kalijärvi, MAI

Title: Convergence in distribution for Markov chains induced by partitions of transition probability matrices.

Abstract: Let S be a denumerable state space, P a transition probability matrix on S and F the set of probability vectors on S. A partition M of P is a denumerable set of nonnegative matrices such that their sum is equal to P. To every partition M of P we associate a transition probability function P_M on K defined in such a way that if p ϵ K and M ϵ M are such that [[p][M] > 0] then, with probability [[p][M]], the vector p is transferred to the vector [[p][M]].

In this talk I will present conditions that imply convergence in distribution towards a unique limit distribution independent of initial distribution for Markov chains generated by transition probability functions induced by partitions of transition probability matrices.

I will give some proofs, and also some examples for which such a conclusion is not true.

The motivation for this work is that every so called Hidden Markov chain induces a partition of the transition probability matrix.

Wednesday 11 February 2009, Kirsti Hemmi, MAI (Joint seminar with Mathematics Education)

Title: Students’ encounters with mathematical proof.

Abstract: There is a renewed emphasis on mathematical proof in the ongoing revisions of school curricula in many countries and proof is also a vital issue in mathematics education research. I will describe the main issues in the didactical research on proof and present some theoretical and empirical results from my study about students’ encounters with proof at a mathematics department in Sweden.

Wednesday 18 February 2009, Prof. Andrzej Szulkin, Stockholms universitet

Title: Convergence in distribution for Markov chains induced by partitions of transition probability matrices.

Abstract: Consider the Schrödinger equation −Δu + V(x)u = f(x, u) in R^2. It describes the behaviour of a particle (or a system of particles) under the influence of an electric potential V and an external magnetic field B. In R^2 we can associate a transition probability function P_M on K defined in such a way that if p ϵ K and M ϵ M are such that [[p][M] > 0] then, with probability [[p][M]], the vector p is transferred to the vector [[p][M]].

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The motivation for this work is that every so called Hidden Markov chain induces a partition of the transition probability matrix.

Wednesday 25 February 2009, Prof. Torsten Ekedahl, Stockholms universitet

Title: A generalised Möbius inversion formula.

Abstract: The inclusion/exclusion principle (or more generally the Möbius inversion formula) can be used very efficiently to count the number of points of a finite set covered by subsets (or more generally computing the Euler characteristic of a topological space covered by open subsets). There are situations however which are not covered by the principle. Examples are when we have a group acting on the set permuting the elements of the cover and one is interested in computing not just the cardinality but the permutation character. I will give a general abstract setup which allows us to get inversion formulas covering these more general situations.

Wednesday 4 March 2009, Prof. Milagros Izquierdo, MAI

Title: On the connectedness of the branch locus of the moduli space of Riemann Surfaces.

Abstract: We use the equiparametric stratification described by Broughton (1990) to study the connectedness of the branch locus of the moduli space of Riemann surfaces of low genus. We also show that for infinite genera the branch locus contains isolated strata of dimension 1, generalizing a result of Kulkarni (1991) for isolated points.

Wednesday 18 March 2009, Prof. Natan Kruglyak, Växjö

Title: Image processing, Sobolev embedding theorem and real interpolation.

Abstract: Nowadays interpolation theory is an important and rather abstract branch of functional analysis which has many applications to harmonic analysis and partial differential equations. However, as I plan to explain during the talk, a part of it which is called real interpolation and goes back to classical theorem of Marcinkiewicz, is connected with modern
mathematical methods in image processing. This connection leads to deep mathematical problems. I plan to discuss them and one approach based on Sobolev embedding theorem and local approximations.

Wednesday 25 March 2009, Prof. S. A. Vakulenko, St. Petersburg Academy of Sciences
Title: Genetic networks.
Abstract: We consider a mathematical model of genetic networks proposed by J. Reinitz , E. Mjölnes and D.Sharp. This model is a generalization of the famous Hopfield model of neural networks (1982) which takes into account diffusion, inhibition and activation of genes.

The talk contains a review of results obtained by the author together with D. Grigor’ev (Ulle), O. Rudalscu (Rennes), S. Geniøis (Lyon), J. Reinitz (New -York). They concern with the following problems: pattern formation process; complicated attractors and patterns for genetic networks; stability of pattern forming under random noise and parameter variation; evolution of networks.

Wednesday 1 April 2009, Joanna Pres, University College Dublin
Title: Positive harmonic functions on Denjoy-type domains.
Abstract: This talk concerns the study of positive harmonic functions on a particular type of unbounded domain. Let $D$ be a closed set in the hyperplane $\mathbb{R}^{N+1} \setminus \{0\}$ of Euclidean space $\mathbb{R}^N$ with $N \geq 2$. A domain of the form $\Omega = \mathbb{R}^N \setminus D$ is called a Denjoy Domain. Benedicks studied the cone of positive harmonic functions in a Denjoy domain vanishing continuously on the boundary. He gave an integral criterion in terms of harmonic measure which characterizes when there is a positive harmonic function $f$ on $\Omega$ satisfying $\Lambda(\sigma) \geq 2\pi$. Later, Cranston and Salisbury obtained a corresponding result in the case of the plane where $f$ lies on $\sigma$ rays leaving the origin. Suppose now that $\Omega$ is a closed subset of the boundary of an infinite cylinder $U \cap \mathbb{R}^N \setminus \{N \geq 2\}$. In this talk a Benedicks-type criterion will be provided for the existence of a positive harmonic function $f$ on $\Omega$ of exponential growth in $U$ vanishing continuously on the boundary. Two applications will be given. The first of these concerns minimal harmonic functions associated with an irregular boundary point, and amplifies a recent construction of Gardiner and Hansen. The second concerns the possible non-approximability of positive harmonic functions by integrable positive harmonic functions.

This is joint work with Marcus Ghergu.

Wednesday 15 April 2009, Tomas Johansson, University of Birmingham
Title: Inverse acoustic multiple scattering using topological derivatives.
Abstract: We consider an inverse problem where the structure of multiple planar sound-soft obstacles is to be determined, given the direction of one or more incoming fields and knowledge of the corresponding scattered fields on a curve outside the obstacles. A method involving topological derivatives will be presented together with some of its properties. In this method, no a priori assumption is needed on the number of obstacles present. Numerical results will also be presented and discussed. The obtained results are a joint work together with Prof. Ana Carpio (Univ. Complutense de Madrid) and Dr. Maria-Luisa Rapun (Univ. Politécnica de Madrid).

Wednesday 15 April 2009, Oliver Riordan, University of Oxford
Title: Sparse graphs: metrics and random models.
Abstract: One of the main applications of graph theory outside pure mathematics is to provide mathematical models for a wide range of real-world networks, both physical and abstract. Very often, random graphs are used, since one cannot hope to produce a model that exactly reproduces a complex real-world network such as a social network.

A key question that is seldom addressed is the following: How good is the fit between the model and the real network? Of course, one can compare the values of various parameters (for example, degree distribution, or network diameter), but often the model can be 'tuned' to match these parameters, which gives no guarantee that the model is accurate in other ways. It would be better to have one standard measure of similarity between graphs, and be able to say that the model is a good fit if it produces graphs that are 'globally similar' to the real-world networks.

In the dense case, for graphs with $n$ vertices and order $\omega(n)$ edges, the work of Borgs, Chayes, Lovász, Sós, Szegedy and Vesztergombi gives a very nice answer to this question, that is closely related to (inhomogeneous) random graphs. For the more realistic sparse case, there are some partial results, but many more open questions.
Wednesday 27 May 2009, Prof. Natan Kruglyak, Växjö
Title: Linear and Non-Linear Ill-Posed Problems and Real Interpolation.
Abstract: 1) how iterative procedure combined with real interpolation leads to solution of non-linear ill-posed problems;
2) real interpolation hidden in regularization theory for linear operators;
3) extension of regularization theory to Banach spaces.

Monday 15 June 2009, Andreas Axelson, LIU och Stockholms universitet
Title: Hilbert transforms and the Cauchy integral in euclidean spaces.
Abstract: The Hilbert transform for a domain in the complex plane is the operator which maps the boundary values of a harmonic function in the domain to the boundary values of its harmonic conjugate function. This operator, as well as the Cauchy integral operator on the boundary, are important examples of singular integral operators and have been much studied in harmonic analysis, for domains with non smooth boundaries. A way to calculate the Hilbert transform is to use that it factors into a product of the Cauchy integral and the inverse of a double layer potential operator. In this talk I will discuss extensions of this method for calculating Hilbert transforms / harmonic conjugate functions to Lipschitz domains in higher dimensional euclidean spaces. This makes use of the Cauchy reproducing integral formula for the Hodge-Dirac system \((\delta + \bar{\delta})f = 0\), which generalizes the Cauchy-Riemann system in the plane.

Wednesday 17 June 2009, Prof. Sergei A. Avdonin, University of Alaska
Title: Boundary Control Approach to Inverse Spectral Problems
Abstract: We establish connections between several approaches to inverse spectral problems: the classical Gelfand-Levitan theory, the Krein approach, the Simon theory, the approach proposed by Remling, and the Boundary Control method. We show that the Boundary Control approach provides simple and physically motivated proofs of the central results of other theories. We demonstrate also the connection between the dynamical and spectral data and derive the local version of the classical Gelfand-Levitan equation.

10-14 August 2009 Nonlinear problems for \(\Delta_p\) and \(\Delta\)
See http://www.mai.liu.se/TM/conf09/

Monday 17 August 2009, Maciej Blaszk, Adam Mickiewicz University, Poznań
Title: Bi-presymplectic representation of Liouville integrable systems and related separability theory
Abstract: Bi-presymplectic chains are of arbitrary co-rank and are considered. The conditions in which such chains represent some Liouville integrable systems and the conditions in which there exist related bi-Hamiltonian chains of vector fields are presented. In order to derive the construction of bi-presymplectic chains, the notions of dual Poisson-presymplectic pair, d- compatibility of presymplectic forms and d-compatibility of Poisson bivectors are used. The completely algorithmic construction of separation coordinates is demonstrated. It is also proved that Stäckel separable systems have bi-inverse-Hamiltonian representation, i.e. are represented by bi-presymplectic chains of closed one-forms. The co-rank of related structures depends on the explicit form of separation relations.

Wednesday 19 August 2009, Visa Latvala, University of Joensuu
Title: Regularity theory of variable exponent \(p\)-Laplace equation
Abstract: We review the basic regularity theory of the variable exponent \(p\)-Laplacean. We also discuss the recent development concerning the borderline cases which allow the value one (or the value infinity) in part of the domain.

Wednesday 2 September 2009, Prof. Lars Erik Andersson, MAI
Title: Existence results for quasistatic frictional contact problems and frictional wedging problems
Abstract: A frictional contact problem in elasticity consists of finding, for a given load history and an initial state, the time evolution of displacements and reaction forces. The problems may be dynamic, quasistatic or static (incremental). It is well known that for large coefficients of friction there are no general results of existence and/or uniqueness for these problems, even for very simple systems. Here we will present some existence and uniqueness for frictional systems with finitely many spatial degrees of freedom, will be summarized. We will formulate a so-called wedging problem, i.e. whether the elastic system has some non-trivial state of equilibrium in the absence of external forces. The main focus of this work is the relation between the wedging problem and the problem of uniqueness for quasistatic evolution problems. In particular we will investigate the relation between critical frictions for wedging and for nonuniqueness of rate problems respectively.

Wednesday 9 September 2009, Prof. Magnus Borga, IMT
Title: Medical Imaging: Segmentation of Blood Vessels
Abstract: The segmentation of blood vessels is a common problem in medical imaging and various applications are found in diagnostics, surgical planning, training and more. Among many different techniques, the use of multiple scales and line detectors is a popular approach. However, the typical line filters used are sensitive to intensity variations and do not target complicated temporal structure (dependent increments), in large dimensions the temporal structure is simple (independent increments) but the spatial structure is more complicated. We apply the filter output to energy optimization techniques for segmentation based on Level Set front propagation.

Wednesday 23 September 2009, Prof. Anna Talarczyk, Warsaw University
Title: Weyl asymptotics for non-self-adjoint differential operators with random perturbations
Abstract: Due to spectral instability the eigenvalues of non-self-adjoint differential operators are often highly unstable under small perturbations. There are now several results stating that when we add a small random perturbation, we get Weyl asymptotic distribution of eigenvalues, with probability close to 1 in the semi-classical limit, and almost surely in the limit of large eigenvalues. Moreover the bounds on the resolvents tend to improve under the action of such perturbations. We describe some of these results, due to M. Hager, W. Bordeaux-Montrieux, and the speaker, as well some underlying ideas and proofs.

Wednesday 30 September 2009, Jörg-Uwe Löbus, MAI
Title: Absolute continuity under time shift of trajectories
Abstract: The talk is divided into two parts. The first part is dedicated to introduce basic objects of the infinite dimensional stochastic calculus. In particular the central role of the Cameron-Martin formula will be explained. The second part is devoted to a class of processes \((X, F_t)\) of the form \(X = W + A\). Here \(W\) is a two-sided Brownian motion with random initial datum \(W_0\) that follows a distribution \(\nu = \mu\otimes e\), and \(A = A(W)\) with \(A_0 = 0\) is a certain function of \(W\). Crucial for absolute continuity under time shift is temporal homogeneity in the sense that

\[ X(W_{\tau + t} + A_{\tau}) = X_{\tau + t}(W), \quad \tau \in \mathbb{R}, \]
where $A_{i1}$ is the trajectory taking the constant value $A_{i1}(W)$. The density relative to time shift of trajectories of $X$ is of the form

$$
\frac{p_i(dx_{i-1})}{p_i(dx_i)} = \frac{m(X_{i-1})}{m(X_i)} \cdot \exp \left\{ \langle e, \nabla X_{i-1} \rangle \right\}.
$$

The basic idea of its proof will be explained. Applications of this formula will be partial integration and a measure valued counterpart to a class of stochastic equations with delay or anticipation.

**Wednesday 7 October 2009, Sandra di Rocco, KTH**

**Toric geometry and certain convex polytope**

Abstract: Toric embeddings are associated to convex lattice polytopes. A lot of the geometry of the embedded variety is detected via combinatorial invariants of the polytope and vice versa. The interplay between toric algebraic geometry and convex geometry will be recalled at the beginning of the talk. The aim of this seminar is to report on some (recent and less recent) results for non singular toric varieties, which translate to unexpected combinatorial properties of convex polytopes. More precisely (as long as time permits) generation of jets, adjoint properties and dual properties of toric embeddings will be presented.

**Wednesday 14 October 2009,**

**Matematik och astronomi – en lång sällskapresa**

**Wednesday 21 October 2009, Prof. Carmel Faber, KTH**

On the moduli space of curves and its intersection theory

Abstract: The moduli space $M_g$ of curves of genus $g$ is a variety whose points correspond in a natural way to the isomorphism classes of curves of genus $g$. Geometric properties of the moduli space have consequences for arbitrary families of curves. After reviewing some basic facts about the moduli space, I will focus on its intersection theory. Several concrete results will be presented.

**Wednesday 28 October 2009, Uffe Jankvist, Roskilde universitet**

Using history as a ‘goal’ in mathematics education

Abstract: Based on a brief, but general, discussion of the use of history of mathematics in mathematics education, I shall discuss a concrete experiment involving two historical teaching modules implemented in a Danish upper secondary class. An often occurring problem when trying to integrate the history of mathematics in mathematics education is that the students’ treatment and discussions of the historical cases could be anchored in mathematics of the modules.

**Wednesday 4 November 2009, Prof. Alexander Nazarov, Saint-Petersburg State University**

The Dirichlet problem for non-divergence parabolic equations with discontinuous in time coefficients

Abstract: In 2001 N. Krylov observed that for non-divergence parabolic equations coercive estimates for solutions can be proved even when the leading coefficients are only measurable with respect to $t$. In this lecture I give an overview of results obtained in this direction and present new ones obtained together with Vladimir Kozlov. We consider the Dirichlet problem for non-divergence parabolic equation with discontinuous in $t$ coefficients in a half space. The main result is weighted coercive estimates of solutions in anisotropic Sobolev spaces.

**Wednesday 11 November 2009, Dr. Rikka Korte, University of Helsinki**

An obstacle problem related to minimal surfaces in metric spaces

Abstract: We discuss the existence of a set with minimal perimeter that separates two disjoint sets in a metric measure space equipped with a doubling measure and supporting a Poincaré inequality. A measure constructed by De Giorgi is used to state a relaxed problem, whose solution coincides with the solution to the original problem for measure theoretically thick sets. Moreover, we show that the De Giorgi measure is comparable to the Hausdorff measure of codimension one.

The theory of functions of bounded variation in metric spaces is used extensively to obtain these results. Therefore the talk starts with an introduction to this subject. These results are based on joint work with J. Kinnunen, N. Shanmugalingam and H. Tuominen.

**Monday 16 November 2009, Dr. Johanna Pejlare, MAI**

Visualiseringsar och åskådning i matematik (Visualisation in Mathematics)

**Tuesday 24 November 2009, Prof. Antonio F. Costa, UNED, Madrid**

Representing automorphisms of Riemann and Klein surfaces as restriction of rigid motions in the Euclidean space.

Abstract: Given a surface embedded in the Euclidean space, such surface has a natural structure of Riemann surface given by the conformal structure produced by the Euclidean metric. If the surface is invariant by a rigid motion, then the restriction of such rigid motion to the surface gives an automorphism of the Riemann surface. In this talk the automorphisms of Riemann and Klein surfaces that can be represented in this way will be presented. As a consequence we shall present some representations of classical Riemann surfaces as the Klein quartic or the Bolza surface.

**Wednesday 2 December 2009, Prof. Kurt Johansson, KTH**

Universality in random matrix theory

Abstract: A central problem in the study of spectra of large random matrices is the question of universality. Here universality refers to the fact that for many choices of probability measures on spaces of matrices, e.g., Hermitian matrices, the local statistics of the eigenvalues is independent of the details of the probability measures. I will give some background on the problem of proving universality and give an overview of some recent results. Spectacular progress for the case of random Hermitian matrices with independent elements was made by Tao and Vu and also by Erdős, Schlein and H.T.-Yau.

**Tuesday 15 December 2009, Prof. Faina I. Solov'eva, Novosibirsk State University Russia**

Perfect codes and related topics

Abstract: The topic of perfect codes is one of the most important topics in the theory of error-correcting codes. The class of perfect codes is very complicated, large (double exponential) and intensively studied by many researches. The investigation of nontrivial properties of perfect codes is significant both from coding point of view and anticipation.

The presented results have been obtained in collaboration with Stanislav Hend and Marianna Cörrniet.
Wednesday 16 January 2008, Mattias Enstedt, Uppsala universitet

Title: Hayter-Fock equations with decreasing external magnetic fields

Abstract: In the presence of a decreasing external magnetic field, we present recent results on existence and non-existence of a ground state within the Hayter-Fock theory of atoms and molecules. The ground state exists provided the magnetic field is decreasing and the total charge $Z$ of $K$ nuclei exceeds $N - 1$, where $N$ is the total number of electrons. In the opposite direction, no ground state exists when $N > Z + K$.

Wednesday 23 January 2008, Andreas Strömbärgsson, Uppsala universitet

Title: The Bézout-Grad limit of the periodic Lorentz gas and the distribution of visible lattice points.

Abstract: The periodic Lorentz gas describes a particle moving in a periodic array of spherical scatterers, and is one of the fundamental mathematical models for chaotic diffusion in a periodic set-up. In my lecture I will describe the recent solution of a problem posed by Y. Sinai in the early 1980s, on the nature of the diffusion when the scatterers are very small. The problem is closely related to some basic questions in number theory, in particular the distribution of lattice points visible from a given position. The main tool in our approach is measure rigidity, a part of ergodic theory which has recently found important applications in several other problems in number theory and mathematical physics.

Wednesday 6 February 2008, Prof. Stefan Rauch-Wojciechowski, MAI

Title: What means to explain the motion of the Tippe Top?

Abstract: The Tippe Top has a shape of a truncated sphere with a peg attached to the flat surface. When spun sufficiently fast on its spherical bottom the tippe top turns up and continues motion on the peg. Research on the Tippe Top has long history since 19-th century and it is presently understood that the gliding friction is responsible for this phenomenon and that it takes place for the values of parameters which measure the eccentricity of the centre of mass.

Wednesday 13 February 2008, Prof. Juha Kinnunen, Helsinky University of Technology

Title: On the definition and properties of superparabolic functions.

Abstract: We discuss potential theoretic aspects of degenerate parabolic partial differential equations of p-Laplacian type. Solutions form a similar basis for a nonlinear parabolic potential theory as the solutions of the heat equation do in the classical theory. In the parabolic potential theory, the so-called superparabolic functions are essential. For the ordinary heat equation we have supercaloric functions. They are defined as lower semicontinuous functions obeying the comparison principle. The superparabolic functions are of actual interest also because they are viscosity supersolutions of the equation. We discuss their structural, convergence and Sobolev space properties.

Wednesday 5 March 2008, Prof. John Wermer, Brown University

Title: The complex Plateau problem: Finding a Riemann surface with prescribed boundary.

Abstract: Given a simple closed curve $K$ in a complex manifold $X$. When does there exist a Riemann surface in $X$ having $K$ as its boundary? We discuss the history of the problem and some recent work on it by Harvey and Lawson, and by the speaker, for the case that $X$ is complex projective space.

Wednesday 26 March 2008, Tomas Johansson, University of Birmingham, UK

Title: An alternating potential based procedure for a Cauchy problem for the Laplace equation in a planar domain with a crack.

Abstract: We consider a Cauchy problem for the Laplace equation in an unbounded region containing a crack. The region is formed by removing a sufficiently smooth arc (the crack) from a bounded simply connected domain $D$. The aim is to reconstruct the solution on the crack from values of the solution and its normal derivative on the boundary of the domain $D$. In 1989, V.A. Kozlov and V.G. Maz'ya proposed an alternating iterative method for solving Cauchy problems for formally self-adjoint elliptic equations, and we extend their ideas to domains with cracks and present a procedure which involves solving direct mixed problems for the Laplace operator in the same region. These mixed problems have either a Dirichlet or a Neumann boundary condition imposed on the crack and are solved by a potential approach. Each of these mixed problems are reduced to a system of integral equations of the first kind with logarithmic and hypersingular kernels and at most algebraic root singularity in the densities at the endpoints of the crack. Numerical examples will be presented illustrating the feasibility of the proposed method. I joint point out that the above is joint work with Roman Chapko from the Ivan Franko National University of Lviv in the Ukraine.

Wednesday 2 April 2008, Kaj Nyström, Umeå universitet

Title: Boundary Harnack inequalities for $p$-harmonic functions and Regularity of Free Boundaries in Two-phase Problems for the $p$-Laplace operator.

Abstract: In this talk I will discuss joint work with John Lewis on boundary Harnack inequalities for $p$-harmonic functions in Lipschitz domains and beyond and their application to the study of the regularity of weak solutions to general two-phase free boundary problems for the $p$-Laplace operator.

Wednesday 9 April 2008, Prof. Antonio Costa, UNED, Spain (Joint Seminar with the Didactics Group)

Title: E-teaching Differential Geometry at UNED

Abstract: This year we have started a new experience in the teaching way of differential geometry of curves and surfaces in UNED. It is a method similar to the Problem Based Learning. In this talk we shall present the results of such an experience.

Monday 14 April 2008, Mikko Parviainen, Helsinki University of Technology

Title: Global reverse Hölder's inequality for parabolic quasiminimizers

Abstract: It was recently shown that a parabolic quasiminimizer globally belongs to a higher Sobolev space than assumed a priori. This can be deduced from the fact that the gradient satisfies a reverse Hölder inequality near the boundary. In this talk, we discuss the parabolic quasiminimizers and touch some aspects of the higher integrability proof.

Wednesday 16 April 2008, Prof. Ragnar Sigurdsson, University of Iceland

Title: Some aspects of pluripotential theory.

Abstract: In the lecture I will begin by introducing a few concepts of pluricomplex analysis and pluripotential theory in particular and relate them to the corresponding concepts of classical complex analysis and potential theory in one variable. Then I will discuss disc envelope formulas and give examples of such formulas for pluricomplex Green functions.
Abstract: Solutions of many diophantine problems like Fermat's Last Theorem or the problem of congruent numbers (natural numbers which are areas of right triangles with rational sides) depend on existence of rational points on particular elliptic curves. We discuss several more or less known situations concerning existence of rational points on elliptic curves and when solutions can be found by sometimes very extensive computer based computations. We concentrate on two problems: finding (relatively) long non-trivial sequences of integers for which second differences of the squares are constant (e.g. 6, 23, 32, 39) - a question closely related to Hilbert's X-th problem, and on a "teacher's problem" related to elementary Linear Algebra courses.

Wednesday 7 May 2008, Prof. Alexander Nazarov, University of St. Petersburg
Title: The A.D. Aleksandrov maximum principle.
Abstract: The talk is devoted to an excellent geometrical tool in nonlinear PDEs - the Aleksandrov maximum principle. I shall give a historical review and prove the simplest version of this statement.

Monday 12 May 2008, Prof. John McNamara, Bristol University (joint with Senior Lectures in Biology)
The importance of individual differences in conflict and the evolution of cooperation
Abstract: Animals are often in competition with other members of the same population. They compete over access to resources such as food, mates and breeding sites. Even parents compete with each other over who should provide care for their common young. When there is competition the fitness of one member of the population usually depends on the behavioural strategies adopted by others. In such circumstances the evolutionary endpoints can be characterised using evolutionary game theory. I first present a brief outline of this theory as it is usually formulated and used. However, uses often ignore differences between individuals. Using a series of examples I will demonstrate that such differences are not innocuous noise, but can fundamentally change the nature of a game. Differences promote the need to negotiate. Difference can completely reverse the direction of evolution in a simple prisoner's dilemma game, and can interact with lifespan to determine how cooperative individuals are with each other. Finally, differences in personality promote the need to be socially sensitive; and once individuals are socially sensitive, this can lead to the maintenance of differences.

Wednesday 21 May 2008, Tomas Sjödin, KTH
Title: Selected topics on quadrature domains.
Abstract: Quadrature domains arise naturally in many contexts where gravitational equivalence between mass distributions and similar situations are being considered. To name a couple of specific well-known examples we have the classical obstacle problem, whose solution is a quadrature domain, as well as the important Hele-Shaw flow from fluid mechanics. In this talk, which aims to be as self-contained as possible, we will give the basic definitions and look at the most natural questions (and their answers where known) from a potential-theoretic point of view. We will also indicate how the methods developed to describe quadrature domains can be used to tackle other problems in potential theory.

Wednesday 28 May 2008, Prof. Kalle Åström, Lunds universitet
Title: Solving systems of polynomial equations and geometric problems in computer vision
Abstract: In this talk I will give examples of geometric problems in computer vision and present some of our latest results concerning (i) finding globally optimal solutions to structure and motion problems and (ii) new techniques for solving systems of polynomial equations. To exemplify these results I will use two simple examples of two view structure and motion and one dimensional retina vision. One-dimensional cameras have proven useful in several different applications, most prominently for autonomous guided vehicles, but also in ordinary vision for analysing planar motion and the projection of lines. Previous results on one-dimensional vision are limited to classifying and solving minimal cases, bundle adjustment for finding local minima to the structure and motion problem and linear algorithms based on algebraic cost functions. In this talk, we present a method for finding the global minimum to the structure and motion problem using the max norm of reprojection errors. We show how the optimal solution can be computed efficiently using simple linear programming techniques. The algorithms have been tested on a variety of different scenarios, both real and synthetic, with good performance. In the talk I will also discuss some new methods for stable and efficient algorithms for finding solutions to polynomial equations.

Wednesday 4 June 2008, Prof. Nikolay Kuznetsov, Russian Academy of Sciences, St. Petersburg
Title: The Benjamin--Lighthill conjecture for near-critical values of Bernoulli's constant
Abstract: The Benjamin--Lighthill conjecture will be discussed. The conjecture was formulated in 1954 for the classical nonlinear problem of steady two-dimensional waves on water of finite depth and concerns a possibility to characterise all such waves by means of two non-dimensional parameters located within a certain cusped region and on its boundary. Along with a survey of results obtained since 1954, a new approach (proposed in a joint work with Professor Vladimir Kuzlov) to this conjecture will be presented. This approach leads to proving the conjecture for near-critical cases (that is, close to the cusp point) values of Bernoulli's constant.

Wednesday 3 September 2008, Anders Björn, MAI
Title: Cluster sets for Sobolev and p-harmonic functions
Abstract: Consider a Sobolev function u with boundary values f in Sobolev sense and assume that f is continuous at a boundary point a. It then turns out that the cluster set of u at a is contains f(α), and contains the boundary value f(α), under suitable conditions. In this talk we study when this result holds in general metric spaces. We also apply the result to p-harmonic functions (and the more general quasiminimizers) where we are able to say a bit more.

Wednesday 10 September 2008, Prof. Erik Larsson, ISY, Communication Systems
Title: MIMO Detection
Abstract: In communications, the receiver often observes a linear superposition of separately transmitted information symbols. This is the case, for example, in so-called MIMO communications, where multiple transmit antennas simultaneously send different data streams. From the receiver's perspective, the problem is then to separate the transmitted symbols. Mathematically, this separation essentially amounts to solving many instances of an integer-constrained least-squares (ICLS) problem. This problem is known to be NP-hard. Therefore in practice, one must resort to approximate algorithms that find the correct solution quickly with high probability, and which are, in addition, suitable for efficient hardware implementation. In this talk we will explain why the fundamental problem is so important, and give an overview of current research on the topic.

Monday 22 September 2008, Prof. Richard Schoen, Stanford University and Institut Mittag-Leffler
Title: Riemannian manifolds of positive curvature
Abstract: It is well known that classical solutions of the Euler equations often lose regularity after finite time. Physically this corresponds to the formation of shock waves. In this talk I will describe work by Fredrik Stahl and myself in which we study this phenomenon for a self-gravitating fluid in general relativity under the assumption of plane symmetry. The strategy is to first obtain control of the geometry and the energy density of the fluid. This shows that the process of breakdown of classical solutions of the Einstein-Euler system is sufficiently similar to the analogous process in flat space to conclude that breakdown must occur.

Wednesday 24 September 2008, Prof. Mikael Passare, Stockholms universitet
Title: Counting paths in digraphs and Koszul algebras
Abstract: I will start with a concrete problem on how to calculate the number of paths of a certain length in a digraph. This will lead to a definition of Koszul algebras, which have been intensively studied in Stockholm. I will review some results about them.

Wednesday 8 October 2008, Prof. Ralf Fröberg, Stockholms universitet
Title: Art and Mathematics
Abstract: I will start with a concrete problem on how to calculate the number of paths of a certain length in a digraph. This will lead to a definition of Koszul algebras, which have been intensively studied in Stockholm. I will review some results about them.
Abstract: Is mathematics the opposite of art? Or is it an art in itself? We can find traces of mathematics in many works of art but is that all the connection there is? Those who expect deep and difficult mathematics will be disappointed, but, you can look forward to an entertaining gallop along the common history of mathematics and art.

Wednesday 5 November 2008, Tatyana Shaposhnikova, MAI
Title: Theory of Sobolev multipliers and their applications to differential and integral operators
Abstract: The talk is a survey of the theory of pointwise multipliers in spaces of differentiable functions developed together with Vladimir Maz'ya. The following topics will be discussed: analytic characterization of multipliers; essential norm and compactness of multipliers; traces and extensions of multipliers; maximal subalgebras of multiplier spaces; miscellaneous properties of multipliers (composition and implicit function theorems, etc). I’ll present some applications to differential and integral operators.

Monday 10 November 2008, Prof. Ayse Humeyra Bilge, Istanbul Technical University
Title: On the classification of scalar integrable evolution equations in 1 space dimension

Wednesday 12 November 2008, Pavel Kurasov, Lunds universitet
Title: Triplet extensions of operators: Krein’s resolvent formula and models for supersingular interactions
Abstract: The extension theory for semibounded symmetric operators is generalized by including operators acting in a triplet of Hilbert spaces. We concentrate our attention on the case where the minimal operator is essentially self-adjoint in the basic Hilbert space and construct a family of its self-adjoint extensions inside the triplet. All such extensions can be described by certain boundary conditions and a natural counterpart of Krein’s resolvent formula is obtained. This method is applied to Schrödinger operators with interaction given by operators acting in the scale of Sobolev spaces.

Wednesday 26 November 2008, Danyo Danev, ISY
Title: A Family of Ternary Quasi-Perfect Codes
Abstract: A linear q-ary \( \mathcal{C} \)-code is a linear subspace of the Hamming space \( H(n, q) \) which is the set of all \( n \)-tuples of elements from the finite field \( \mathbb{F}_q \) of cardinality \( q \). In this talk we shall introduce the notions of minimum distance, packing radius and covering radius of a code. Some special types of codes, such as perfect, quasi-perfect and BCH codes will be defined. As a main result we shall present a novel family of ternary quasi-perfect BCH codes. These codes are of minimum distance \( 5 \) and covering radius \( 3 \). The first member of this family is the ternary quadratic-residue code of length \( 13 \).

Wednesday 3 December 2008, Vitalij Tjatyrko, MAI
Title: On dimensional properties of subsets lying in the long band
Abstract: Some examples of closed subsets \( B \) of the product \( [0, \omega_1] \times [0, 1] \) having dim \( B = 1 \) and Ind \( B = \text{Ind} B = 2 \) will be presented. These examples answer to questions posed by different authors, in particular, by R. Engelking in the book, Theory of Dimensions Finite and Infinite, 1995.

Wednesday 17 December 2008, Prof. Johan Tysk, Uppsala universitet
Title: Convexity in financial theory
Abstract: Convexity for prices of financial derivatives is of importance for instance when hedging such instruments. We will consider methods from the theory of parabolic differential equations and stochastic processes to demonstrate such convexity for different types of instruments and various models for the underlying assets.
The Mathematical Colloquia held in 2007 at Linköpings universitet

Tuesday 17 January 2007, Douglas Rogers, University of Hawaii

Title: Bounds Archimedes missed: exercises in geometric extrapolation.

Abstract: Pi is a topic of abiding fascination that engages the interest of all mathematicians, pure and applied alike. We know, or think we know, that it was Archimedes who early calculated pi to considerable accuracy by bounding a circle inside and out by regular polygons. However, this program, with an explicit argument in the case of inscribed polygons, is already contained in Book XII of Euclid's Elements. Closer examination of the works of Euclid and of Archimedes suggests that everything you can do with inscribed and circumscribed polygons together can be done just as well with inscribed polygons alone. Moreover, it seems that the Chinese mathematician Liu Hui, working over seventeen hundred years ago, was able to lower the bound on the area of a circle by interpolation using only inscribed polygons. Perhaps even more surprisingly, whereas the combined work of Euclid and Archimedes shows that the difference between circumscribed and inscribed polygons more than halves on doubling the number of sides of these polygons, an argument that would have been accessible to both of them, as well as to Liu Hui, shows that, in fact, it more than quarters. The talk is presented as an exercise in "mathematics from history", where we take the mathematics from a given period and see what (more) can be extracted by means of it alone. Thus, when we look back on this material from the later perspective of the calculus, we find that these geometric arguments remarkably powerful, giving results akin to Richardson-Romberg integration - the quartering inequality just mentioned is accurate up to the term in the sixth power of the reciprocal of the number of sides of the largest and smallest polygons. It seems that we - not just Archimedes - might have been missing something.

Wednesday 21 February 2007, Prof. Lars Devling Andersen, Institute of Mathematical Sciences, Aalborg

Title: Algebraic curves with automorphisms

Abstract: Curves with (extra) automorphisms are loci of interest in moduli spaces. We report on ongoing work (joint with T. Shaska) seeking defining equations for such loci in terms of thetanulls, for small genus. This work uses properties of covers of algebraic curves. We then focus on covers of tori to determine some topological properties of the loci (joint work with R.D.M. Accola) and applications to coding theory (joint with D. Coles).

Wednesday 28 March 2007, Prof. Nikolay Kuznetsov, Russian Academy of Sciences, St. Petersburg

Title: The Schottky Problem

Abstract: An algebraic curve determines an abelian variety, the Jacobian of the curve. For example, for a Riemann surface the Jacobian is a complex torus associated to the periods of the Riemann system, that are important in quantum and classical mechanics, we formulated an algorithmic criterion of separability that allows for deciding if the problem is separable and for solving equations by quadratures. It is a solution of an old problem stated by C.G.J.Jacobi in his book "Vorlesungen uber Dynamik"(1866) when he introduced the method of Hamilton-Jacobi equation for finding solutions of the Hamilton equations.

Wednesday 14 March 2007, Prof. Gerard van der Geer, Universiteit vam Amsterdam and Mittag-Leffler Institute

Title: The Schottky Problem

Abstract: An algebraic curve determines an abelian variety, the Jacobian of the curve. For example, for a Riemann surface the Jacobian is a complex torus associated to the periods of integrals over the Riemann surface. Not every abelian variety is the Jacobian of a curve and the Schottky problem, due to Riemann, asks for a characterization of the Jacobians among all abelian varieties. Various answers have been proposed. We shall discuss the problem, its history and some of the proposed answers to this problem.

Wednesday 24 January 2007, Prof. Olle Häggström, Mathematical Statistics, Chalmers

Title: Problem solving is often a matter of cooking up an appropriate Markov chain.

Abstract: Problem solving is often a matter of cooking up an appropriate Markov chain. The aim of talk is to consider a problem that describes waves on the water surface which are generated by a pressure system in the forward motion (a mathematical model of hovercraft). The method of separation of variables is a very useful tool for finding solutions of differential equations. It consists of finding suitable new variables such that the problem splits into a set of uncoupled ODE's, often of 1-st order, that can be solved by quadratures. I shall discuss the meaning of separability for certain classes of ordinary differential equations and for partial differential equations. For a given differential equation it is difficult to know if separation variables exist and to find them. For the Schrödinger equation and for the Hamilton-Jacobi equation of natural Hamiltonian systems, that are important in quantum and classical mechanics, we formulated an algorithmic criterion of separability that allows for deciding if the problem is separable and for solving equations by quadratures. It is a solution of an old problem stated by C.G.J.Jacobi in his book "Vorlesungen uber Dynamik"(1866) when he introduced the method of Hamilton-Jacobi equation for finding solutions of the Hamilton equations.

Wednesday 7 February 2007, Prof. Stefan Rauch-Wojciechowski, MAI

Title: The method of separation of variables and an effective criterion of separability.

Abstract: The method of separation of variables is a very useful tool for finding solutions of differential equations. It consists of finding suitable new variables such that the problem splits into a set of uncoupled ODE's, often of 1-st order, that can be solved by quadratures. I shall discuss the meaning of separability for certain classes of ordinary differential equations and for partial differential equations.

Wednesday 25 April 2007, Olle Axling, MAI

Title: Arkinredes palipsast.

It is well known that this is true for almost every $f$. A locally integrable function $f$ on $\mathbb{R}^n$ is called a Sobolev function if its first derivatives belong to $L^2$. Through integral representations for Sobolev functions, we are concerned with Riesz potentials, which are defined by

$$I_f(z) = \int_{\mathbb{R}^n} \frac{\phi(|y-z|)}{|y-z|^{n-\alpha}} f(y) \, dy,$$

where $\phi$ is a nonnegative and monotone function on the interval $[0,\infty)$. We first show that $I_f(z)$ is continuous on $\mathbb{R}^n$ if

$$I_f(z) = \int_{B(z,r)} |y-z|^{-\alpha} f(y) \, dy.$$

Abstract: Let $R$ be a Noetherian ring and let an ideal $I$ in it be regular, that is, let $I$ contain a nonzerodivisor. Then the ideals $(I^{n+1} : I^n)$, $n \geq 1$, increase with $n$. The union $I = \bigcup_n (I^{n+1} : I^n)$ was first studied by Ratliff and Rush in [1]. They show that $(I^{n+1} : I^n)$ for sufficiently large $n$ and that $I$ is the largest ideal with this property. Hence, $I = I_f$. Moreover, they show that $I = I_f$ for sufficiently large $I$. We call $I_f$ the Ratliff-Rush ideal associated to $I$, and an ideal such that $I = I_f$ a Ratliff-Rush ideal. The Ratliff-Rush reduction number of $I$ is defined as $r(I) = \max \{ n \in \mathbb{Z} : I^{n+1} : I^n = 0 \}$. The operation $*$ cannot be considered as a closure operation in the usual sense, since $J \subseteq I$ does not generally imply $J_f \subseteq I_f$. An example from [2] shows this: let $J = (y^2, z^2)$ and $I = (y^2, z^2, x^2) \subseteq \mathbb{R}[x,y,z]$, then $I_f = \mathbb{R}$ but $J_f = \emptyset$. One of the reasons to study Ratliff-Rush ideals is the following. Let $I$ be a regular $m$-primary ideal in a local ring $(R, m)$. The Hilbert function $H_I(t) = \dim_R(R/I^t)$ is a polynomial $P_I(t)$ which is the Hilbert polynomial of $I$ for all large $t$. Then $I_f$ can be defined as the unique largest ideal containing $I$ and having the same Hilbert polynomial as $I$. Ratliff-Rush ideals associated to monomial ideals are monomial by definition, which makes the computations easier. There is always a positive integer $L$ such that $I = I_f^{L+1} : I^L$, but it is not clear how big that $L$ is.

Wednesday 16 May 2007, Veronica Crispin, KTH

Title: Ratliff-Rush Monomial Ideals

Abstract: Let $R$ be a Noetherian ring and let an ideal $I$ be regular, that is, let $I$ contain a nonzerodivisor. Then the ideals $(I^{n+1} : I^n)$, $n \geq 1$, increase with $n$. The union $I = \bigcup_n (I^{n+1} : I^n)$ was first studied by Ratliff and Rush in [1]. They show that $(I^{n+1} : I^n)$ for sufficiently large $n$ and that $I$ is the largest ideal with this property. Hence, $I = I_f$. Moreover, they show that $I = I_f$ for sufficiently large $I$. We call $I_f$ the Ratliff-Rush ideal associated to $I$, and an ideal such that $I = I_f$ a Ratliff-Rush ideal. The Ratliff-Rush reduction number of $I$ is defined as $r(I) = \max \{ n \in \mathbb{Z} : I^{n+1} : I^n = 0 \}$. The operation $*$ cannot be considered as a closure operation in the usual sense, since $J \subseteq I$ does not generally imply $J_f \subseteq I_f$. An example from [2] shows this: let $J = (y^2, z^2)$ and $I = (y^2, z^2, x^2) \subseteq \mathbb{R}[x,y,z]$, then $I_f = \mathbb{R}$ but $J_f = \emptyset$. One of the reasons to study Ratliff-Rush ideals is the following. Let $I$ be a regular $m$-primary ideal in a local ring $(R, m)$. The Hilbert function $H_I(t) = \dim_R(R/I^t)$ is a polynomial $P_I(t)$ which is the Hilbert polynomial of $I$ for all large $t$. Then $I_f$ can be defined as the unique largest ideal containing $I$ and having the same Hilbert polynomial as $I$. Ratliff-Rush ideals associated to monomial ideals are monomial by definition, which makes the computations easier. There is always a positive integer $L$ such that $I = I_f^{L+1} : I^L$, but it is not clear how big that $L$ is.

Wednesday 23 May 2007, Elena Kreines, Mittag-Leffler Institute

Title: Dessins d'entendants: Solving equations determining Belyi pairs

Abstract: This paper deals with the Grothendieck dessins d'entendants, that is tamely embedded graphs on surfaces. Detailed introduction to the theory including its relations with other branches of mathematics will be given. We investigate combinatorics of systems of equations determining a Belyi pair corresponding to a dessin, that is a rational function with at most three critical values on an algebraic curve, such that the preimage of a segment between two critical values is the dessin under consideration. Several properties of extra, or so-called parasitic, solutions of such systems are described. Some special compactification of the moduli space $M_{Belyi}$, related to the dessins, will be discussed.

Wednesday 30 May 2007, Anna Torstensson, KTH

Title: Class numbers of finite groups

Abstract: In this talk I would like to address two basic problems concerning class numbers (that is the number of conjugacy classes of finite groups).

1) Given a class number $k=k(G)$, which is the largest finite group $G$ having this class number?

2) Find a (good) upper bound on $|G|$ in terms of the class number of $G$.

In the second part of the talk I will describe some of the work that has been done to answer those questions both generally, and for particular types of groups such as $p$-groups and simple groups. In the second part we will describe my own results concerning groups of square free order. They include a formula for the class number of any such group, and also an estimate $|G| \leq k(G)^3$. Finally I want to describe some ideas I have for future work in this area.

Friday 31 August 2007, Yoshihiro Mizuta, Hiroshima University

Title: Lebesgue point theory for Riesz potentials of Orlicz functions

Wednesday 26 September 2007, Marta Sanz-Solé, Universitat de Barcelona

Title: A class of stochastic partial differential equations driven by a fractal noise

Wednesday 19 September 2007, Petter Brändén, KTH. Joint Colloquium with Mathematical Statistics

Title: Negative Dependence and the Geometry of Polynomials

Wednesday 5 September 2007, Gunnar Aronsson, MAI

Title: Interpolation of real functions under a gradient bound — uniqueness aspects.

Wednesday 19 September 2007, Petter Brändén, KTH. Joint Colloquium with Mathematical Statistics

Title: Negative Dependence and the Geometry of Polynomials

Abstract: We develop a theory of negative dependence for the class of strongly Rayleigh probability measures. This class is defined by means of geometric properties of the generating polynomials of the measures, and contains uniform random spanning tree measures, determinantal measures (for contractions) and distributions for symmetric exclusion processes. In the process we settle several conjectures of Liggett, Pemantle and Wagner, respectively, and extend Lyons' recent results on determinantal measures.

This is joint work with Julius Borcea (SU) and Thomas M. Liggett (UCLA).

References


Wednesday 3 October 2007, Matti Hessel, MAI
Title: Standard methods in combinatorial optimization and their relation to the PWT-model
Abstract: Results in combinatorial optimization have been achieved through a number of different methods based upon ideas from different fields of science. Relating these methods to each other has proven fruitful in furthering our understanding of the field of combinatorial optimization. In this presentation we will predominantly discuss the problem of finding the expected cost of a minimal matching in a graph with edge costs given by exponential random variables. The "Poisson weighted infinite tree"-model translates the discrete structure of an infinite graph into a system of distributional equations. Although the model is based upon ideas from statistical mechanics, one can observe basic ideas and properties from the finite case, some which survive and some which do not survive intact.

The aim of the presentation is to give any listener with basic knowledge of graphs and exponential random variables a feel for the structure of combinatorial optimization. Note that the PWT-model was briefly covered in the context of statistical mechanics by Johan Wåstlund in a previous colloquium.

Wednesday 10 October 2007 Hans Ringström, KTH
Title: Problems in Operator Theory
Abstract: Results in combinatorial optimization have been achieved through a number of different methods based upon ideas from different fields of science. Relating these methods to each other has proven fruitful in furthering our understanding of the field of combinatorial optimization. In this presentation we will predominantly discuss the problem of finding the expected cost of a minimal matching in a graph with edge costs given by exponential random variables. The "Poisson weighted infinite tree"-model translates the discrete structure of an infinite graph into a system of distributional equations. Although the model is based upon ideas from statistical mechanics, one can observe basic ideas and properties from the finite case, some which survive and some which do not survive intact.

The aim of the presentation is to give any listener with basic knowledge of graphs and exponential random variables a feel for the structure of combinatorial optimization. Note that the PWT-model was briefly covered in the context of statistical mechanics by Johan Wåstlund in a previous colloquium.

Wednesday 17 October 2007, Magnus Herberthson, MAI
Title: Future global non-linear stability of cosmological models with accelerated expansion
Abstract: We consider several applications by proving the existence and uniqueness of solutions to first and second order perturbed differential equations in Banach spaces.

Wednesday 24 October 2007, Eulerfest
See http://www.mai.liu.se/~gober/GRmeetingDec07.html

Tuesday 4 December 2007, Relativity Day
See http://www.mai.liu.se/~gober/GRmeetingDec07.html

Wednesday 12 December 2007 Johan Thim, MAI
Title: Fixed Point Theorem in Locally Convex Spaces
Abstract: By a symmetry of a Riemann surface we understand an antiholomorphic involution of X. The classical Harnack theorem asserts that the set of fixed points of a single holomorphic automorphism of a Riemann surface of genus g is non-conjugate to the corresponding representation of Aut(X) in the symmetrized group. Later we deal with the bounds for the total number of fixed points of a holomorphic involution on a Riemann surface X of genus g is said to be (1) cyclic ggonal if its orbit space X/g is the Riemann sphere. It can be characterized as an automorphism of order g having the maximal possible number of fixed points. The classical Castelnuevo-Severi Theorem implies that for g > 3 the group generated by γ is unique and we deal with the case g ≤ 3.

By a (1) nonorientable Riemann surface we mean a nonorientable unbordered topological surface equipped with a dianalytic structure which roughly speaking differs from the classical analytic structure by the fact that reflections x → iy → x → iy for the transition functions of charts are allowed. Such surfaces correspond to so called purely imaginary real algebraic curves and we give a formula for the topological type of the set of fixed points of a given automorphism of such surface.
Title: Verifying proofs by reading only 3 bits.

Abstract: Probabilistically Checkable Proofs or more succinctly PCPs have played a significant role in complexity theory in the last decade. A PCP is a written proof that is verified by a probabilistic verifier that reads a very small portion of the proof. Not only are PCPs interesting in their own right but they also lead to strong inapproximability results for interesting optimization problems.

As a concrete example take satisfiability of Boolean formulas. A classical NP-proof that a formula is satisfiable is given by an assignment that satisfies the formula and this is verified by reading the entire proof and checking that indeed the assignment satisfies the formula. The PCP-theorem says that for satisfiability and hence for any NP-statement, there is a PCP that allows proofs of polynomial size and such that the verifier reads a constant number of bits, always accepts a correct proof and rejects any proof of a false NP-statement with probability at least 1/2.

In the application to inapproximability it is important to optimize some of the parameters of the PCP and in particular we will be interested in proofs where the verifier only reads three bits.

In the lecture we will explain, but not prove the PCP-theorem and discuss the connection to inapproximability.
The Mathematical Colloquia held in 2006 at Linköpings universitet

Organized by Armen Asratian, Anders Björn, Milagros Izquierdo Barrios, Vladimir Kaziev Svante Linusson and Stefan Rauch-Wojciechowski.

Wednesday 11 January 2006 Natan Krugljak, Luleå University

Open Property of Invertibility of Operators on Interpolation Scales

Abstract:
A remarkable theorem of Shneiberg extended to complex interpolation scalee the well-known fact that the set of bounded invertible operators acting on a Banach space is open in the space of all operators. After that this property has been intensively studied in the literature. Recently in joint paper with H.Milman we derived a unified approach to Shneiberg’s theorem that works for complex, real and many others methods of interpolation. I plan to discuss known results and their proofs, give some examples and formulate several problems and conjectures.

Wednesday 18 January 2006. Sten Kaijser, Uppsala university

An orthogonal polynomial basis for a Hilbert space of analytic functions in a strip

Abstract.
A few years ago I amused myself by calculating the orthogonal polynomials with respect to the weight \( \frac{1}{1 + x^2} \). In my calculations I used some simple operators, and these operators more or less forced me to investigate another system of polynomials that turned out to be orthogonal with respect to the Poisson kernel for a strip. Both these sets turned out to have very simple generating functions and also other interesting properties, in particular they were well adapted to the so called umbral calculus, developed by Gian-Carlo Rota and his students. This connection was found by my graduate student Tszhay K. Araia and was developed in his thesis which was presented in June 2003. I will also present some new results concerning these polynomials.

Wednesday 25 January 2006. Hans Lundmark, MAI

Peakons and shock waves in the Degasperis-Procesi equation

Abstract:
The Degasperis-Procesi (DP) equation is a nonlinear wave equation which was discovered by Degasperis and Procesi in 1998 when searching for completely integrable cases in a family of equations similar in form to the famous Camassa-Holm (CH) equation derived as a model for shallow water waves in 1993. Both these equations admit a special kind of solution consisting of a superposition of so-called peakons (peaked solitons) interacting in a nonlinear but explicitly describable fashion. A peakon is a wave shaped like \( \frac{1}{|x|} \), so that its derivative has a jump discontinuity at the crest, and consequently these solutions have to be interpreted in a weak sense. The CH equation has attracted a lot of attention because of its interesting properties, in particular they were well adapted to the so called umbral calculus, developed by Gian-Carlo Rota and his students. This connection was found by my graduate student Tszhay K. Araia and was developed in his thesis which was presented in June 2003. I will also present some new results concerning these polynomials.

Tuesday 31 January 2006. Linus Carlsson, Umeå University

Holomorfområden i flera komplexa variabler

Abstract:
Holomorfområden i flera komplexa varibler skiljer sig avsevärt från holomorfområden i en komplex variabel eftersom dessa alltid är triviala om grundmängden är öppen. Vi kommer att påvisa skillnaden mellan dessa. Vi kommer även att prata om holomorfområden för begränsade holomorfa funktioner och avsluta med att visa ett tillräckligt villkor för att ett område ska vara ett holomorfområde för begränsade funktioner.

Wednesday 1 February 2006. John Noble, MAI

The Directed Polymer in a Random Environment

Abstract:
Consider a random walk in \( Z \), where each step is taken to the left or right, each with probability \( \frac{1}{2} \), independently of the other steps. After \( t \) steps, the mean squared displacement is \( \frac{t}{2} \). Now suppose that each to each site in \( Z^+ \), there corresponds a random weight \( V(t,x) \). We discuss a continuous space time analogue of this problem, where the mean squared displacement is no longer \( \frac{t}{2} \), but is instead superdiffusive, growing according to \( \frac{t^{4/3}}{2} \). This corresponds to a continuous space time analogue of this problem, where the superdiffusive exponent of 4/3 can be shown explicitly. The proof relates the mean squared displacement problem to the two traveller problem; if two travellers take independent random walks on the same environment, how quickly do they separate? Unfortunately, while the continuous model under discussion preserves the mean squared displacement, the low temperature phase (another very important aspect of the problem) has been eliminated.

Wednesday 8 February 2006, Lars Ingelstam, LIU

Between pure art and pragmatic use: on the place of mathematics in the Systems society.

Abstract:
The first step will be to identify mathematics as one of several “knowledge cultures” with reference to aspects such as usefulness, scientific principles and self-image. This is particularly important in relation to the teaching of mathematics in schools as well as in technical universities. As a second step I will discuss where the center of gravity in mathematics teaching should lie. Alternatives advocated in the debate are analysis and computations. Another point of departure could be systems mathematics. This will be discussed at some length in the seminar. In the seminar I will use and elaborate ideas from my two recent books: System - ett tänka över samhälle och teknik. Energimyndighetens förlag, Eskilstuna 2002 (finns även som CD-rom) Kampen om kunskapen. Lärarförbundets förlag, Stockholm 2004.

Short biography of the speaker:
Lars Ingelstam was professor of Technology and social change in the Tema Institute, Linköping University, 1980-2002, and is now author and researcher based in Bromma. 1973-1980 he was Director of the Secretariat for Futures Studies in Stockholm. He has a Dr Tech in mathematics (1964) and was docent and Associate Professor of Mathematics at KTH from 1964 to 1973.

Wednesday 15 February 2006, F. Calogero, University of Rome “La Sapienza”, Italy

The transition from regular to irregular motions, explained as travel on Riemann surfaces.

Abstract:
We introduce and discuss a simple Hamiltonian dynamical system, interpretable as a 3-body problem in the (complex) plane and providing the prototype of a mechanism explaining the transition from regular to irregular motions as travel on Riemann surfaces. The interest of this phenomenology is illustrating a mechanism for the onset in a deterministic context
of irregular motions -- is underlined by its generality, suggesting its eventual relevance to understand natural phenomena and experimental investigations. This is joint work with David Gomez-Ullate, Paolo Santini and Matteo Sommacal.

Wednesday 8 March 2006, Milagros Izquierdo, MAI
Art and Mathematics: The Möbius Band

Abstract
A Möbius band is formed by identifying the short sides of a rectangle after giving a half turn to one of them. Or equivalently turning upside down a partiture in music. The Möbius band has inspired many artists during the XIXth century. We can use the Möbius band to illustrate how mathematical concepts help us to "see" art and how art helps us to illustrate mathematical concepts.

Wednesday 15 March 2006, Jan Snellman, MAI
Walks in directed graphs

Abstract
Many problems in combinatorics can be formulated as follows: determine the number of walks (of a certain length) in a certain digraph (directed graph). Furthermore, since such walks can be encoded as non-commutative monomials, there is also a close connection to the theory of Hilbert series of non-commutative graded rings.

I will describe the well-known "transfer matrix method" for finding the (rational) length generating function of walks in the digraph. I will also discuss a formula by Frobberg, Bruno-Vetter, and others, relating the generating function for a graph G with the g.f. of its complement G bar. Together with a theorem of Backelin, classifying graphs with a fixed number of edges having a maximal number of walks of length 2, these results will enable us to answer the following question: what is the maximal spectral radius (i.e., the pole closest to the origin of the rational g.f.) of a digraph with n^2-s edges?

Wednesday 22 March 2006, Niels Dencker, Lunds universitet
Solvability and the Nirenberg-Treves Conjecture

Abstract
In the 50's, Ehrenpreis and Malgrande proved that all constant coefficient linear partial differential equations are solvable. The consensus at that time was that at least all linear PDE's were solvable. Therefore, it came as a surprise when Hans Lewy in 1957 constructed a non-solvable complex vector field, whose image is a set of the first category. The vector field is a natural one; it is the Cauchy-Riemann operator on the boundary of a strictly pseudo-convex domain.

A rapid development in the 60's to the conjecture by Nirenberg and Treves in 1969: that condition (i) is necessary and sufficient for solvability of (pseudo-)differential operators of principal type. This is a condition only on sign changes of the imaginary part of the principal symbol along the bicharacteristics of the real part. Thus, it only depends on the the highest order term of the operator.

The Nirenberg-Treves conjecture has recently been resolved, and we shall present the background and the ideas of the proof, which will appear in Annals of Mathematics, 163:2, 2006.

Wednesday 29 March 2006, Jana Björn, MAI
Maximal functions, A_p-conditions and Poincaré inequalities

Abstract
I will explain the group theorist point of view of local properties of finite groups, the parallel development of localization and completion of classifying spaces in homotopy theory and how recent developments of algebraic topology led to the definition of new objects, called p-local finite groups, that unify both points of view.

Wednesday 5 April 2006, Carles Broto, Universitat Autonoma Barcelona
Local properties of finite groups and classifying spaces

Abstract
I will explain the group theorist point of view of local properties of finite groups, the parallel development of localization and completion of classifying spaces in homotopy theory and how recent developments of algebraic topology led to the definition of new objects, called p-local finite groups, that unify both points of view.

Wednesday 26 April 2006, Kathryn Hess, EPF Lausanne
A gentle introduction to a powerful tool: operads and their bimodules

Abstract
Operads were developed in the 1970's as a powerful tool for describing operations and the identities they must satisfy in different types of algebras, such as associative algebras, commutative algebras, Lie algebras, Poisson algebras, etc. Recently, Paul-Eugène Parent, Jonathan Scott and I realized that bimodules over operads play a similar role in describing highly structured homomorphisms between different types of algebras.

I will first define operads and explain how they parameterize algebraic operations. I will then outline our new understanding of the role of bimodules over operads.

Wednesday 3 May 2006, Christer Bergsten, MAI (joint seminar with the didactic group)
The role of algebra in reasoning about limits

Abstract
The role of algebra in students' mathematical reasoning about limits of functions is analysed, using data from a video study of six students working in pairs to solve problems on limits.

Wednesday 10 May 2006, Douglas Rogers, University of Hawaii (joint seminar with the didactic group)
Dissecting the Pythagorean proposition

Abstract
Euclide gives the Pythagorean proposition a double take, in Book I of the Elements in terms of congruent triangles, and in Book VI in terms of Eudoxos' doctrine of proportionality. However, it has been suggested that the prototypical proof was rather by dissection. I will focus on proofs by dissections, in particular after the manner of the ancient Chinese mathematical commentators, notably Lui Hui.

Wednesday 17 May 2006, José M. M. Senovilla, University of the Basque Country
Riemannian vs. semi-Riemannian geometry

Abstract
Semi-Riemannian geometry is a largely unexplored mathematical world, specially comparing with its older sibling branch, Riemannian geometry, much more developed and better understood. In this talk I will present, by means of pertinent examples of mathematical interest, several underdeveloped routes within semi-Riemannian geometry which are surely very appealing to mathematicians and physicist alike and have a direct relevance to gravitational and other physical theories as well as to pure differential geometry.

Tuesday 23 May 2006, Hans Thunberg, KTH (joint seminar with the didactic group)
Matematik från gymnasium till högskola. Gammal problem och pågående reformer

Abstract
I en undersökning gjord vid KTH Matematik har vi velat studera den välkända övingskapitalen om matematik ur ett perspektiv där vi jämför gymnasieskolans mål och ambitioner med den tekniska högskolans förväntningar och förkunskapskrav. En slutsats man kan dra är att problemet till stor del är strukturerat. De allmänna behörighetskraven i matematik till civilingenjörbyggnadsläraerna har särts i flera avseenden under de senaste to åren, i många fall utan motsvarande reformering av högskolans matematikkurser, och gymnasieskolans agenda i matematik har förändrats successivt på ett för vidare matematikstudier inte alltid gynnsamt satt.

Det finns flera klart definierade stoffområden som högskolan förväntar sig som förkunskaper som antingen inte ingår i gymnasiets kurser överhuvudtaget, eller som behandlas med helt andra förtecken och kunskapsnivå än vad högskolan tycks föreläser sig. Man lättsler också en skild syn på vad matematisk kunskap är. Det gäller till sidan på räknetäckningsgrad och formellkunskap - är detta ytliga skillnader som hämnar matematisk förståelse och därför bör tadas ner och undanrättas med räknetjänster och formelsamlingar eller handlar det tvärtom om osättliga problem utan att vilka ett större och djupare matematiskt kunskap kunnat bli omöjligt?

Medvetenheten om detta problem verkar i dag vara stor. Seminariet avslutas med en diskussion kring aktuella satsningar och reformer.

Referenser:
Asymptotic analysis for large t of solutions to parabolic systems

**Abstract**

We study asymptotics as \( t \to \infty \) of solutions to the parabolic system of the form \( u_t + Au = 0 \) in \( \Omega \times [0, \infty) \), where \( \Omega \) is a bounded domain. On \( \partial \Omega \) we prescribe the homogeneous Dirichlet boundary conditions. The elliptic part \( L \) stabilizes for large \( t \) in a certain integral sense, i.e., the leading coefficients, which depend on \( t \), tend to coefficients independent of \( t \) in integral sense (not necessarily in \( L^\infty \)-norm). In particular, we include such situations when leading coefficients may take different values on different parts of \( \partial \Omega \) and the boundaries between them can move with \( t \) but stabilize as \( t \to \infty \). Under these conditions we derive an asymptotic representation of solutions for large \( t \).
Title: Pólya-Schur problems for hyperbolicity and stability preservers with applications
Abstract: A linear operator \( T \) on \( \mathbb{C}[z] \) is called hyperbolicity-preserving or an HPO for short if \( T(P) \) is hyperbolic whenever \( P \in \mathbb{C}[z] \) is hyperbolic, i.e., it has all real zeros. One of the main challenges in the theory of univariate complex polynomials is to describe the monoid of all HPOs. This reputedly difficult problem goes back to Pólya-Schur’s characterization of multiplier sequences of the first kind, that is, HPOs which are diagonal in the standard monomial basis of \( \mathbb{C}[z] \). Pólya-Schur’s celebrated result (Crelle, 1914) generated a vast literature on this subject and related topics at the interface between analysis, operator theory and algebra but so far only partial results under rather restrictive conditions have been obtained. In this talk I will report on the progress towards complete solutions to both this problem and its analog for stable polynomials as well as their multivariate extensions made in an ongoing series of papers jointly with Petter Brändén and Boris Shapiro. If time permits I will also discuss applications to mixed determinants and Lax-type problems for real stable and (Garding) hyperbolic polynomials.

Title: Projections in Banach spaces
Abstract: Let \( E \subset F \) be Banach spaces. A linear, bounded mapping \( P : E \rightarrow F \) is called a projection if \( P \) restricted to \( E \) is the identity. The existence of a projection is equivalent to \( E \) being complemented in \( F \), i.e., there exists a Banach space \( G \) such that \( F = E \oplus G \). We shall discuss two types of uncomplementedness for a separable Banach space, one separable and one unseparable, and its similarity (relation?) to other problems.

Title: Complex methods for real Lorentzian geometry
Abstract: We give a simple introduction to how four-dimensional real Lorentzian (the metric is not positive definite) geometry can be described in two complex dimensions. Natural objects in this formalism are so-called spinors and we present some results whose (only or first) proofs were obtained by complex methods. Our examples are related to the Weyl conformal curvature tensor or to purely geometric characterisations of solutions to Einstein’s field equations in general relativity.

Title: Optimal Passion at a Distance
Abstract: I explain quantum nonlocality experiments and discuss how to optimize them. Statistical tools from missing data maximum likelihood are crucial. New results are given on Bell, CGLMP, CH and ladder inequalities. Open problems are also discussed. It is advantageous not to have any prior understanding of quantum theory or indeed physics. It may be difficult to resist discussion of the philosophical implications of Bell’s inequality.

Title: Existence and a priori estimate for elliptic problems with subquadratic gradient dependent terms
Abstract: In this lecture I will consider the nonlinear elliptic model problem

\[
\begin{align*}
\Delta u(x) + a(x)u(x) &= f(x), & u \in H^2(\Omega), \\
\end{align*}
\]

with \( A \) a coercive matrix with bounded coefficients, \( a \geq 0, \), \( -\frac{1}{2} \leq q \leq 2 \) and \( f \in L^2(\Omega) \) for some suitable \( \mathbb{R} \). This is a model problem, and there are many possible variants of it. In the case where \( q \leq 1 \), existence is classical for \( f \in H^{-1}(\Omega) \). When \( q \) is large, the case where \( q = 1 \), \( f \in H^{-1}(\Omega) \) is difficult but has been solved by G. Bottaro and M.E. Marina in 1973. On the other hand, the case \( q = 2 \) has been treated by many authors, including in particular in a series of papers by L. Boccardo, J.-P. Puel and myself. In a more recent paper, V. Ferone and myself proved the existence of a solution \( u \) which further satisfies \( u^m - 1 \in H^2(\Omega) \), and an a priori estimate for such solutions, when \( f \in L^2(\Omega) \). In this lecture I will mainly report about recent joint work with Nathalie Grenon and Alessio Porretta, the announcement of which has been published in C. R. Acad. Sci. Paris, Serie I, 342, (2006), pp. 23-28. When \( 1 < \frac{q}{2} \leq q < 2 \) and \( f \in L^2(\Omega) \) with \( m = m(q) \) and \( f \) small enough (we also solved the case where \( 1 \leq q < 1 + \frac{1}{2} \), but I will not discuss it since it uses the notion of renormalized solution), and when either \( a \) or \( f \) is sufficiently small in \( L^2(\Omega) \), we prove the existence of a solution \( u \) which enjoys the further regularity \( u^m \in H^2(\Omega) \) with \( m = (2q-2)/(2q-1) \), as well as an a priori estimate for any solution which enjoys this further regularity. One of the main interests of our result lies in the priori estimate, the proof of which is non standard.

Title: On the Moduli Space of Cyclic Trigonal Riemann Surfaces of Genus 4
Abstract: A closed Riemann surface which can be realized as a 3-sheeted covering of the Riemann sphere is called trigonal, and such a covering is called a trigonal automorphism. Accola showed that the trigonal automorphism is unique for Riemann surfaces of genus \( g \geq 5 \). This theorem characterizes the cyclic trigonal Riemann surfaces of genus \( g \) with non-unique trigonal automorphism using the automorphism groups of the surfaces. The thesis shows that Accola’s bound is sharp with the existence of a uniparametric family of cyclic trigonal Riemann surfaces of genus 4 having several trigonal automorphisms. The structure of the moduli space of trigonal Riemann surfaces of genus 4 is also characterized.

Finally, by using the same technique as in the case of cyclic trigonal Riemann surfaces of genus 4, we are able to deal with \( p \)-gonal Riemann surfaces and show that Accola’s bound is sharp for \( p \)-gonal Riemann surfaces. Furthermore, we study families of \( p \)-gonal Riemann surfaces of genus \( (p-1)^2 \) with two \( p \)-gonal morphisms, and describe the structure of their moduli space.
The Mathematical Colloquia held in 2005 at Linköpings universitet

Organized by Armen Asratian, Anders Björn, Milagros Izquierdo Barrios, Vladimir Kozlov, Svante Linusson and Stefan Rauch-Wojciechowski.

Friday 14 January 2005.
Meeting of the Swedish Mathematical Society.

Professor Per Enflo, Kent State University,
Minimal points and contractive projections

Abstract:
The talk connects to applications in mathematical economy.

Lars Inge Hedberg,
Spectral synthesis in function spaces; atomic theory

Abstract:
I will discuss the modern definitions of classes of function spaces by means of “smooth atoms”, formulate the spectral synthesis problem in this general context, and give some indications of its solution by Netrusov. No prerequisites beyond basic analysis will be assumed. In particular, the talk is independent of my talk in December 2004.

Wednesday 26 January 2005.
Anders Björn,
A boundary regularity classification for harmonic and p-harmonic functions

Abstract:
Let \( G \) be a bounded open set in \( \mathbb{R}^n \) and let \( f \) be a continuous function on the boundary of \( G \). The Dirichlet problem asks for finding a harmonic function \( u \) in \( G \) which has \( f \) as its boundary values.

In general it is not possible to require that \( \lim_{y \to x} u(y) = f(x) \) holds for all \( x \) in \( G \). It is however possible to obtain unique solubility in general by saying that the equality above should hold for almost every boundary point (in a sense that will be made precise in the talk).

A boundary point \( z \) is said to be regular if \( \lim_{y \to z} u(y) = f(z) \) for all continuous boundary functions \( f \). In fact, most boundary points are regular, but there are also irregular boundary points.

The dichotomy between regular and irregular boundary points has been studied extensively. It is less known that one can go one step further and divide the irregular boundary points into two classes, semiregular points and strongly irregular points, with vastly different boundary behaviour. In this talk I will discuss the trichotomy between regular, semiregular and strongly irregular boundary points both for harmonic functions and for their nonlinear generalizations p-harmonic functions.

Wednesday 2 February 2005.
Professor Igor Abrikosov, IFM,
Quantitative quantum description of materials properties: Physics and Mathematics

Abstract:
Quantum mechanics revolutionized physics in the beginning of the last century. In 1927 Sommerfeld applied the quantum description to metals, within the model of free electrons, and obtained a qualitatively correct picture of some basic properties. But due to an enormous complexity associated with quantum mechanical calculations for real materials, accurate quantitative results were rarely obtained. The possibilities to study material properties from the basic principles of quantum mechanics were enormously enhanced when the density functional theory (DFT) and the local spin density approximation (LSDA) were formulated by Kohn and co-workers in the mid-60s. In 1998 this groundbreaking theory was awarded the Nobel Prize. I will give a very brief and informal description of the DFT equations. I will also explain general ideas on how one numerically solve the equations within the DFT. I will start with a variational principle, and show how one derives the so-called secular equation, the main equation to be solved numerically. I will particularly point out unsolved mathematical/numerical problems that we are dealing with in our research.

Wednesday 9 February 2005.
Professor Bo Berndtsson, Chalmers,
Prekopa’s theorem and its complex versions

Abstract:
A celebrated theorem, due to Prekopa, states that if \( g(x,y) \) is a convex function on \( \mathbb{R}^n_+ \times \mathbb{R}^n_+ \), then the function \( h \) defined by

\[
 e^{h(x)} = \int_{\mathbb{R}^n_+} e^{g(x,y)} \, dy
\]

is also convex. This theorem implies several other results in convex analysis like the Brunn-Minkowski inequality. If we think of the function

\[
 e^{h(x)}
\]

as the density of the operator that assigns to a function \( f(y) \) its weighted mean value with respect to \( e^{g(x,y)} \) we see that the corresponding object in the complex case is the Bergman kernel. We will discuss a theorem on the subharmonic dependence of the Bergman kernel on a parameter. This theorem implies the theorem of Prekopa and also has several other applications related to interpolation theory and the local structure of plurisubharmonic functions.

Wednesday 16 February 2005.
Niko Marola, Helsingfors tekniska högskola,
Moser’s argument for minimizers of the p-Dirichlet integral

Abstract:
The regularity of the nonlinear elliptic equations can be proved using the celebrated Moser iteration technique. It seems that Moser’s argument is strongly based on the differential equation, which in our case is the p-Laplace equation. An alternative approach to consider the p-Laplace equation is to study its variational formulation, the nonlinear p-Dirichlet integral. It can be shown that to run Moser’s method a differential equation is not needed. In this talk we prove by using Moser’s technique that minimizers of the p-Dirichlet integral
satisfy Harnack’s inequality from which the Hölder continuity follows.

Thursday 17 February 2005.
Ingemar Eriksson defended his licentiate thesis,
The Chevreton tensor and its trace

Abstract:
In this thesis we investigate the Chevreton tensor in Einstein-Maxwell theory. It was introduced in 1964 as the counterpart, for electromagnetic fields, of the well-known Bel-Robinson tensor of the gravitational field. We prove that, in the absence of electromagnetic sources, this tensor is completely symmetric. We consider currents constructed from the Chevreton tensor with Killing vectors and show that these currents are conserved for some types of spacetimes with a hypersurface orthogonal Killing vector or two commuting Killing vectors that act orthogonally transitive on non-null surfaces. In addition, we show that the trace of the Chevreton tensor is a rank-two, symmetric, trace-free, divergence-free tensor and that it is related to the Bach tensor. This allows us to investigate Einstein-Maxwell spacetimes with a vanishing Bach tensor.

Friday 18 February 2005.

Geometry and Relativity Meeting.

Wednesday 23 February 2005.
Professor Ari Laptev, KTH,
Mass transportation approach to sharp functional inequalities

Abstract:
Following the recent articles of C. Villani with his co-authors we shall discuss new proofs of Sobolev and Brezis-Lieb inequalities.

Wednesday 9 March 2005.
Professor Anders Melin, Lunds universitet,
Backscattering and multilinear singular integral operators

Abstract:
The mathematical colloquium at Linkping university March 9, 2005. Speaker: Anders Melin, Lund University

Backscattering and multilinear singular integral operators

Abstract: Let $H_v = -\Delta + v(x)$ be the Schrödinger operator in $\mathbb{R}^n$, where $n \geq 3$ is odd and the potential $v$ is real valued and satisfies appropriate decay and smoothness conditions. The wave operators are the strong limits as $t \to -\infty$ of $e^{it\Delta} e^{-itH_v}$ and the scattering operator $S = S(v) = W^+ W_-$ is unitary in $L^2(\mathbb{R}^n)$. The anti-diagonal part of the distribution kernel of $FSF^*$, where $F$ is the Fourier transform, forms the backscattering data and the real part of its inverse Fourier transform is after suitable normalization given by the expression

$$b_v(x) = 2^n \int (v(x-y) - y) W(x+y) dy,$$

where $W(x,y)$ is the distribution kernel of $(W_+ + W_-)/2$ and the integral is interpreted in the distribution sense.

Here $Bv$ depends on $v$ in a highly nonlinear way, but it turns out that the restriction of $Bv$ to an open set of small $v$ extends to an entire analytic function of $v$ in suitable Banach spaces of functions containing $S(\mathbb{R}^n)$. We shall denote by $Bv$ this entire analytic mapping and remark that $Bv - Bv_0$ can be expressed in terms of the bound states of $H_v$.

By considering suitable representations for $Bv$ one finds that $Bv$ is defined and analytic in $L^1_{osc}(\mathbb{R}^n)$ when $a > 2n$. Let

$$Bv = \sum_{N=1}^{\infty} B_{Nv},$$

be the power series expansion of $Bv$, where $B_{Nv}$ is $N$-linear in $v$. The operators $v \mapsto B_{Nv}$ are multilinear singular integral operators. Their complexity increase with $N$ and $n$. We have $B_0 = v$, and it turns out that if $v \in L^{2n}_{osc}$ with $a$ as above, then $Bv = \sum_{N=1}^{\infty} B_{Nv} \in C^{N\ell}(\mathbb{R}^n)$, where $N_\ell \to \infty$ as $k \to \infty$. Thus $Bv$ is smoothing when $N$ is large.

In my lecture I will describe how one derives representations for $Bv$ and $B_{Nv}$ suitable for analysis, and then I will discuss PDE-methods to examine the mapping properties of $Bv$ in various Sobolev spaces. Because of the invariance of $Bv$ with respect to the family of transformations $v \mapsto \rho v(\rho x)$, where $p > 0$, the Sobolev space $W^{m,p}$ of functions with $m$ derivatives in $\mathbb{R}^n$ is a natural candidate for consideration when $p = 1$ and $m = n - 2$. In that case good mapping properties are already established when $n = 3$, and they are likely to hold for arbitrary $n$. When $p > 1$ the situation becomes much more complicated because the high degree of singularity of the distribution kernels of the $Bv$. We finally notice that if a Banach space $X$ is invariant under the backscattering transform then it follows that $v$ is uniquely determined by $Bv$, and hence by $S(v)$ for all small $v$ in $X$, and it would be interesting to develop numerical schemes for computing $v$ from $Bv$.

Wednesday 23 March 2005.
Professor Richard Ehrenborg, University of Kentucky, Lexington,
Lifting inequalities for polytopes

Abstract:
The f-vector enumerates the number of faces of a convex polytope according to dimension. The flag f-vector is a refinement of the f-vector since it enumerates face incidences of the polytope. To classify the set of flag f-vectors of polytopes is an open problem in discrete geometry. This was settled for 3-dimensional polytopes by Steinlitz a century ago. However, already in dimension 4 the problem is open.

We will discuss the known linear inequalities for the flag f-vector of polytopes. These inequalities include the non-negativity of the toric g-vector, that the simplex minimizes the cd-index, and the Kalai convolution of inequalities.

We will introduce a method of lifting inequalities from lower dimensional polytopes to higher dimensions. As a result we obtain two new inequalities for 6-dimensional polytopes.

The talk will be accessible to a general audience.
Monday 4 April 2005.
Professor Richard P. Stanley, MIT,
Ordering events in Minkowski space

Abstract:
Suppose that we are given $k$ points (events) in $(n+1)$-dimensional Minkowski space ($n$ space dimensions and one time dimension). The events need not occur in the same order to observers in different reference frames. What sets of orders are possible, and how many such orders are there? We will show how these questions can be investigated using the theory of hyperplane arrangements. Much of the talk will consist of background information on hyperplane arrangements, focusing on the question of counting the number of regions into which a real vector space is divided by a finite set of hyperplanes.

Wednesday 6 April 2005.
Peter Basarab-Horvath,
Symmetries and classification of differential equations

Abstract:
Symmetries are an important aspect of differential equations and are a useful tool in finding solutions to nonlinear differential equations as well as providing us with useful information such as conservation laws. Lie algebras first arose in the study of symmetries of differential equations. In the present talk I shall give a survey of some work concerning the classification of evolution equations according to symmetry properties.

Tuesday 12 April 2005.
Andreas Rietz defended his Ph.D. dissertation,
Existence theorems for noncoercive incremental contact problems with Coulomb friction

Opponent was Professor Jaroslav Haslinger, Charles University, Prague.

Abstract:
Friction is a phenomenon which is present in most mechanical devices and frequently encountered in everyday life. In particular, understanding of this phenomenon is important in the modelling of contact between an elastic object and an obstacle. Noncoercive incremental contact problems with Coulomb friction constitute an important class of such friction problems due to their frequent occurrence in mechanical engineering. They occur for example when modelling an object which is not fixed to a support. The topic of this thesis is to study this class of friction problems.

This thesis considers both discrete and continuous systems. For the continuous systems we consider both problems with a nonlocal friction law where the contact force is mollified and problems with a normal compliance friction law where the body may penetrate the obstacle. For all friction problems we derive a sufficient condition for the existence of a solution. This condition is a compatibility condition on the applied force field, and if it is violated there exists a nontrivial solution to a corresponding dynamical problem.

Wednesday 13 April 2005.
Professor Jaroslav Haslinger, Charles University, Prague,
Approximation and numerical realization of contact problems with Coulomb friction and a solution-dependent coefficient of friction (static case)

Wednesday 27 April 2005.
Milagros Izquierdo Barrios,
Ovals of Riemann surfaces

Abstract:
After Klein a real curve can be represented as a symmetric complex curve. A symmetric complex curve is a Riemann surface together with a symmetry of the surface. A symmetry is an anticonformal involution acting on the surface. The Riemann surface $X$ and the conjugacy class of the symmetry in the automorphism group give us the real (model of the) curve. The fixed point-set of the symmetry consists of a collection of disjoint Jordan curves: the ovals. Each oval of the symmetry correspond to a connected component of the real curve. In this talk we introduce some combinatorial techniques (Fuchsian and NEC groups) to deal with symmetric Riemann surfaces and we present some results.

Wednesday 4 May 2005.
Professor Capi Corrales Rodrígáñez, Universidad Complutense de Madrid, spoke to a wider audience about
From space as container to space as a web in mathematics and painting

Abstract:

Velázquez, Las Meninas (1656, Museo del Prado, Madrid)
At the end of the XVII century, “space” in mathematics was identified with Physical Space, the space in which natural phenomena take place. And from a corner of this space, conceived as a huge three dimensional container, a box in which objects “float”, and using the elements of the geometry of Euclid, mathematicians looked, described and constructed.

By mid XIX century, mathematicians had realised that this identification between Physical Space and mathematical space was just a convention, and a very limiting one. They left the corner of the box and they got closer and closer to the objects, first placing themselves on them, so to speak, with the intrinsic geometry of Gauss, later on touching them with the topology of Poincaré. This allowed them to perceive that any relation between objects, arbitrary objects, can be used to produce a spatial structure. And so, by the beginning of the XX century, a more adequate definition space was reached in mathematics (Hausdorff): any web or net of relations between objects.

The idea of space as a container involves thinking of space as a huge global object given a priori, an external reference we look from. A net space is a space which is not an a priori choice, but a structure constructed for each concrete situation by patching together smaller pieces, local pieces.

From the container space we get a global view. From within the net space we get local views, detailed information of smaller regions. Going back and forth, as contemporary mathematicians do, allows us to coherently patch local pieces of information into global information of whatever it is that we want to look, describe, or construct.

In this talk we will follow the mathematical evolution that takes us from space conceived as a container to space viewed as a web (of relations), and we will do it using as graphical reference the paintings that were being done as the mathematical ideas were being “cooked”.

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**Wednesday 11 May 2005.**

**Professor Nageswari Shanmugalingam, Cincinnati,**

*An introduction to conformal Martin boundary for Euclidean domains*

**Abstract:**

In this talk, we will discuss the construction of singular functions associated with the \( p \)-Laplacian on domains in Euclidean spaces when \( 1 < p < \infty \), where \( n \) is the dimension of the space. We will then use the singular functions to construct the conformal Martin boundary of a Euclidean domain. Such a boundary is a conformally invariant compactification of the domain. We will also explore the behavior of the conformal Martin kernel functions near the boundary of the domain, and use the boundary Harnack principle to discuss the growth behavior of such functions near boundaries of John domains.

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**Wednesday 18 May 2005.**

**Professor Mireille Bousquet-Mélou, Bordeaux,**

*Algebraic series in enumerative combinatorics*

**Abstract:**

Let \( A(t) \) be the generating function of a class of discrete objects. That is, \( A(t) = \sum a_n t^n \), where \( a_n \) is the number of objects of size \( n \) in the class. Then \( A(t) \) is said to be algebraic if it satisfies a (non-trivial) polynomial equation \( P(A(t)) = 0 \). Algebraic series form a well-behaved family:

* It has interesting closure properties (+, *, /, derivatives, composition, ...).
* These series are reasonably easy” to handle (elimination, resultants, Gröbner bases, ...).
* Their algebraicity can be guessed from sufficiently many of their first coefficients.
* The asymptotic behaviour of these coefficients can be obtained in a systematic way.

Most importantly, there is a combinatorial intuition of how a class of objects with an algebraic generating function looks like: VERY roughly speaking, A class of objects has an algebraic structure if these objects have an algebraic structure: that is, if they admit a recursive description based on the concatenation of smaller objects of the same type.”

However, many classes of objects simply refuse to show clearly their algebraicity. The aim of this talk is twofold: I will first present general techniques for proving the algebraicity of a series, and then several challenging problems that still resist these general techniques.

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**Friday 20 May 2005.**

**Professor Mireille Bousquet-Mélou, Bordeaux, will gave her installation lecture for honorary doctor,**

*What on earth are these mathematicians doing?*

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**Wednesday 25 May 2005.**

**Professor Alexander M. Khudnev, Novosibirsk,**

*Cracks in solids with possible contact between crack faces*

**Abstract:**

Presence of cracks in solids means that we have to find a solution in domains with cuts (cracks). In the talk we discuss boundary value problems considered in cracked domains. Inequality type boundary conditions given on the crack faces do not allow the crack faces to penetrate each other. New results obtained recently in this field are presented.

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**Friday 27 May 2005.**

**Jens Jonasson defended his licentiate thesis,**

*The Levi-Civita geodesic equivalence problem and multiplication of cofactor pair systems*

**Abstract:**

When studying equivalence of dynamical systems, in the sense of Levi-Civita, the concept of cofactor pair systems plays an important role. Cofactor pair systems can be constructed through a multiplicative structure of the so called quasi-Cauchy-Riemann equations \( \text{cof} J^1 \text{ grad} V = \text{cof} (J')^{-1} \text{ grad} (V') \), where \( J \) and \( J' \) are special conformal Killing tensors. In this thesis we study this multiplication and its role in the theory of equivalent dynamical systems. We have isolated the properties that are responsible for the multiplication, allowing us to give an elegant characterization of systems that admit multiplication. We describe how the multiplication of cofactor pair systems can be considered as a special case of a more general kind of multiplication. We also investigate algebraic properties of the multiplication and provide several methods for constructing new systems with multiplicative structure.
Friday 27 May 2005.
Professor Sergio Benenti, University of Turin,
Dynamical systems with nonholonomic constraints - user friendly approach

Abstract:
The theory of non-holonomic dynamical systems, even in recent times, is treated in a growing number of papers.

Most of them use high-level and refined structures of differential and algebraic geometry, which are not commonly accessible. I think that in using too sophisticated tools for dealing with non-holonomic mechanics, most of its beauty remains hidden. Thus, my aim is to provide a simple and natural approach to this matter, by using the elementary vector calculus in the Euclidean three-space, and the elementary structure of the tangent bundle of a configuration manifold. Starting from the Gauss principle, we shall arrive in a short way to two different (but equivalent) dynamical equations, readily available for any concrete example. These two kinds of dynamical systems are related to the two possible representations of a non-holonomic constraint: by parametric equations or by zero-equations.

In other words, my first aim is to show the essential features of the theory, present in the literature, without redundant and/or inessential notions. The second aim is to propose some special devices realizing non-linear non-holonomic constraints, after that of Appell-Hamel.

Wednesday 14 September 2005.
Johan Wästlund, Linköping
The random travelling salesman problem – a challenge to physicists, mathematicians and computer scientists.

Abstract:
Assign independent uniform \((0,1)\) lengths to the edges of the complete graph on \(n\) vertices and let \(L_n\) be the length of the minimum travelling salesman tour. The distribution of \(L_n\) for large \(n\) has been a challenge to physicists, mathematicians and computer scientists for the last twenty years. According to a long-standing conjecture, \(L_n\) converges in distribution to a certain "universal constant", about 2.0415. I will describe the background as well as some recent progress towards a proof of this conjecture, including a definite integral for the universal constant.

Wednesday 21 September 2005.
Professor Richard Beals, Yale University,

Abstract:
The well-known KdV equation was proposed to describe waves in shallow water. It is now known to have explicit solutions (multi-solitons) with very interesting interactions. The same is true of an equation proposed much more recently: the Camassa-Holm equation. Its special solutions (peakons, antipeakons) have even more interesting interactions. They come from finite-dimensional Hamiltonian systems and can be calculated explicitly, but in a completely different way from KdV.

Friday 23 September 2005.
Professor Natan Kruglyak, Luleå University of Technology,
Covering Theorems, Singular Integrals and Applications

Abstract:
The importance of singular integral operators for theoretical and applied mathematics is well-known. For example, they appear naturally in the theory of elliptic and parabolic partial differential equations and in computerized tomography. I plan to discuss two recent results (and some of their applications) obtained on the base of old and new covering theorems.

Wednesday 28 September 2005,
Professor Nikolay Kuzjurin, Russian Academy of Sciences,
On-line strip packing and scheduling parallel tasks in Grids

Abstract.
The Grid computing paradigm is originated from a new computing infrastructure for scientific research and cooperation, and is becoming an established technology for large-scale resource sharing and distributed integration. The main problem arises: how to efficiently schedule tasks in such systems. In my talk I am going to present new class of packing problems that related closely to scheduling parallel tasks in grids. Such problems can be formulated as packing of a given set of rectangles (corresponding to tasks) into a set of strips (corresponding to clusters in grid).

Strip packing problems have been studied intensively for the case of one strip and some interesting results were obtained. In my talk I’ll present some new approximation algorithms for the case of few strips (in the worst and the average cases).

- In the worst case we present an on-line approximation algorithm with constant approximation ratio;
- In the average case we present an on-line strip packing algorithm that achieves \(O(N^{2/3} \log^{1/3} N)\) expected wasted area where \(N\) is the number of rectangles to be packed each with width and height distributed uniformly in \([0,1]\).

Wednesday 5 Oktober 2005.
Professor David Sattinger, Yale University,
How Deep is the Bay of Bengal?

Abstract.
Russell’s velocity formula was at the center of the controversy over the existence of the solitary wave; but today the topic is rarely mentioned. It is an immediate corollary of modern bifurcation theory; and it is fundamental to modelling waves in deep water. A tsunami 60 cm high in an ocean 4 km deep is 377 km long, travels with a velocity of 713 km/hr, and carries a transverse energy density of \(2 \times 10^{10}\) joules/meter, yet the maximum speed of the surface current is only 2.97 cm/s.

Professor Johann Engelbrecht, University of Pretoria
Title: Comparison of students’ procedural and conceptual understanding in mathematics

Abstract.
When teaching a scientific discipline care should be taken to cultivate procedural and conceptual understanding as opposed to blind application of rules and methods. Procedural understanding enables the student to perceive a process or method in its entirety and not simply as a sequence of steps. Conceptual understanding, on the other hand, requires of the student to grasp the underlying principles in such a way that it can be used in applications, within or outside the particular discipline. The general perception is that high school teaching of mathematics in South Africa tends to be fairly procedural and that students that enter university are better equipped to deal with procedural problems rather than conceptual. In this study we compare the conceptual and procedural skills of first year calculus students in life sciences. We also investigate students' confidence in handling conceptual and procedural problems. The study seems to indicate that these students do not perform better in procedural problems than in conceptual problems. They are also more confident of their ability to handle conceptual problems than to handle procedural problems. Furthermore the study seems to indicate that students do not have more misconceptions about conceptual mathematics than about procedural issues.

Daniel Ying, Linköping

Title: A short history about Riemann surfaces

Abstract.
Riemann surfaces are an appealing feature to mathematicians (and hopefully to non-mathematicians as well) in that they appear in a variety of mathematical fields. The point of the introduction of Riemann surfaces made by Riemann, Klein and Weyl (1851-1913), was that Riemann surfaces can be considered as both a one-dimensional complex manifold and an algebraic curve. Another possibility is to study Riemann surfaces as two-dimensional real manifolds, as Gauss (1822) had taken on the problem of taking a piece of a smooth oriented surface in Euclidean space and embedding it conformally into the complex plane. A fourth perspective came from the uniformisation theory of Klein, Poincaré and Koebé (1882-1907), who showed that every Riemann surface (which by definition is a connected surface equipped with a complex analytic structure) also admits a Riemann metric. This is a short survey about the history of Riemann surfaces and the development of such surfaces from Bernard Riemann's doctoral thesis and some of the later results made by Poincaré.

Wednesday 26 Oktober 2005, 13.00-14.00, Glashuset.
Professor Frank Nijhoff, Leeds University

Title: Integrable systems on the lattice and associated partial differential equations

Abstract.
I will review some of the insights that have been obtained in recent years on the integrability of partial difference equations. The intimate interplay between such systems on the space-time lattice and certain parameter-families of partial differential equations will be elucidated.

Per Enflo,

Title: Likformiga homeomorfier i Banachrum

Abstract.

Pertti Mattila, University of Helsinki

Title: Rectifiability in Euclidean and metric spaces

Abstract.
Rectifiable ‘surfaces’ (sets, measures, currents, varifolds) in Euclidean spaces form in many ways an essentially largest possible class of surfaces including smooth surfaces and having their main geometric properties, often interpreted in a generalized sense. They are very central in geometric measure theory and they are useful, for example, in calculus of variations because of strong compactness properties. In Euclidean spaces they can be defined in many natural and equivalent ways. Recently there has been interest for looking at generalizations to metric spaces, both to very general metric spaces and spaces with special non-Euclidean structure such as the Heisenberg groups. Then many new problems arise and it is not even always clear what should be the proper definitions. The talk will be a survey on part of such developments.

Thursday 10 November 2005, 15.00-16.00, Glashuset.
Professor Martin Aigner, Freie Universität Berlin

Title: From Fibonacci to Ramanujan via Lattics Paths

Abstract.
Of the many results due to Ramanujan the Rogers-Ramanujan identities are probably the most famous. They are of interest in numbertheory, algebra, combinatorics, and statistical mechanics, and they have the touch of the extraordinary because of the mysterious appearance of the number 5. We begin by proving a Fibonacci identity by a double count of two sets of lattice paths, and go on to demonstrate that the Rogers-Ramanujan identities are just a suitably weighted version of it. On the way some of the standard repertoire of combinatorics is encountered, such as inclusion-exclusion, q-binomial numbers, formal power series, and Jacobis ‘s triple product theorem.

Krzysztof Marciniak, ITN

Title: Finite-dimensional separable systems give rise to hierarchies of commuting evolutionary PDE's.

Abstract.
Classical dynamical systems that are separable in the sense of the Hamilton-Jacobi theory can be constructed from a set of algebraic equations that are known as separation relations
Emma Previato, Institut Mittag-Leffler and Boston University
Title: Commuting Partial Differential Operators.
Abstract.
This talk is an introduction to the question of classification of commutative rings of partial differential operators, especially as regards the geometric aspects, such as their spectral variety and quantum integrable systems. The talk will be centered on examples. Non-trivial examples are provided by algebraic surfaces, Sato's tau function, differential Galois theory.

Chris Eilbeck, Institut Mittag-Leffler and Heriot-Watt University, Edinburgh, UK
Title: Breathers in discrete systems.
Abstract.
The concept of a solitary wave or soliton has been around since Scott Russell's discoveries in the 1830's, but the "breather" as a type of wave in nonlinear systems is less well known. Breathers, like solitary waves, are localized, but in addition they have some internal oscillations. They are more prevalent in discrete lattice systems rather than continuum systems. I will concentrate on a simple model for breathers in coupled oscillator lattices, the Discrete Nonlinear Schrodinger equation, and survey briefly both the classical and quantum version of this system.

Bruce Sagan, Michigan State University
Title: Congruences for Combinatorial Sequences
Abstract. We derive congruences for various sequences involving binomial coefficients. In particular, we are able to prove some conjectures of Benoit Cloitre. Surprisingly, the Thue-Morse sequence (from the theory of combinatorics on words) makes an appearance. No prior knowledge of combinatorics will be assumed. (Joint work with Emeric Deutsch.)
The Mathematical Colloquia held in 2004 at Linköpings universitet

Organized by Anders Björn, Vladimir Kozlov, Svante Linusson and Stefan Rauch-Wojciechowski.

Wednesday 14 January 2004.

Professor A. V. Shapovalov, Corresponding Member of Russian Academy of Sciences, Tomsk University,
Commutative and noncommutative separation of variables in the Klein-Gordon equation

Abstract:
In the framework of theorem on necessary and sufficient conditions for separation of variables in the scalar 2nd order PDE admitting a complete set of 1st and 2nd order symmetry operators a commutative separation of variables in the Klein-Gordon equation is performed. A method of separation of variables with the use of noncommutative symmetry operators is also explained and compared with the previous one.


Professor Ernie Kalnins, University of Waikato, New Zealand, Fellow of the Royal Society of New Zealand,
Special functions and group representation theory

Abstract:
An explanation of the connection between group theory and the classical special functions of mathematical physics is outlined. Particular attention is paid to the case of Euclidean motions in the plane and the corresponding Helmholtz equation. Properties of special functions such as Mathieu functions, Bessel functions and parabolic cylinder functions are obtained. An addition theorem for Bessel functions is given a group theoretic interpretation. Extension of these ideas to more general cases is briefly discussed.


Raffaele Rani, Department of Theoretical Astrophysics, University of Tübingen,
A numerical approach to solving evolution equations for isolated systems in general relativity

Abstract:
We present a numerical scheme to evolve isolated systems in General Relativity. Isolated systems serve as models for real systems of physical interest like neutron stars or merging black holes. This particular class of systems is described by asymptotically flat spacetimes which possess the property of admitting a conformal extension. We work directly on the extended conformal manifold and solve numerically the conformal field equations, which assure that Einstein equations hold in the original spacetime. Because of the compactness of the conformal spacetime the whole manifold can be computed on a finite numerical grid. The final goal of this work is to apply these techniques to a self-gravitating, isolated system consisting of a distorted black hole and analyse the outgoing gravitational radiation comparing the results with the quasi normal mode behaviour observed in linear perturbation theory.

Wednesday 4 February 2004.

Dr. Rieuwert Blok, Rome University,
Activity on matroids and relations to topology and algebra

Abstract:
A matroid can be thought of as a ground set \( E \) together with a family of base subsets. For example, a finite spanning set \( E \) for a vector space, together with the family of linear bases contained in \( E \) forms a matroid. Although initially largely motivated by problems in linear algebra and graph theory, matroid theory provides a unified framework for studying topics from a variety of areas including design theory, combinatorial geometry, lattice theory, hyperplane arrangements, and combinatorial optimization. After ordering the ground set \( E \) linearly one can introduce the notion of activity. This is best seen in the context of a graphic matroid, but generalizes easily. A graphic matroid is the matroid on the edge set of a connected graph \( G \), where the base sets are the spanning trees. Given a spanning tree \( T \) any edge not in \( T \) closes off a unique circuit in \( T + e \). If \( e \) happens to be the least edge in \( C \), then \( e \) is called (externally) active for \( T \). Note that by inserting \( e \) and removing any other edge from \( C \) one obtains a new spanning tree that is "close" to \( T \), but cheaper. Activity is used for instance to define search algorithms in graphs. Also, the famous Tutte polynomial is the activity generating function for the base sets of the matroid.

An interesting invariant of a matroid \( M \) is its Orlik-Solomon algebra. For instance, in the context of a complex hyperplane arrangement, it is isomorphic to the cohomology ring of the arrangement's complement. In general however, it is unknown exactly what (combinatorial) aspects of the matroid it captures. It is known though that the independent sets of zero activity yield a (linear) basis for this algebra.

Las Vergnas introduced a partial order on the base sets whose rank function is (external) activity; its atoms correspond to basis elements of the algebra. This poset encapsulates information on the linear dependence of other elements on the basis corresponding to its atoms. A fundamental invariant of this lattice, its Möbius function, was analyzed by Bruce Sagan and the speaker through the topology of its order complex. At this point we present new directions for research, new results, and try to understand their meaning for the Orlik-Solomon algebra and its relation to the matroid.

No prior knowledge of matroid theory, lattice theory, or homology theory is required.

Wednesday 11 February 2004.

Armen Asratian,
Localization theorems in Hamiltonian graph theory

Abstract:
A Hamilton cycle of a graph \( G \) is a walk in \( G \) that starts and finishes at the same vertex and visits each other vertex exactly once. A Hamilton path of a graph \( G \) is a path that includes each vertex of \( G \) exactly once. Some problems in algebra and combinatorics can be formulated as problems of the existence of a Hamilton path or cycle in an appropriate graph. It is known that the classical global criteria for the existence of Hamilton cycles and paths only apply to the graphs with large edge density and small diameter. In 1984-1990 A. Asratian and N. Khachatryan developed some local criteria for the existence of Hamilton cycles in a connected graph, which are analogues of the global criteria due to Dirac, Ore and others. The idea was to show that the global concept of hamiltonicity can, under rather general conditions, be captured by local phenomena, using the structure of balls of small radii. This local approach gives the possibility to find new classes of graphs with Hamilton cycles which, in particular, also contain infinite subclasses of graphs with small edge density and large diameter.

I will give a review of this topic and present some new results.

Wednesday 18 February 2004.

Dr. Alfonso García-Parrado, University of the Basque Country, Bilbao,
Causality, geometry, and generalized symmetries

Abstract:
In this seminar we present a number of results dealing with Lorentzian manifolds and more general manifolds equipped with a metric of arbitrary signature. On the one hand we provide a new tool to study global causal properties of Lorentzian manifolds paying special attention to its applications to the study of the global causal properties of spacetimes. We
are able to provide a simple mean to decide if two given Lorentzian manifolds look the same from the causal point of view and we can generalize the classical hierarchy of causality conditions used in general relativity among other things. On the other hand we generalize the well known conformal motions to the so called bi-conformal vector fields whose differential conditions involves two complementary orthogonal projectors $P_{ab}$ and $P_{ab}$. These generalized symmetries can in principle be defined in any manifold endowed with a metric and we argue that they may be used to provide an intrinsic geometric characterization of certain spaces in which the metric tensor decomposes in two pieces (double twisted spaces).


Andreas Rietz,
Noncoercive contact problems with friction

Abstract:
I open this talk by discussing the mathematical properties of contact problems with friction. I then focus on noncoercive contact problems, that occur for example when the body has no prescribed displacements. Some recent results on the existence of solutions are presented and these results are interpreted mechanically in terms of dynamical stability. I also present the main ideas on how to derive these results.

Wednesday 3 March 2004.

Dr. Federico Incitti, Rome,
Bruhat order on the involutions of classical Weyl groups

Abstract:
It is known that a Coxeter group $W$, partially ordered by the Bruhat order, is a graded poset, with rank function given by the length, and that it is El-shellable, hence Cohen–Macaulay, and Eulerian.

We wish to investigate whether a particular subposet of $W$, namely that induced by the set of involutions of $W$, which we denote by $\text{Invol}(W)$, is endowed with similar properties.

The problem arises from a geometric question. In fact, as well as the Bruhat order on the symmetric group encodes the cell decomposition of Shubert varieties, the Bruhat order on its involutions, considered for the first time by Richard and Springer in 1990 in a more general context, describes the cell decomposition of some symmetric varieties.

In this talk we prove that if $W$ is a classical Weyl group, then the poset $\text{Invol}(W)$ is graded, with rank function given by the average between the length and the absolute length, and that it is El-shellable, hence Cohen–Macaulay, and Eulerian.

The proofs are combinatorial and use the descriptions of classical Weyl groups in terms of permutation groups: the symmetric group for type $A_n$, the hyperoctahedral group for type $B_n$ and the even-signed permutation group for type $D_n$.

In particular we obtain, as new results, a combinatorial description of the absolute length of the involutions in classical Weyl groups, and a combinatorial description of the covering relation in the hyperoctahedral and in the even-signed permutation group.

It is also conjectured that the result proved for classical Weyl groups actually holds for every Coxeter group.

Wednesday 10 March 2004.

Doc. Alexander Stolin, Göteborgs universitet,
Deformation quantization, Yang-Baxter equation and algebraic orbit method

Abstract:
The fact that any Poisson bracket on a manifold $M$ leads to a star-product on $C^\infty(M)$ was explained by M. Kontsevich a few years ago. However finding of the explicit formulas in concrete cases is still an open problem. In my talk I will explain relations between quantization of the Kirillov-Kostant bracket on certain orbits of the co-adjoint representation of the simple complex finite dimensional Lie algebra $g$ and certain representations of $g$. Relations with the dynamical Yang-Baxter equation will be also explained.

Wednesday 17 March 2004.

Professor Nail Ibragimov, Blekinge tekniska högskola,
Invariants of families of differential equations

Abstract:
The present talk is a survey of the basic method and recent results in the theory of invariants of families of differential equations.

The problem of invariants of differential equations can be dated back to Laplace’s 1773 work, when young Laplace (he was 24) published his renowned method based on what is known today as the Laplace invariants $h$ and $k$. These invariants (rather semi-invariants) were found earlier by Leonard Euler and published in his "Integral Calculus", 1769/70. In 1960, L. Ovsiannikov found two proper invariants for hyperbolic equations. The problem, Laplace's problem, on determining all invariants for hyperbolic equations remained open until recently.

In classical literature, invariants of families of differential equations were considered for linear equations only (J. Cockle, E. Laguerre, G. Darboux, E. Goursat, G.H. Halphen, A.R. Forsyth, etc.). S. Lie (1895) regretted that these authors did not use advantages provided by his theory of infinite continuous groups, but he himself did not undertake further developments in this direction.

Recently, I considered the possibility hinted by Lie's remark and developed the infinitesimal technique in the theory of invariants of families of equations that was lacking in the old methods. In consequence, a simple unified approach was developed for calculation of invariants of algebraic and differential equations independent on the assumption of linearity of the equations. It was employed recently for solution of Laplace's problem.


Doc. Sergei Silvestrov, Lund,
Introduction to q-difference equations

Abstract:
In this lecture an introduction to the area of q-difference equations and q-analysis will be given, algebraic structures behind q-difference operators will be described, and q-deformations of KdV-equation will be also discussed.

Wednesday 31 March 2004.

Professor José M. M. Senovilla, University of the Basque Country, Bilbao,
Trapped submanifolds in Lorentzian geometry

Abstract:
In Lorentzian geometry, the concept of trapped submanifold will be introduced by means of the properties of the mean curvature vector. Trapped submanifolds are generalizations of the standard maximal hypersurfaces and minimal surfaces, of geodesics, and also of the trapped surfaces introduced by Penrose. Examples and selected applications to gravitational theories will be presented.

Wednesday 7 April 2004.

Vladimir Kozlov,
Zeros of eigenfunctions

Abstract:
It is known, that the nth eigenfunction, $n=0,1,\ldots$, to the second order Sturm-Liouville ordinary differential operator on an interval has exactly n zeros. I intend to discuss what is known about multi-dimensional problems and to present some new results.
Abstract: Separable Hilbert spaces are familiar to those who have been taught functional analysis, and separation of variables in differential equation is a standard tool being researched here at the Mathematics Department. I will here introduce another notion of separability, relevant for positive operators with trace one (e.g., quantum-mechanical "states"), and some criteria to determine separability. Among other things, the difference between positive maps and completely positive maps will be important in this context.

**Wednesday 21 April 2004.**
**Dr. Torbjörn Lundh, Chalmers,**
Möbius mushrooms and other complex organisms

Abstract: One of the more intriguing questions in embryology is how we, from one uniform egg, through successive cell-divisions, become those complex creatures we are. This riddle has engaged people for centuries. Today, when we are faced with overwhelming genetic information, we are mainly intrigued by the question how this DNA-code is realized into a developing organism.

In the colloquium, we are going to look at a few embryonic developments, and a couple of mathematical models which are used today in morphogenesis (a term which was introduced by Goethe when he was studying how biological organisms got their shape). We will also speculate if some other mathematical tools could be useful in the study of morphogenesis, such as Möbius mappings.

**Wednesday 25 May 2004.**
**Professor Ari Laptev, KTH,**
On the p-Laplace equation including its limit case for p=∞, and related problems

Abstract: The talk will be a survey of the p-Laplace equation (also called the p-harmonic equation) and its limit case, the infinity-Laplace equation, in euclidean n-space. The point of departure will be the classical Laplace equation. Special attention will be given to geometric aspects, regularity questions, some similarities with complex analysis for the case n=2, and a brief discussion of various solution concepts.

**Wednesday 27 April 2004.**
**Professor Sergei Avdonin, University of Alaska, Fairbanks,**
Boundary control method in inverse problems of mathematical physics

Abstract: The BC method was first proposed for the multidimensional wave equation (Belishev, 1987) and was extended to non-self-adjoint inverse problems, to the heat equation and several other parabolic equations, to the Schrödinger equation and the hyperbolic equations. The method reveals that the two central problems of the theory of inverse problems and control theory have a direct connection with each other. The first one, together with the recovery of the coefficients, consists in the construction of a map extending the solution inside the domain, from the data on their behavior on the boundary. The second one is the controllability of the corresponding initial boundary value problem. Roughly speaking, the BC method gives the realization for distributed systems of R. Kalman's idea that the controllable (or observable) part of a system can be identified. One of the important results of the BC method is obtaining multidimensional analogs of the Gelfand-Levitan-Krein-Marchenko equations. It is interesting to note that these equations have a clear control-theoretic meaning which makes their derivation much more simple than the original derivation of one-dimensional versions.

The BC method was first proposed for the multidimensional wave equation (Belishev, 1987) and was extended to non-self-adjoint inverse problems, to the heat equation and several...
other types of PDEs. In the first part of this talk we shall describe the main ideas of this method on a classical example of the (1d) string equation. Then we shall discuss new controllability and identifiation results for the Schrödinger equation and for the wave equation on graphs.

Wednesday 9 June 2004.
Professor Roland Häggkvist, Umeå,
On the cycle double conjecture

Abstract:
A cycle double cover of a graph G is a collection C of cycles of G such that each edge of G belongs to exactly two members of C. Szekeres (1973) and Seymour (1979), motivated by quite different considerations, conjectured that every 2-edge-connected graph admits a circuit double cover. This conjecture is called the cycle double conjecture.

I shall survey some of my work on this conjecture. Recently together with Herbert Fleischner I found a simple proof of his old theorem that the strong cycle double conjecture is true for hypohamiltonian graphs. I shall talk about this proof as well as on my joint work with Klas Markström on the following problem: Assume that the 3-regular graph G is obtained from a 3-regular graph H, all of whose components have a proper 3-edge-colouring, where every pair of colour classes form a hamiltonian cycle by the rule that into each component of H we insert an even number of vertices into the edges and arbitrarily adding a matching incident with the new vertices. Show that G has a cycle double cover!

Friday 27 August 2004.
Markus Kildstad defended his licentiate thesis,
Analysis of the phase space, asymptotic behaviour and stability for heavy symmetric top and tippe top

Abstract:
In this thesis we analyse the phase space of the heavy symmetric top and the tippe top. These tops are one of the very few examples of rigid bodies for which the structure of the phase space can be completely analysed. The heavy symmetric top is the standard example in all textbooks but the proofs of stability of the vertical rotation that are presented there are logically not correct, they provide only the right value of the threshold angular velocity. We provide a complete proof.

The tippe top is a toy that has the form of a truncated sphere equipped with a little peg. When spun fast on the spherical bottom its centre of mass rises above its geometrical centre and after a few seconds the top is spinning vertically on the peg. We study the tippe top through a sequence of embedded invariant manifolds to unveil the structure of the top's phase space. The last manifold, consisting of the asymptotic trajectories, is analysed completely. We prove that trajectories in this manifold attract solutions that stay in the plane of support at all times. We give (for the first time) a complete description of stability-instability of asymptotic motions for all admissible choices of the model parameters and for all initial conditions.

Wednesday 1 September 2004.
Peter Rand,
Asymptotic analysis of a nonlinear partial differential equation in a semicylinder

Abstract:
Small solutions of a nonlinear partial differential equation in a semi-infinite cylinder will be studied. We consider the asymptotic behaviour of these solutions at infinity under Neumann boundary condition as well as Dirichlet boundary condition. In the Neumann case it can be shown that any solution small enough either vanishes at infinity or tends to a nonzero periodic solution of a nonlinear ordinary differential equation. In the Dirichlet case every solution small enough vanishes. Parts of the proofs of these statements will be given.

Professor Michael Zarichnyi, Lviv University (Ukraine) and University of Rzeszow (Polen),
Large scale topology

Abstract:
The asymptotic topology deals with the large scale properties of metric spaces. Recently, its results found deep applications in geometric functional analysis, group theory, and topology of manifolds. The aim of the talk is to introduce some fundamental notions of asymptotic topology as well as to formulate some results on absolute extensors in asymptotic categories, embedding theorems and coarse invariants.

Wednesday 8 September 2004.
Professor Ljudmila Bordag, Halmstad,
Projective differential geometrical structure of the Painlevé equations

Abstract:
The necessary and sufficient conditions that an equation of the form $y''=f(x,y,y')$ can be reduced to one of the Painlevé equations under a general point transformation are obtained. A procedure to check these conditions is found. The theory of invariants plays a leading role in this investigation. The reduction of all six Painlevé equations to the form $y''=f(x,y)$ is obtained. The structure of equivalence classes is investigated for all the Painlevé equations. Following Cartan the space of the normal projective connection which is uniquely associated with any class of equivalent equations is considered. The specific structure of the spaces under investigation allows us to immerse them into $\mathbb{R}P^3$. The surfaces corresponding to all the Painlevé equations are presented.

Wednesday 15 September 2004.
Professor Nikolai Kuzjurin, Russian Academy of Sciences, Moscow,
Probabilistic methods in packing and covering problems

Abstract:
Packaging and covering problems form a wide class of combinatorial problems where probabilistic methods play an important role. Using probabilistic techniques some best known bounds were obtained in packing and covering problems including the famous result about the existence of nearly perfect packings and coverings (Rödl, 1985). A natural question is: can one obtain similar results without using probabilistic methods? In several cases it is possible to give a positive answer and to present explicit constructions.

In my talk I will describe the main ideas of explicit constructions of nearly perfect packings and then present a simple probabilistic method for counting the number of nearly perfect packings. In the second part of my talk I am going to present a new class of packing problems that arise in scheduling parallel tasks in networks. Such problems can be reformulated as packing of a given set of rectangles (corresponding to tasks) into a set of strips (corresponding to computers in a network). Some new results about approximation algorithms for this problem will be presented for the worst and the average cases.

Wednesday 22 September 2004.
Peter Rand defended his licentiate thesis,
Asymptotic analysis of a nonlinear partial differential equation in a semicylinder

Abstract:
We study small solutions of a nonlinear partial differential equation in a semi-infinite cylinder. The asymptotic behaviour of these solutions at infinity is determined. First, the equation under the Neumann boundary condition is studied. We show that any solution small enough either vanishes at infinity or tends to a nonzero periodic solution of a nonlinear ordinary differential equation. Thereafter, the same equation under the Dirichlet boundary condition is studied, but now the nonlinear term and right-hand side are slightly more general than in the Neumann problem. Here, an estimate of the solution in terms of the right-hand side of the equation is given. If the equation is homogeneous, then every solution small enough tends to zero. Moreover, if the cross-section is star-shaped and the nonlinear term in the equation is subject to some additional constraints, then every bounded solution of the homogeneous Dirichlet problem vanishes at infinity. An estimate for the solution is given.
Wednesday 22 September 2004.
Professor Henrik Shahgholian, KTH,
The structure of the singular set of a free boundary in potential theory

Abstract:
We characterize the structure of the singular set in the following free boundary problem
\[ \Delta u - f u = 0, \quad \text{in } B = B(0, 1), \]
where \( f \) is Lipschitz, and \( u \) is in \( W^{2, p}(B), p > n \). The free boundary \( \partial \Omega \), represented by \( \partial \Delta u = f \), appears in certain problems in geophysics and inverse problems in potential theory.

This is joint work with Luis Caffarelli.

Friday 24 September 2004.
Jonas Bergman defended his licentiate thesis,
Conformal Einstein spaces and Bach tensor generalizations in n dimensions

Abstract:
In this thesis we investigate necessary and sufficient conditions for an \( n \)-dimensional space, \( n > 4 \), to be locally conformal to an Einstein space. After reviewing the classical results derived in theories we consider the four-dimensional spinor result of Kozameh, Newman and Tod. The involvement of the four-dimensional Bach tensor (which is divergence-free and conformally well-behaved) in their result motivates a search for an \( n \)-dimensional generalization of the Bach tensor \( \mathfrak{b} \) with the same properties. We strengthen a theorem due to Belfagón and Jaén and give a basis \( \{U_{ab}, V_{ab} \} \) for all \( n \)-dimensional symmetric, divergence-free 2-index tensors quadratic in the Riemann curvature tensor. We discover the simple relationship \( U_{ab} = (1/2) \, W_{ab} \) and \( (1/6) \, V_{ab} \) and show that the Bach tensor is the unique tensor with these properties in four dimensions. Unfortunately we have to conclude, in general that there is no direct analogue in higher dimension with all these properties.

Nevertheless, we are able to generalize the four-dimensional results due to Kozameh, Newman and Tod to \( n \) dimensions. We show that a generic space is conformal to an Einstein space if and only if there exists a vector field satisfying two conditions. The explicit use of dimensionally dependent identities (some of which are newly derived in this thesis) is also exploited in order to make the two conditions as simple as possible; explicit examples are given in five and six dimensions using these tensor identities.

For \( n \) dimensions, we define the tensors \( \mathfrak{b} \_ {\text{abc}} \) and \( \mathfrak{b} \_ {\text{abc}} \), and we show that their vanishing is a conformal invariant property which guarantees that the space with non-degenerate Weyl tensor is a conformal Einstein space.

Wednesday 6 October 2004.
Professor Natan Krugljak, Luleå,
On one new covering theorem and its applications

Abstract:
Classical covering theorems (Vitali, Whitney, Besicovitch) are not only beautiful but they also have important applications in analysis, harmonic analysis, theory of approximations, ergodic theory and PDEs. Some years ago in connection with real interpolation of Sobolev spaces appeared theorems which have simultaneously features of Whitney and Besicovitch covering theorems. I plan to discuss these new theorems and their applications to interpolation and possible applications to singular integrals.

Thursday-Saturday 14-16 October 2004.
Conference,
The \( p \)-Laplace equation, the infinity-Laplace equation and related topics.

Wednesday 20 October 2004.
Professor Juan J. Manfredi, University of Pittsburgh,
Convexity from the PDE point of view

Abstract:
Convex functions in Euclidean space play an important role in the regularity theory of non-linear elliptic partial differential equations. They can be characterized as universal subsolutions of homogeneous fully nonlinear second order elliptic partial differential equations. In the first part of the talk, we will first show that this PDE definition is equivalent to the usual one. Then we will use well-known estimates for subsolutions of familiar PDEs to derive estimates for convex functions.

Another advantage of the PDE definition of convexity is that it can be considered in the case of Carnot groups. In the second part of the talk we will present the theory of convex functions on Carnot groups. Our approach is based on the viscosity theory of subsolutions for subelliptic equations and the geometric role played by infinity-harmonic functions.

Professor Anders Björner, KTH,
Blockers and vanishing ideals of subspace arrangements

Abstract:
The blocker of a set family \( A \) is the collection of inclusionwise minimal sets that intersect all sets in \( A \). This construction is well-known in combinatorics and combinatorial optimization. The corresponding construction on set partitions (and more generally on geometric lattices) arises in the study of vanishing ideals of arrangements of linear subspaces in a vector space.

I will survey examples and properties of blockers and a combinatorial duality that they satisfy, beginning with some new results on blocker duality in general posets. I will then describe the relevance of this concept for vanishing ideals that are generated by products of linear forms. The results also touch on some Turan-type problems from extremal combinatorics.
Wednesday 3 November 2004.
Professor Martina Simunková, Liberec, Czech Republic,
The Poisson Integral and the Kelvin Transform

Abstract:
The Poisson integral which gives an explicit solution of the Dirichlet problem of the Laplace equation on a ball plays an important role in classical potential theory. There are several possibilities to derive the Poisson integral - some of them are based on the Kelvin transform. The connection between the Poisson integral and the Kelvin transform will be shown. Also Kelvin type transforms of elliptical operators will be described.

Wednesday 10 November 2004.
Professor Antonio F. Costa, UNED, Madrid,
On the connectedness of the locus of real Riemann surfaces in the moduli space

Abstract:
This talk is dedicated to expose some results on the connectedness of the set of special types of real curves in the moduli space of complex algebraic curves. We review some known results where the above set is connected. We present some cases where the set of real p-gonal algebraic curves is not connected. We also show that the set of real elliptic-hyperelliptic curves of even genus > 5 is not connected.

Thursday 11 November 2004, 10.15.
Daniel Ying defended his licentiate thesis,
Cyclic trigonal Riemann surfaces of genus 4

Abstract:
A closed Riemann surface which can be realized as a 3-sheeted covering of the Riemann sphere is called trigonal, and such a covering is called a trigonal morphism. Accola showed that the trigonal morphism is unique for Riemann surfaces of genus $g \geq 5$. This thesis will characterize the Riemann surfaces of genus 4 with non-unique trigonal morphism. We will describe the structure of the space of cyclic trigonal Riemann surfaces of genus 4.

Wednesday 17 November 2004.
Svante Linusson,
A survey on trees in mathematics and biology

Abstract:
A mathematical tree is easy to understand and has been studied not only in pure mathematics. Trees have also been important objects in e.g. optimisation and computer science as for instance search trees, decision trees and computational trees. It would not be unreasonable to believe that such a simple object with many applications would be so thoroughly studied that when questions arise in the new biology related mostly to evolutionary trees, the mathematicians could present all the relevant answers at once. This is however not the case. Several new difficult problems arise.

I will give a survey of interesting theorems/conjectures about trees from both pure mathematics and biology. It is my firm belief that mathematicians have a crucial role in transforming biology into an information science. But also that biology can inspire new beautiful and interesting mathematics.

The talk does not require much prerequisites of the audience. It will be understandable to every mathematician at the department, especially every PhD student.

Wednesday 24 November 2004.
Dr. Mattias Jonsson, KTH,
Singularities in complex dynamics

Abstract:
I will discuss how algebrao-geometric methods can sometimes be used to study objects of nonalgebraic nature, e.g. certain dynamical systems.

In dynamics one is often interested in asymptotic behavior as time evolves. For instance, given a polynomial map $F: \mathbb{C}^2 \to \mathbb{C}^2$ one may ask at what speed the orbit $p, F(p), F(F(p)), \ldots$ approaches infinity, as $n$ tends to infinity, if the orginal point $p$ is chosen generically near infinity. This speed is governed by the behavior of $\deg F^n$, the degree of the highest order term in $F^n$. For example, if $F(X,Y) = (Y,XY)$, then $\deg F^n$ gives the Fibonacci numbers, so in a suitable sense, the speed above equals the golden mean.

A classical field of algebraic geometry is the study of singularities, such as the curve in $\mathbb{C}^2$ parameterized by $t \mapsto (t^2,t^3)$, which has a cusp at the origin. It is known that singularities typically can be resolved, i.e. viewed as shadows of nonsingular objects; the cusp above is the shadow of the space curve $t \mapsto (t^2,t^3)$.

As I will explain, it turns out that a dynamic version of resolution of curve singularities can be used to understand the speed of convergence to infinity of polynomial maps of $\mathbb{C}^2$. As a consequence, the speed is always a quadratic integer.

Wednesday 1 December 2004.
Professor Nikolay Kuznetsov, St. Petersburg,
Uniqueness in the water-wave problem for bodies intersecting the free surface at arbitrary angles

Abstract:
The linearized water-wave problem involving a surface-piercing cylinder in water of infinite depth will be considered. A solution to this problem will be shown to be unique for all values of the radian frequency when the cylinder intersecting the free surface at arbitrary angles is subjected to certain geometric arrangements. The previous result by Simon and Ursell (1984) provided the uniqueness only for bodies intersecting the free surface at angles greater or equal to 45 degrees.

Wednesday 8 December 2004.
Lars Inge Hedberg,
Spectral synthesis in function spaces

Abstract:
I will discuss some old and new results in this area, which is related to some important problems for partial differential equations. No prerequisites beyond basic analysis will be assumed. In particular the concepts mentioned in the title will be defined in the talk.

Thursday 16 December 2004.
Magnus Österholm defended his licentiate thesis,
Läsa matematiska texter: Förståelse och lärande i läsprocessen
(Reading mathematical texts: Understanding and learning in the reading process)

The thesis can be downloaded from here.

Abstract:
The focus of this thesis is the reading of mathematical texts, especially how and what you can understand and learn from reading. The main interest is the reading process, that is, the
reading itself and what you understand after reading a text. The main purpose is to study the reading of mathematical texts in particular, in order to test and develop an existing general theory of reading comprehension. An essential part is to study how the use of symbols in mathematical texts can affect the reading process. The thesis consists of theoretical discussions about the reading of mathematical texts and an empirical study among students from the Swedish upper secondary school and from the university.

A study of existing literature that deal with properties of mathematical texts constitute a starting point for the theoretical discussions. In particular, the reading of mathematical symbols and algebraic expressions is discussed.

The empirical study, which includes 106 participants, used three different texts: one history text about the Russian revolution and two mathematical texts about group theory. The same information about groups is included in both mathematical texts, but one of the texts uses mathematical symbols in the presentation while the other does not use symbols at all. Each participant read one of the mathematical texts and the history text, and after each text they got to answer questions about the content of the text.

The group of participants who read the mathematical text without symbols has a better result on the questions about the text than the group of participants who read the text with symbols. This seems to be caused by an inability to articulate the symbols and by the fact that the ability to decode a text does not seem to be used in the same way for the text with symbols as it is for the history text and the mathematical texts without symbols. Thus, the reading of mathematical texts with symbols is a rather special activity and there might be a need for learning how to read such texts. On the other hand, there seems to be many similarities between the reading of the mathematical text without symbols and the historical text. Therefore, the main factor of the texts influencing the reading process is not the content of the text but the form of the text, that is, how the content is presented.

In the theoretical discussions, some suggestions are presented on how the reading of mathematical texts with symbols can be included in the general theory of reading comprehension. In general there is no reason to consider the reading of mathematical texts as a special kind of reading process, different from the reading of other types of texts. Thus, the general theory of reading comprehension can function as a theoretical framework also for the comprehension of mathematical texts, possibly with the suggested additions about mathematical symbols.
The Mathematical Colloquia held in 2003 at Linköpings universitet

Organized by Anders Björn, Vladimir Kozlov, Svante Linusson, Stefan Rauch-Wojciechowski and Claes Waksjö.

Wednesday 22 January 2003.
Docentföreläsning by Jana Björn,
Wiener criterion and boundary continuity of solutions to the Dirichlet problem

Abstract:
The classical Dirichlet problem for the Laplace equation is the problem of finding a harmonic function in a given domain so that it has prescribed boundary values on the boundary of the domain. For domains with sufficiently smooth boundary and continuous boundary data, solutions of the Dirichlet problem are continuous up to the boundary and attain their boundary data at every boundary point. This is no longer true for more general domains.

By the celebrated Wiener criterion from 1924, solutions of the Dirichlet problem for the Laplace equation with continuous boundary data are continuous at a boundary point if and only if the so-called Wiener integral associated with this point diverges. Similar criteria have later been obtained for p-harmonic equations, which are non-linear analogues to the Laplace equation, and for other elliptic equations.

In recent years, the Dirichlet problem for p-harmonic equations has been studied in the context of metric measure spaces without a differentiable structure. This new theory unites and generalizes some of the earlier results, but it also gives new results in the classical setting.

In the talk, I will give a survey of some older results related to the Wiener criterion and discuss some new results concerning boundary continuity of solutions to the Dirichlet problem.

Wednesday 12 February 2003.
Docentföreläsning by Anders Björn,
Removable singularities for spaces of analytic functions

Abstract:
Small exceptional sets that can be ignored occur in many parts of mathematics. For instance, when calculating the integral of a function one can ignore the values of the function on any set of (Lebesgue) measure zero.

Another example of exceptional sets is removable singularities. Consider an open connected set G in the complex plane and let E be a compact subset of G. We can then consider the class consisting of all bounded analytic functions on the set G\E. We say that the set E is a removable singularity (for this class) if all of these functions are analytic not only on G\E but also on all of G. (To be precise they should have analytic continuations to all of G.) This means that the set E can be ignored in this context. In this example it is well-known from any first course in complex analysis that a single point is a removable singularity. Painlevé showed already in 1888 that if G has zero generalized length, in particular if G has (Hausdorff) dimension less than one, then E is a removable singularity. It is also true that if G has dimension greater than one then it is never a removable singularity. For one-dimensional sets the story is more complicated.

In this talk I will discuss removable singularities for bounded as well as other classes of analytic functions.

Wednesday 19 February 2003.
Professor Jan-Erik Björk, Stockholms universitet,
Classical mechanics: A lecture about the spinning top

Abstract:
The lecture is devoted to dynamical equations describing the motion of a rigid body which rotates around a fixed point while gravity is the only external force. These dynamical equations are derived from laws of classical mechanics. The proof is very instructive, where two systems of coordinates are used - one is attached to the rigid rotating body and the other is fixed in R^3.

Two cases will be discussed in more detail. First, the spinning top - Case of Lagrange - which arises when the body is symmetric and the center of mass is placed on the line of symmetry. Second, the gyroscope of Sonja Kovalevsky which arises when the body is symmetric with respect to the fixed point and the center of mass is placed in the plane of symmetry.

Wednesday 5 March 2003.
Dr. Andreas Bette, KTH Syd,
On spinning objects in (special) relativity

Abstract:
A relativistic (twistor) phase space formulation of the dynamics of a spinning electrically charged massive particle in an external electro-magnetic field will be presented. The function used to generate such a dynamics is chosen so that it preserves the (second order) Dirac operator.

If time permits, a relativistic (twistor) action integral will be presented describing a free massive spinning (no Grassman variables are needed) string.

Wednesday 12 March 2003.
Armen Asratian,
Some results on proper edge colorings of graphs

Abstract:
A proper edge coloring of a graph G is an assignment of colors to the edges of G such that no two adjacent edges receive the same color. I will give a review of some results on proper edge colorings of graphs and point out some applications of these results to solving scheduling problems and matrix theory.

Wednesday 19 March 2003.
Lars Inge Hedberg,
The Schwarz lemma, the Poincaré metric, and a theorem of Ahlfors.

Abstract:
In 1938 Lars Ahlfors found a beautiful generalization of the classical Schwarz lemma in complex analysis, which gave new insights into the connections between complex analysis and geometry, and had far-reaching consequences, among others simple proofs of the Picard theorems on omitted values. I will present Ahlfors's theorem from scratch, i.e., without assuming any prerequisites beyond elementary complex analysis.

Föredraget är mycket lämpligt för alla deltagare i kursen Komplex Analys

Wednesday 26 March 2003.
Professor Ingemar Bengtsson, Stockholms universitetet,
Metrics with a potential

Abstract:
Differentiating a convex function twice, we get a matrix that can be regarded as a metric tensor. (It sounds like Kähler manifolds, but it is not.) I will sketch some magical tricks that
are performed in mathematical statistics using this construction, and then mention other applications including the theory of Frobenius manifolds and black hole thermodynamics.

**Wednesday 2 April 2003.**

Leif Melkersson,  
Local cohomology  
Abstract:  
I will try to give some glimpses into some of the main objects I deal with in my research, namely the local cohomology modules $H^i_X(M)$. They were introduced by Grothendieck. They provide a very powerful technical tool and they have found increasing applications in commutative algebra and neighbouring fields. As an example I may mention that if $A=C[X_1,...,X_n]$ is the polynomial ring, then the local cohomology modules $H^i_A(A)$ with respect to an arbitrary ideal $a$ are (holonomic) modules over the Weyl algebra (the ring of differential operators with polynomial coefficients). Thus in this case they satisfy strong finiteness properties. Using techniques from the theory of local cohomology I have recently solved a problem in the homological theory of noetherian commutative rings, generalizing a result of Hartshorne (Inventiones 9 (1979)).

**Wednesday 16 April 2003.**

Svante Linusson and Johan Wåstlund,  
A proof of Parisi’s conjecture on the random assignment problem  
Abstract:  
An assignment problem is the optimization problem of finding, in an $m$ by $n$ matrix of nonnegative real numbers, $k$ entries, no two in the same row or column, such that their sum is minimal. Such an optimization problem is called a random assignment problem if the matrix entries are random variables. We have in a recent article given a formula for the expected value of the optimal $k$-assignment in a matrix where some of the entries are zero, and all other entries are independent exponentially distributed random variables with mean 1. Thereby we prove the formula $1 + 1/4 + 1/9 + ... + 1/k^2$ conjectured by G. Parisi for the case $k = m = n$, and the generalized conjecture of D. Coppersmith and G. B. Sorkin for arbitrary $k$, $m$ and $n$.  
We will give a very basic description accessible to everyone of how one may find the expected value of small random assignment problems in general. We will also give an outline of what enabled us to solve the famous conjecture.

**Wednesday 7 May 2003.**

Dr. Hans Lundmark, University of Saskatchewan,  
Inverse scattering and multipeakons  
Abstract:  
The Camassa-Holm equation is an integrable nonlinear PDE modelling waves in shallow water. It admits solitons solutions with waves having peaks of the form $e^{imx}$. These solutions, known as multipeakons, can be explicitly computed using inverse scattering, a well-known method in the theory of integral systems. In fact, this problem is an unusually nice example for illustrating the technique, since it can be handled by completely elementary means (in contrast, for example, to the rather complicated inverse scattering theory for the KdV equation).

I will give an introduction to these ideas, which go back to work by Krein on inverse spectral problems for inhomogeneous strings, and by Moser on the Toda lattice. The application to the Camassa-Holm equation is due to Beals, Sattinger and Szmigielski. I will also describe some new results by Szmigielski and myself on the corresponding problem for the Degasperis-Procesi equation, which is a recently discovered integrable modification of the Camassa-Holm equation.

**Wednesday 14 May 2003.**

Daniel Mondoc,  
Kantor triple systems  
Abstract:  
Kantor triple systems (KTS) are generalisations of Jordan triple systems. KTS are connected to 5-graded Lie algebras by the so called Kantor-Koecher-Tits construction. The KTS are called (real) classical or (real) exceptional if the corresponding Lie algebras are (real) classical or (real) exceptional, respectively. The aim of this talk is to give a presentation of the notions mentioned above and to give results on the classification of real simple compact classical and exceptional KTS defined on tensor products of composition algebras.

**Wednesday 21 May 2003.**

Per-Olov Lindberg,  
Dynamiska trafikjämviker  
Abstract:  

Vi har alltid upplevt trafikutskningar (zi synnerhet Stockholmare). Trafiklänkar karakteriseras av att restiden växer med ökande trafikflöden. Samtidigt vill resenärerna välja (tex. i tids) kortaste väg från start till mål, men deras vägval påverkar flödena och alltså tiderna. Vid jämviket har inga resenärer anledning att byta rutter, under de restider som uppstår då de utnyttjar de rutter de valt.

I den östasiatiska versionen av problemet att bestämma jämviken, antar man att flödet mellan ett antal givna start- och målpunkter är konstant. Detta problem formulerades till ett (ändligdimensionellt) optimieringsproblem redan på 50-talet, och genomförbara beräkningsmetoder togs fram i början på 70-talet, och används ännu idag.

I den mer realistiska dynamiska versionen av jämviksproblem, som ska efterlikna t.ex. morgonrusningens uppåg och fall, är flödet mellan start och målpunkter inte konstant. Här har man till dags dato inte hittat någon allmänt vetenskapelig matematisk beskrivning.


**Wednesday 28 May 2003.**

Dr. Staffan Rodhe, Uppsala universitet,  
Samuel Klingenstierna - 1700-talets viktigaste svenska matematiker  
Abstract:  

**Wednesday 4 June 2003.**

Tomas Johansson, ITN,  
Rekonstruktion av temperatur från randdata  
Abstract:  

**Thursday 12 June 2003.**

Professor Vladimir Varlamov, University of Texas,  
On the wave propagation in the presence of moving boundaries  
Abstract:  
Nonlinear wave propagation became a popular topic after the historical discovery of solitary waves by the famous Scottish physicist John Scott Russell in 1834. In fact solitons represent a delicate balance between nonlinearity and dispersion. In order to observe nonlinear wave propagation in laboratory experiments, one has to generate these waves...
effectively. Usually a moving piston- or flap-type wave maker is employed for this purpose. This wave maker is mounted at one end of a sufficiently long channel. A Korteweg-de Vries-
type equation is chosen to model the nonlinear wave propagation on the surface of water. It is examined in the domain $\mathbb{R}^2$, where the function $x$-gamma($t$) describes the law of movement of the wave maker. An interesting feature of the problem is the appearance of a forced nonlinear oscillator equation (Emden-Fowler-type equation) relating the motion of the wave maker to the wave amplitude at the boundary. Local- and global-in-time solvability of the initial-boundary problem is investigated. Asymptotic solution of the boundary equation is constructed.

**Wednesday 25 June 2003.**

**Professor Nageswar Shannumalingam, Cincinnati,**

Banach space valued Newton-Sobolev on metric measure spaces

Abstract:

Sobolev spaces have been an integral part of the study of PDEs and quasiconformal mappings between Euclidean spaces. Recent surge of interest in the study of quasiconformal mappings between domains in metric measure spaces indicates the desirability of constructing Sobolev type spaces of functions between metric spaces.

Given that general metric spaces need not have a group structure, spaces of functions between two metric spaces in general need not have a vector space structure. We can however compensate for this by embedding the target metric space isometrically into a Banach space, for example, into $p^\infty$, and the corresponding space of functions inherit the vector space structure.

In this talk, we will construct an analogue of Sobolev spaces, called Newtonian spaces, of functions from a metric measure space into a fixed Banach space. To do so, we will use the notion of upper gradients first developed by Heinonen and Koskela. We will discuss some elementary properties of this function space, and discuss the independence of Poincaré inequalities from the target Banach space. In particular, we will prove that Newtonian functions from the given metric space $X$ into any Banach space satisfy a Poincaré inequality if and only if real-valued Newtonian functions from $X$ satisfy a Poincaré inequality.

We will also discuss how to extract the class of Newtonian functions from $X$ to a given metric space $Y$ from the Newtonian space of functions from $X$ to a Banach space into which $Y$ was embedded.

This talk is based on joint work with Heinonen, Koskela, and Tyson (2001).

**Wednesday 3 September 2003.**

**Professor Vadim Kuznetsov, University of Leeds,**

Separation by combing and plating

Abstract:

We introduce a new notion of a $\mathcal{F}$oc $\rightarrow$ ried Separatinscha $\sim \{\text{or simply Faktura}\}$ which is a superstructure responsible for separability of a fairly large class of Louiville integrable systems and their quantum analogues. It consists of two strings of mutually inverse transformations, the combing and the plating. The former transform combs out separation variables one by one, while the latter binds down an extra separation variable on each step. Examples include Calogero-Moser systems, monomial/5Dhar symmetric functions and Jack polynomials.

**Wednesday 10 September 2003.**

**Professor Yasunao Hattori, Shimane University, Japan,**

Special metrics appeared in topology

Abstract:

The notion of a metric function (shortly, a metric) is one of the most fundamental concepts in topology. Metric functions appear almost everywhere in topology. For a metrizable space $X$, there are many metrics which induce the original topology of $X$. Some of them may determine a topological property of $X$. On the other hand there exist admissible metrics which determine any topological property. We shall talk about the relationship between metric properties and topological ones.

**Wednesday 17 September 2003.**

**Professor Kyrill Tintarev, Uppsala University,**

Invariant energies and their minimizers in spaces with rich symmetries

Abstract:

Given a differentiable manifold and a topological group acting on it transitively, there is an essentially unique (up to a choice of fixed matrix) invariant metric together with a dual Sobolev quadratic form. Existence still holds if transitively is replaced by a requirement that the manifold is co-compact. Similar argument extends also to the sub-Riemannian/sub-elliptic case. In the resulting metric the group becomes a group of isometries and, via the abstract concentration compactness method, yields existence of Sobolev minimizers in the case when the manifold (and so the correspondent Sobolev imbedding) is not compact. This is a joint work with K.-H. Fieseler.

**Wednesday 24 September 2003.**

**Professor Vitaly Fedorchuk, Moscow State University,**

Probability measures and infinite-dimensional manifolds

Abstract:

In 1931 O. H. Keller proved that every infinite-dimensional compact convex subset of the Hilbert space $l_2$ is homeomorphic to the Hilbert cube $Q = \mathbb{R}^\mathbb{N}$. It implies that for every infinite compact metric space $X$ the space $P(Q)$ of all probability measures on $X$ is homeomorphic to $Q$. I'll try to explain why the following topological equalities or non-equalities hold:

$(R_\infty) = (R_\infty) \neq (R_\infty) \neq (R_\infty) 

As for the problem, if $(R_\infty)$ is homeomorphic to $(R_\infty)$, is unsolvable in ZFC. In order to answer these questions one has to know when a mapping $f: X \rightarrow Y$, in particular a mapping of type $P(f)$, is a trivial bundle. In early 80th H. Toruncyck and J. West gave a characterization for mappings $f: X \rightarrow Y$, in particular a trivial bundle. If time permits, I am going to show how their results work.

**Wednesday 1 October 2003.**

**Professor Francesco Calogero, University of Rome 1 “La Sapienza”,**

Isochronous systems are not rare

Abstract:

A dynamical system is here called isochronous if there exists an open set of initial data (having full dimensionality in the phase space of such initial data) such that all motions emerging out of it are completely periodic with the same fixed period (independent of the initial data). It will be shown how, from a quite arbitrary dynamical system, a deformed one is found. These include Hamiltonian and non Hamiltonian systems, and systems naturally interpretable as many-body problems, possibly rotation-and/or translation-invariant in two- or more-dimensional space, possibly appearing as deformations of classical problems such as the many-body gravitational problem in ordinary (three-dimensional) space. The relevance of these results is underscored by the observation that isochronous systems are generally superintegrable. Although the approach is also applicable to infinite dimensional systems (for instance, also to nonlinear evolution PDEs), the talk will mainly focus on the finite-dimensional case.

**Wednesday 8 October 2003.**

**Lars Falk, FOI (totalförsvarsforskningsinstitut), Stockholm,**

The force on Newton’s apple

Abstract:

In Principia Newton proved that a spherical shell attracts as if all mass is concentrated at the centre. This formula gives the force on an apple and simplifies the analysis of the Solar system considered as a system of point masses. The proof in Principia is based on geometry, but many people believe that Newton used calculus in the first place. A number of methods discussed in the literature are reviewed and compared with a simple geometrical approach, which may be close to Newton’s original derivation.

**Wednesday 15 October 2003.**

**Class Waksjö, MAI,**

From elliptic to cofactor-elliptic coordinates

Abstract:

In 1839 Jacobi introduced elliptic coordinates as a means to integrate the geodesic equations on an ellipsoid. Since then, several important problems have been solved by using them to separate variables in the Hamilton-Jacobi or Schrödinger equations. In this talk, I will give a review of the fundamental properties of elliptic coordinates, and show how they can be generalized in a natural way within the framework of the recently developed theory of Newton systems of cofactor type. The so found coordinates, which are called cofactor-elliptic, are given by non-orthogonal families of non-confocal quadrics. These coordinates allow new Newton systems to be solved by separation of variables in a somewhat modified Hamilton-Jacobi sense.

**Wednesday 22 October 2003.**

**Andreas Axelsson, MAI,**
Kombinatoriska problem som att sortera en kortlek med hjälp av enkla tekniker, som att vända de översta k korten, har länge roat många matematiker. Det visar sig nu att sådana problem har viktiga tillämpningar inom bioinformatik, för att avgöra hur nära släkt olika bakteriearter är. Vi kommer att presentera några av de viktigaste resultaten inom detta decenni-agam område.

**Wednesday 29 October 2003.**

Dr. Niklas Eriksen, 
Atta blandande och ge - en genordnings-odysse.

Abstract:
Kombinatoriska problem som att sortera en kortlek med hjälp av enkla tekniker, som att vända de översta k korten, har länge roat många matematiker. Det visar sig nu att sådana problem har viktiga tillämpningar inom bioinformatik, för att avgöra hur nära släkt olika bakteriearter är. Vi kommer att presentera några av de viktigaste resultaten inom detta decenni-agam område.

**Friday 7 November.**

Professor Sergio Benenti, University of Turin, 
On the connection between the additive separation of the Hamilton-Jacobi equation and the multiplicative separation of the Schrödinger equation. 1. The completeness and Robertson conditions

Abstract:
The fundamental elements of the variable separation theory are revisited, including the Eisenhart and Robertson theorems, Kalnins-Miller theory, and the intrinsic characterization of the separation of the Hamilton-Jacobi equation, in a unitary and geometrical perspective. The general notion of complete integrability of first-order normal systems of PDEs leads in a natural way to completeness conditions for separated solutions of the Schrödinger equation and to the Robertson condition. Two general types of multiplicative separation for the Schrödinger equation are defined and analyzed: they are called "free" and "reduced" separation, respectively. In the free separation the coordinates are necessarily orthogonal, while the reduced separation may occur in nonorthogonal coordinates, but only in the presence of symmetries (Killing vectors).

**Wednesday 12 November 2003.**

Professor Issai Kantor, Lunds universitet, 
An Introduction in Supermathematics

Abstract:
The Supermathematics is a branch of Mathematics which was started recently (approximately 30 years ago) in connection with existence of two types of elementary particles: bosons and fermions. While behavior of bosons could be described in ordinary variables (called in Supermathematics "even" variables) for fermions one need so called "odd" variables. Using both types of variables together one can consider, for example, the Schrödinger equation and the Pauli equation as the one equation in which both types of variables participate together. This situation has influence on the whole of Mathematics which become more and more what people call Supermathematics. In the talk will be given an elementary introduction to Supermathematics mostly in terms of linear algebra. No preliminary knowledge is needed.

**Wednesday 19 November 2003.**

Professor Maciej Blaszak, Adam Mickiewicz University, Poznan, 
How to solve integrable systems by separation of variables

Abstract:
The notion of integrable systems is introduced. Then, the concept of separation conditions (and a related separation curve) in the theory of Hamiltonian integrable systems is discussed. It is demonstrated that such conditions contain a lot of information on properties and solutions of finite and infinite dimensional integrable systems. Finally, the main ideas of modern geometric separability theory are sketched.

**Wednesday 26 November 2003.**

Dr. Jörgen Backelin, Stockholms Universitet, 
Ramsey theory

Abstract:
The most classical problem in Ramsey theory concerns the smallest size R(n₁, ..., nᵣ) of a complete graph, such that for each colouring of its edges in r colours, there is an i, such that there is an nᵢ-subset of vertices, with all its edges i-coloured.

More generally, one may ask questions of the type "How large can a graph be, if it allows an edge colouring without any of certain inheritable properties?". Thus, there are close connections to extremal graph theory; and in particular, there are 'Ramsey extremal graphs' of various kinds, with interesting properties.

I plan to give an introduction to the theory, including a proof of the existence of the limits; a summary of some of the results up to now; and an extension to a general setting. In particular, I'll speak about the numbers R(3, +1), and of some related techniques and extremal graph properties.

I shall make an honest effort to cram this into a 1 hour lecture. No prerequisites are required, above the abstract definition of simple undirected graphs.

**Wednesday 3 December 2003.**

Dr. Alexandru Aleman, Lunds universitet, 
Analytic contractions and boundary behavior of analytic functions

Abstract:
There is a large class of contractive linear operators on a separable Hilbert space that can be modeled by the operator of multiplication by the independent variable on a Hilbert space of analytic functions on the unit disc. This talk will focus on a basic problem concerning this model namely, the relation between the abstract properties of the operator in question and the boundary behavior of the functions in the model space. Problems of this type emphasize the interplay between complex analysis and operator theory and in this particular case, they are closely related to index theory and polynomial approximation.

**Wednesday 10 December 2003.**

Magnus Herbertsson, MA, 
Gravitationsdöpsalen, eller: vad är derivatan av ett svart hål?

Abstract:
Frågan om klimatet och människans roll som en drivkraft för klimatförändringen är dagsaktuella vetenskapliga och praktiska frågeställningar. Enligt den senaste internationella sammanställningen av klimatforskning (IPCC 2001), beräknas antropogena utsläpp av koldioxid m.m. leda till en global uppvärmning mellan 1,4 och 5,8 grader från år 1990 till år 2100. Ett annat rönt som delvis baseras på klimatmodellering är att människan sannolikt står bakom en stor del av den redan inträffade globala uppvärmningen på 0,6 grader under 1900-talet. Dessa förändringar överträffar de naturliga variationer som samhället är van vid och uppknappats leda till omfattande negativa konsekvenser världen över. I denna presentation diskuteras klimatmodellering och klimatscener, med svenska särfrågor i fokus.

Klimatmodeller är viktiga verktyg i studier av hur klimatsystemet fungerar, hur det kan påverkas och hur känsligt det är för påverkan. Trots sina olikheter omfattar och komplicerade klimatsystemet, inklusive systemets återkopplingar och interna frihetsgrader.


När det är frågan om klimatet som studeras, blir simuleringsarna typiskt långa (flera hundra år), de måste upprepas för olika antaganden av socioekonomiskt värdegutspeck (utsläppsscenarier) och genomföras med flera modeller (t.ex. att uppskatta säkerheten med avseende på klimatsystemets känslighet för påverkan ökar det antalet modeller som benödvändiga för att handskas med det omfattande och komplicerade klimatsystemet, inklusive systemets återkopplingar och interna frihetsgrader.


När det är frågan om klimatet som studeras, blir simuleringsarna typiskt långa (flera hundra år), de måste upprepas för olika antaganden av socioekonomiskt värdegutspeck (utsläppsscenarier) och genomföras med flera modeller (t.ex. att uppskatta säkerheten med avseende på klimatsystemets känslighet för påverkan ökar det antalet modeller som benödvändiga för att handskas med det omfattande och komplicerade klimatsystemet, inklusive systemets återkopplingar och interna frihetsgrader.)
between eigenvalues? Another problem is if classical ergodicity forces eigenfunctions to be equidistributed in a certain sense. We will give a short introduction to quantized Hamiltonians, and then show that the study of the above mentioned questions for some simple dynamical systems gives rise to interesting problems in number theory.

**Wednesday 20 March 2002.**

Lars Inge Hedberg,

Sliding of cones and other convex bodies

**Abstract:**
Keith Ball proved in 1986 that for any n the (n-1)-dimensional slice cut out of the n-dimensional unit cube by a hyperplane is (n-1)-dimensional area at most 2^{1/2}. Equality takes place only when the hyperplane contains an (n-2)-dimensional face of the cube. As Ball observed, for n⇒10 his result also gives a simple negative solution to a famous problem posed in 1956 by H. Busemann and C. M. Petty, asking whether of two convex bodies in R^n, symmetric with respect to the origin, the one whose (n-1)-dimensional central sections have the greater area always has the greater n-dimensional volume. I will present a simplified proof of Ball's theorem due to N. Makarov and A. Podkorytov, and if time permits, I will also discuss the complete solution of the Busemann -- Petty problem due to G. Y. Zhang and others.

**Wednesday 27 March 2002.**

Dr. Vladimir Ya. Eiderman, Moscow,

Uniqueness theorems for analytic functions

**Abstract:**
Assume that an analytic function f(z) in a domain D in the plane tends to 0 rapidly on a sequence of points {zn} in D as zn tends to the boundary of D. Does it follow that f=0 for all f that are, say, bounded in D? We give a survey of theorems of this type including some new results obtained jointly with M. Essén. Some applications of uniqueness theorems will be given.

**Wednesday 10 April 2002.**

Professor Kjell Rosquist, Physics, Stockholm University,

A geometric/tensorial approach to integrable systems

**Abstract:**
A geometric formulation of the Lax pair equation is described. In this picture, the integrable dynamical system is realized as a geodesic flow on a curved space which carries all the dynamical information in its metric, or equivalently, in its geodesic Hamiltonian. The geometric version of the Lax pair equation then appears as a torsorial equation written entirely in terms of configuration space tensors, one of which may be viewed as a generalized third rank killing tensor. A similar formulation of the classical R-matrix is also given. The specific geometric nature of the classical R-matrix provides a natural explanation of its transformation properties.

**Wednesday 17 April 2002.**

Jesper Thorén,

Quantum groups and the Yang-Baxter equation

**Abstract:**
Quantum groups first arose in the physics literature in the early 1980s from the inverse scattering method which had been developed to construct and solve integrable quantum systems. They have excited great interest in the past few years because of their unexpected connections with such, at first sight, unrelated parts of mathematics as the construction of knot invariants and the representation theory of algebraic groups in characteristic p. In their original form, quantum groups are associative algebras whose defining relations are expressed in terms of a matrix of constants called a quantum R-matrix, i.e. the matrix is a solution of the Yang-Baxter equation. It was realized independently by V. G. Drinfel’d and M. Jimbo around 1985 that these algebras are Hopf algebras, which, in many cases, are deformations of universal enveloping algebras of Lie algebras.

In this talk, we will introduce the Yang-Baxter equation and show how we can produce solutions of it (i.e. R-matrices) using representations of quantum groups.

**Monday 22 April 2002.**

Professor José M.M. Senovilla, University of the Basque Country, Bilbao,

On the definition and the existence of singularities in general relativity

**Abstract:**
The question of how to define singular spacetimes, and how to attach properties to the singularities in Lorentzian geometry, is carefully analyzed. It turns out that the existence of singularities is intimately related with the question of extendibility of spacetimes, a problem with no unique solution, if any, in general. The existence of singularities under general conditions is also shown via the famous singularity theorems in general relativity, which are critically reviewed. Many explicit illuminating examples will be given.

**Monday 22 April 2002.**

Professor Valeriu Dryuma, Institute of Mathematics and Infomatics, Academy of Sciences of Moldova, Kishinev,

Geometric problems in the theory of differential equations

**Abstract:**
Some properties of the 4-dimensional Riemannian spaces with the metrics
ds^2 = 2P_{ij}(x) dx^i dx^j + 2 dx^k dX_k
connected with nonlinear differential equations are considered. The properties of 3-dimensional Einstein-Weyl spaces connected with the theory of second and third order ordinary differential equations are also discussed.

**Wednesday 24 April 2002.**

Kristina Crona,

Hilbert functions and Gröbner bases

**Abstract:**
Consider the homogeneous coordinate ring S/I of a projective algebraic set, where S is a polynomial ring. The Hilbert function H(S/I,n) measures the dimension of the n-th homogeneous piece of S/I. For n⇒0, this function coincides with a polynomial - the Hilbert polynomial - which is an important invariant. Macaulay's theorem and theorems by Gotzmann give a very precise knowledge of these Hilbert functions. My presentation will rely on Gröbner bases theory, in particular generic initial ideals and lexicographic ideals. I will also treat Hilbert functions for other gradings that appear naturally, primarily standard bigradings, corresponding to products of projective spaces. Bounds of Macaulay type as well as a persistence result will be given for bigraded Hilbert functions.

**Friday 3 May 2002.**

Göran Bergqvist,

Causal tensors and superenergy tensors

**Abstract:**
That a quantity is positive is often a required property or a needed assumption in the demonstrations of many important results. We will discuss properties of causal tensors in Lorentzian geometry; these are geometric objects which are positive in a certain sense. We present a way of constructing causal tensors, so-called superenergy tensors, from any given tensor. Applications of both algebraic and analytic nature will be discussed.

**Wednesday 8 May 2002.**

Professor Nikolai Makarov, Caltech,

Conformal welding

**Abstract:**
Let G_1 and G_2 be two complementary Jordan domains on the Riemann sphere, and let f_1: D → G_1 and f_2: D → G_2, be conformal maps defined on the unit disc D = {z: |z| < 1}. The equation f_1 o f_2 on the boundary S^1 = {z: |z| = 1} determines a map a: S^1 → S^1. A classical topic of complex analysis is to relate the properties of the curve which is the common boundary of G_1 and G_2. and the welding homeomorphism a; in particular, it includes the problems of existence and uniqueness.

The welding operation and its generalizations have important applications in several areas of mathematics. I will discuss an approach which is based on the study of the action of the homeomorphism a in the Dirichlet space on the circle, and review some results and open problems.

**Tuesday 14 May 2002.**

Professor Andrzej Trautman, Institute of Theoretical Physics, Warsaw University,

Two approaches to spinor fields on manifolds

A survey dedicated to the memory of Marcel Riesz

**Abstract:**
Spinor fields and the Dirac equation on pseudo-Riemannian manifolds of general relativity theory were introduced, by the great masters (Wigner, Fock, Weyl) shortly after the appearance of the 1928 paper by Dirac. From the very beginning, two competing approaches were present: in one, the emphasis was on orthonormal tetrads and the use of constant Dirac matrices. In the second, initiated by Tetrode and Schrödinger, the Dirac matrices were allowed to depend on curvilinear coordinates. In the language of contemporary differential geometry, the first approach is subsumed by the notion of a principal bundle defining a $(\gamma\otimes)$ spin structure, whereas in the second, the basic object is a vector bundle of spinors, carrying a representation of a Clifford bundle. This last notion can be traced back to a 1953 paper by Riesz. In the talk, the two approaches will be compared and shown to be essentially equivalent. Hypersurfaces in Euclidean space have a pin structure which is non-trivial, in general, but the associated bundle of spinors is trivial, a fact that leads to a simple formula for the Dirac operator on such hypersurfaces. General considerations will be illustrated by the example of spheres. Spinor connections on low-dimensional spheres can be identified with simple gauge configurations. The triviality of the spinor bundles of spheres easily leads to a determination of the spectra and eigenfunctions of the Dirac operator on these manifolds.
absolutely continuous, its spectrum has infinite multiplicity and coincides with the positive half-axis. Then we find the large-time behavior of solutions \( \exp(-i H t) f \) of the time dependent Schrödinger equation. Our main observation is that a quantum particle has always a preferable (depending on its charge) direction of propagation along the current. Similar result is true in classical mechanics.

**Wednesday 25 September 2002.**
Professor Nikolay Kuznetsov, St. Petersburg.
On sloshing frequencies in the ice-fishing problem

**Abstract:**
The ice-fishing problem is a boundary value problem for the Laplace equation with a spectral parameter in a boundary part of the boundary. This problem describes free oscillations of water in a half-space covered by a rigid dock with apertures, where the above mentioned condition is imposed. The aim of talk is twofold:

1. Assuming that the problem is two-dimensional and that there are two equal gaps in the dock, it will be demonstrated by differentiating the Rayleigh quotient that all eigenvalues are monotonic functions of the spacing between gaps. For the fundamental eigenvalue and the corresponding eigenfunction the asymptotic formulae for large values of spacing will be discussed.

2. For the three-dimensional problem, it occurs that the fundamental eigenvalue depends in a complicated way on the geometry of apertures. Some examples illustrating this dependence will be given.

**Wednesday 2 October 2002.**
Professor Adrian Constantin, Lund,
The Camassa-Holm model for shallow water waves

**Abstract:**
A recently derived nonlinear partial differential equation models the unidirectional propagation of waves on shallow water. The rich structure of the equation is the object of our presentation: the equation is an integrable infinite-dimensional Hamiltonian system and a re-expression of geodesic flow on the diffeomorphism group of the circle. Moreover, it models waves of permanent form as well as wave breaking and its solitary waves interact like solitons.

**Wednesday 9 October 2002.**
Professor Kurt Johansson, KTH,
Probability measures from random matrix theory

**Abstract:**
Probability measures coming from random matrix theory, usually from appropriate limits of the spectrum as the size of the matrix goes to infinity, have been the focus of much interest. They occur in spectral problems (quantum chaos), number theory and also unexpectedly in certain probability problems related to random growth and random tilings. I will give some background and then concentrate on the last topics.

**Wednesday 16 October 2002.**
Professor Michael Solomyak, Weizmann Institute of Science, Rehovot, Israel,
On the spectrum of the Laplacian on metric graphs

**Abstract:**
A metric graph is a graph whose edges are viewed as line segments of positive length, rather than just pairs of vertices. The Laplacian on such graph is the operator of second derivative on each edge, complemented by the Kirchhoff matching conditions at vertices. The spectrum of the Laplacian can be quite different, reflecting geometry of a given graph. Recent results on this subject will be reported. The most detailed results concern a special case of graphs, namely the so-called regular trees.

**Thursday 17 October 2002.**
The film
The CMI millenium meeting
was shown.

**Wednesday 23 October 2002.**
Jonas Lundgren defended his licentiate thesis,
Reconstruction of stresses in plates by incomplete Cauchy data

**Wednesday 23 October 2002.**
Dr. Björn Gustafsson, KTH,
Some multiplicative potential theory

**Abstract:**
In ordinary potential theory one gets the potential of a body by adding (or integrating) the contributions from the individual parts of it. It sounds of course a little crazy to instead multiply the contributions with each other, but sometimes this makes sense and leads to interesting mathematics. One simple example is any polynomial in one complex variable, which can be viewed as a multiplicative version of the (logarithmic) potential for finitely many point masses.

I will discuss another instance of multiplicative potential theory, namely the so-called exponential transform, which originally appeared in operator theory but now is studied for its own sake and for applications in other areas. The talk is based on joint work with Mihai Putinar (Santa Barbara).

**Friday 25 October 2002.**
Autumn meeting of the Swedish Matematical Society.

**Wednesday 30 October 2002.**
Professor Stanislav Smirnov, KTH,
Critical lattice models and conformal invariance

**Abstract:**
For a number of lattice models in the plane (Percolation, Ising Model, Self Avoiding Random Walk, ...) physicists were able to predict exact values of various scaling exponents and dimensions. E.g., they reason that Hausdorff dimension of the critical percolation cluster should be 91/48 almost surely.

We will review recent mathematical progress in this area.

**Thursday 31 October 2002.**
A film from the lecture by Professor Timothy Gowers, Cambridge,
The importance of mathematics
The lecture was given at the Clay mathematics institute millennium meeting in Paris, 2000.

**Wednesday 6 November 2002.**
Stefan Rauch-Wojciechowski,
Theory of quasi-potential Newton equations and an effective criterion of separability for the Helmholtz and Hamilton-Jacobi equations. "Two accidents at work".

**Abstract:**
The method of separating variables for solving the Hamilton-Jacobi equation of a natural Hamiltonian \( H=p^2/2+V(q) \) has been conceved by W. R. Hamilton and by C. G. J. Jacobi around 1830-40. It consists of finding a curvilinear change of variables \( u(q) \) so that the problem is reduced to integration of a system of uncoupled ODEs. It has been the most successful method of integrating mathematical problems that we now find in textbooks. However for a given potential \( V(q) \), the variables of separation are a priori unknown and usually do not exist. The problem of deciding and finding \( u(q) \) for any given potential \( V(q) \) has been considered unsolvable by Jacobi (Vorlesungen über Dynamic, 1866) as later cited by Arnold in his Mechanics §47, p. 266.

Jacobi's opinion had a profound influence on the further development of separability theory, which focused on characterising separable Hamiltonians in terms of variables of separation (Stäckel, Levi-Civita) and on classifying all separation variables (Eisenhart, Benenti, Kalnins & Miller).

Being unaware of this classical line of development we have together with C. Waksjö formulated and proved an effective, completely algorithmic criterion of separability. It is based on the structure of quadratic integrals of motion for \( H=p^2/2+V(q) \) and on the use of a set of \( n(n-1)/2 \) second order linear PDEs characterising separable potentials.

Closely related to this result is the theory (developed together with H. Lundmark and K. Marciniazi) of cofactor pair systems \( \delta^2 q/\delta t^2 = (\text{cof } G)^{-1} \text{grad } k(q) = -(\text{cof } G')^{-1} \text{grad } k'(q) \) which, naturally generalises the classical separability theory, but has its origin in soliton theory.

This theory leads to a new type of nonorthogonal variables of separation and has two equivalent characterisations in terms of certain Poisson pencils or through a set of fundamental
We discuss local formulas for the $b_n$ with various physically relevant boundary conditions (Dirichlet, Neumann, transmission, transfer, and spectral).

Models for interacting fermions play an important role in theoretical condensed matter physics.

Abstract:

Exactly solvable models of interacting fermions

Dr. Edvin Langmann, KTH, Wednesday 4 December 2002.

The lecture was given at the Clay mathematics institute millennium meeting in Paris, 2000.

some important examples of current interest. In particular I will mention two-dimensional Hubbard-like models and the problem of understanding correlated fermion systems.

I will give a general introduction to such models: explain what they are from a general mathematical point of view, mention a few standard methods to study them, and then describe some important examples of current interest. In particular I will mention two-dimensional Hubbard-like models and the problem of understanding correlated fermion systems.
I will then concentrate on a particular class of such models which can be solved exactly using group theory. Simple examples are Hartree-type models which are related to Abelian groups. Another well-known example is a BCS-type model for superconductivity which is related to SU(2). I then present a few recent examples which describe 2D correlated fermions.
Stefan Rauch-Wojciechowski,
Three theorems on integrable Newton equations

Abstract:
The Newton equation which says that the acceleration is equal to an external force is fundamental for the whole analytical mechanics. The standard theory studies extensively the case when the force \( F(q) = -\nabla V(q) \) is generated by the potential \( V(q) \). The Kepler problem of motion of Earth around Sun: \( V(q) = k/|q| \) is a pivotal example in this theory. A new theory of Newton equation with quasipotential forces \( F(q) = -\text{lim}_{\theta \to \pi} \partial_{\theta} \text{arg} \, k(q) \), developed by us, gives new light on many results of integrable dynamics and leads to new, interesting mathematics. I shall present three important theorems within this theory: on an effective criterion of separability for potential forces, on triangular systems of Newton equations and on cofactor pair systems of Newton equation.

Friday 2 February 2001.
Professor Alexander P. Veselov, Loughborough University,
The Hadamard problem and generalised quantum Calogero–Moser systems

Abstract:
The Hadamard problem of description of all second order hyperbolic equations satisfying Huygens’ principle (in the narrow Hadamard sense) is one of the classical open problems which still remains open. Over the last decade a substantial progress in this direction has been made as a result of the discovered relations between this problem and the problem of classification of all integrable generalisations of the quantum Calogero–Moser system. In the talk these relations due to Yu. Berest, O. Chalykh, M. Feigin and the speaker will be discussed.

Thursday 8 February 2001.
Professor E.Jabłonka Pol, Warsaw University,
On hereditarily indecomposable continua

Abstract:
A continuum is said to be indecomposable if it is not the union of two of its proper subcontinua, and hereditarily indecomposable (h.i.) if each of its subcontinua is indecomposable. In 1922 Knaster gave the first example of an h.i. one-dimensional continuum. Later one called it a pseudo-arc because it was homeomorphic to each of its nondegenerate subcontinua, like an arc. But unlike the arc it was homogeneous, like a circle. The pseudoarc has appeared in many areas of continuum theory. In 1951 Bing showed that there were h.i., \( n \)-dimensional continua for every integer \( n \geq 2 \). He also proved the existence of h.i., \( n \)-dimensional continua in a strong tool in the construction of unusual spaces such as Henderson’s infinite-dimensional compactum all of whose closed finite-dimensional subsets are zero-dimensional (Levin). In this talk some new results in the theory of h.i. continua will be presented.

Professor Vitaly V. Fedorchuk, Moscow State University,
Manifolds and their dimensions

Abstract:
In celebrated papers of Lebesgue, Brouwer, Urysohn, and Menger the main dimensional invariants \( \text{dim} \), \( \text{ind} \), \( \text{Ind} \) were introduced. These invariants coincide for subsets of Euclidean spaces, in particular, for metrizable manifolds. Recall that a topological \( n \)-manifold is a Hausdorff connected space which is locally homeomorphic to the Euclidean space \( \mathbb{R}^n \). For an \( n \)-manifold \( M \), which is a normal space, we have \( \text{ind} \, M \leq \text{dim} \, M \leq \text{Ind} \, M \). For nonmetrizable manifolds these dimensions generally do not coincide. The talk will concern this topic.

Friday 23 February 2001.
Dr. Maria Roginskaya, Chalmers,
Some criteria for Riesz sets

Abstract:
The F. and M. Riesz theorem says that, as soon as a finite measure on an interval has Fourier transform supported on the positive half line, the measure has no singular part. A Riesz set \( S \subset \mathbb{R}^d \) is a set such that, as soon as a finite measure has Fourier transform supported on the set, the measure has no singular part. I’m going to show some examples of Riesz and non-Riesz sets, and discuss two types of criteria for a set to be Riesz.

Professor Konstantin Kozlov, Moscow State University,
Dimension of equivariant compact extensions

Abstract:
Let \( G \) be a topological group. By a \( G \)-space \( X \) we mean a Tychonoff space \( X \) (phase space) with a continuous action of the group \( G \). If for a \( G \)-space \( X \) there exist a compact \( G \)-space \( \mathcal{X} \) and an equivariant dense embedding of \( X \) into \( \mathcal{X} \) then we call \( \mathcal{X} \) a \( G \)-compactification of \( X \). If a \( G \)-space has a \( G \)-compactification then it has a maximal \( G \)-compactification \( \mathcal{X}_G \). In the presented talk it will be shown how the maximal \( G \)-compactifications can be obtained and then their dimensional properties will be discussed.

Friday 16 March 2001.
Bengt Josefson,
Quasicomplements in Banach spaces

Abstract:
Let \( F \) be a closed subspace of the Banach space \( E \). A closed subspace \( G \) of \( E \) is said to be a quasicomplement of \( F \) in \( E \) if \( F \cap G = \{0\} \) and \( F + G \) is dense in \( E \). This notion was introduced around 1940 by Murray and generalizes the notion of complement (i.e. \( F + G = E \)). Known results and open problems will be discussed.

Friday 23 March 2001.
Professor Vladimir E. Nazarov, kinskii\, Moscow State University,
Noncommutative analysis: theory and applications
Abstract: 
Noncommutative analysis, which deals with functions of several noncommuting operators, has numerous applications to algebraic problems, differential equations, asymptotics, etc. A concise survey of basic elements of the theory will be given along with a variety of specific applications.

1. Theory

2. Applications

Literature:
- V. P. Maslov, Operational Methods, Mir, Moscow, 1976.


Jan Snellman,
Combinatorial properties of generic initial ideals

Abstract:
Su-called Gröbner bases are a standard tool in computational (commutative) algebra. They provide a way of associating to each homogeneous ideal (in a polynomial ring, in several variables, over a field) its initial ideal, which is a monomial ideal. The initial ideal is a simpler object which shares many properties with the original ideal (i.e. Hilbert series).

From the point of view of algebraic geometers, however, this construction is flawed, since it depends on the choice of basis for the polynomial ring. They much prefer the generic initial ideal, the initial ideal of the ideal obtained by a generic linear change of coordinates.

Generic initial ideals give deep understanding of the corresponding variety. However, since I'm not a geometer, I am going to concentrate instead on their combinatorial properties: I'll show that, if the ground field has characteristic zero, generic initial ideals correspond to filters in the Young lattice of numerical partitions. Time permitting, I might say something about the finite characteristic case, and about non-commutative generic initial ideals.

Thursday 5 April 2001.

Royal Academy of Sciences Lecturer Professor Vaughn Jones, University of California, Berkeley, Knots

The talk is intended for a general scientific audience.

In 1990 Jones was awarded the Fields medal, the most prestigious of all mathematical prizes. The ostensible reason was his discovery in 1984 of a new polynomial invariant for knots and links in 3-space. Knot theory is a rather established field, and his discovery came as a complete surprise to knot-topologists, who had been searching for new invariants for the better part of a century. Striking as such a discovery may have been, it was just a spin-off from discovering startling, and hitherto unsuspected, relationships between von Neumann algebras and geometric topology. At the heart of the matter lies Jones Index theorem, with repercussions, not only on the aforementioned knot-theory, but also tying together better part of a century. Striking as such a discovery may have been, it was just a spin-off from discovering startling, and hitherto unsuspected, relationships between von Neumann algebras and geometric topology. At the heart of the matter lies Jones Index theorem, with repercussions, not only on the aforementioned knot-theory, but also tying together.

Professor Maciej Błaszak, A. Mickiewicz University, Poznań,
From bi-Hamiltonian geometry to separation of variables

Abstract:
The separation of variables belongs to the most important methods of solving nonlinear ordinary differential equations of Hamiltonian type. It is known from the 19th century, when Hamilton and Jacobi proved that given a set of appropriate coordinates, the so called separated coordinates, it is possible to solve a related dynamical system by quadratures.

Unfortunately in the 19th century and most of the 20th century, for a number of models of classical mechanics the separated variables were either guessed or found by some ad hoc methods. A fundamental progress in this field was made in 1985, when Sklyanin adopted the method of soliton systems, i.e. the Lax representation, to systematic derivation of separated variables. In his approach, the appropriate Hamiltonians appear as coefficients of the spectral curve, i.e. the characteristic equation of the Lax matrix. Recently, a new constructive separability theory was constructed, based on a bi-Hamiltonian property of integrable systems. In this seminar we briefly summarise the results of the theory in the simplest case of one-Casimir Poisson pencils and illustrate it on some examples. We also make a few comments on the relation between a separation curve of bi-Hamiltonian approach and a spectral curve of Sklyanin approach.

Friday 4 May 2001.

Pontus Andersson,
Random permutations and random circuits

Abstract:
Let $L_k$ be the length of the $k$-th longest cycle in a random (uniformly distributed) permutation of $n$ elements. It is well known that $(L_k/n, L_k/n^2, \ldots)$ converges in distribution to a Poisson–Dirichlet distribution as $n$ tends to infinity. I will give a survey of generalizations and variations of this result, including results on excursion lengths in Brownian motion, factorization of random integers and polynomials, and component sizes of certain random combinatorial structures. The focus will be on combinatorial structures; in particular, I will present a result on the lengths of the circuits obtained by randomly decomposing the set of edges of the complete directed or undirected graph into circuits.


Hans Lundmark,
Driven Navier equations and time-dependent separable potentials

Abstract:
I will show how to solve the system of ordinary differential equations $\ddot{q} = -\nabla V(x, t)$ for certain time-dependent potentials $V(x, t)$, where $q \in \mathbb{R}^d$. This involves a somewhat nonstandard application of the Hamilton–Jacobi method, using new types of separation coordinates. The result comes from a study of driven Newton systems $\ddot{q} = M(q)q$, $q \in \mathbb{R}^{n+m}$.


Dr. Mikhail Shapiro, KTH,
Hurwitz numbers and Hodge integrals

Abstract:
We shall discuss a relation between the classical problem of counting ramified coverings of the sphere with fixed branch points and the theory of moduli spaces of complex genus curves with marked points. One of the applications is a new proof by A. Okounkov and R. Pandharipande of the famous Witten's conjecture.

Boundary value problems for Dirac operators on Lipschitz domains with applications to Maxwell's equation

Abstract:
This talk will be about boundary value problems like

\[ \mathcal{D} \Phi(x) + \mathcal{K} \Phi(x) = 0 \text{ in } \Omega \]

\[ \mathcal{F}(\partial) \Phi(x) = g(x) \text{ on } \partial \Omega \]

Here, \( \Omega \) is a bounded Lipschitz domain, \( F: \Omega \rightarrow \mathbb{R} \) is a function with values in the full exterior algebra, with boundary trace \( \mathcal{T}( \partial \Omega; \mathcal{H}^p(\Omega)) \). Conditions on the normal part \( \mathcal{N} \) ensuring that the solution \( \Phi \) maps \( \Omega \) to \( \mathcal{H}^p(\mathbb{R}^n) \) for given \( k = 0, \ldots, n+1 \), and how this applies to Maxwell's equation, will be discussed.

Friday 1 June 2001.
Professor Grigori Mints, Stanford University,
Epsilon substitution: past and future

Abstract:
The epsilon substitution method introduced by Hilbert provides numerical realizations of existential sentences. It attracted interest of J. von Neumann, H. Weyl, W. Ackermann and other logicians. After original setbacks and successes in number-theoretic setting before 1941 further progress was made in the 1990s for mathematical analysis (second order arithmetic). We describe original formulation in the framework of Hilbert's program, subsequent change of emphasis to verifiable computer programs, results obtained for predicative subsystems of analysis and the most recent progress for impredicative part.

Professor Daniel Lesnic, University of Leeds,
Inverse problems with applications

Abstract:
The field of inverse problems is a relatively new area of research in mathematical physics, having its origins in the fundamental papers of Tikhonov in the mid-1960's. As with any new area of mathematics, one can ask the question why did it start, when it did and why not sooner? In the case of inverse problems, the answer is one of historical prejudice meeting scientific pressure. The historical prejudice dates back to Hadamard (1923) who claimed that the only problems of physical interest were those that had a unique solution depending continuously on the given data. Such problems were called well-posed and problems that were not well-posed were labeled ill-posed. In particular, ill-posed problems connected with partial differential equations of mathematical physics were considered to be of purely academic interest. The success of aerospace industry caused scientists to ask the question how can one determine the temperature and the heat flux at the outer nozzle of a re-entry vehicle in the atmosphere from measurements taken inside the rocket.

In this talk, I shall formulate and present methods of solution of several types of inverse problems for partial differential equations which will include inverse boundary value problems, inverse initial value problems and inverse coefficient identification problems. In particular, the determination of the temperature and heat flux at a known or unknown inaccessible boundary of a metal in conduction, the determination of underspecified boundary conditions in Stokes flows and plate bending, the determination of the initial temperature of a metal in heat conduction, the determination of underspecified boundary conditions in Stokes flows and plate bending, the determination of the initial temperature of a metal in heat conduction, the determination of underspecified boundary conditions in Stokes flows and plate bending, the determination of the initial temperature of a metal in heat conduction, the determination of underspecified boundary conditions in Stokes flows and plate bending.

Anders Björn,
Removable singularities for Hardy spaces of analytic functions

Abstract:
In this talk we will study removable singularities for the Hardy spaces \( H^p(G) \) (\( p \) analytic in \( G \) : \( |f| < u \) for some \( u \) harmonic in \( G \), \( 0 < p \leq \infty \), and \( H^0(G) = \{ f \text{ analytic in } G : f \text{ is bounded} \} \)). A compact set \( K \) is a removable singularity for \( H^p(G) \) if all functions in \( H^p(G-K) \) have analytic continuations to all of \( G \).

The talk will be elementary and will contain both the history of the problem and recent results. Recently (August 2001) Xavier Tolsa announced the complete solution of the long standing problem (it goes back at least to 1988) of characterizing the removable singularities for bounded analytic functions, i.e. for the functions in \( H^p \). This characterization will also be mentioned.

Wednesday 19 September 2001.
Bjarte Bøe, Universitetet i Bergen and Institut Mittag-Leffler,
Interpolation in the Bloch Space

Abstract:
The Bloch space consists of the holomorphic functions in the unit disk \( D \) satisfying \( \|f(z) - f(w)\|_B \leq C b(z,w) \), for some \( C > 0 \). Here \( b \) is the hyperbolic metric. We say that a sequence \( \{z_n\} \) in \( D \) is interpolating if whenever \( \{w_n\} \) satisfies \( |w_n - z_n| \leq C b(z_n,0) \), then we can find \( f \) in the Bloch space having \( f(z_n) = w_n \). We give a characterisation of such sequences. This is joint work with Artur Nicolau.

Dr. Jana Björn, Lunds tekniska högskola,
Poincaré inequalities, admissible weights and PDEs on metric spaces

Abstract:
In 1982, Konig--Fabes--Serapioni singled out a few conditions sufficient for extending Moser's iteration technique to weight degenerate equations. In the 1990s, it was shown that two conditions are enough -- the doubling condition \( \mu(2B) \leq C \mu(B) \) and the \( (1,p) \)-Poincaré inequality

\[ \mu(B)^{-1} \int_B |u-u_B| \, d\mu \leq C \, \mathrm{diam}(B) \left( \mu(B)^{-1} \int_B \nabla u \cdot \nabla v \, d\mu \right)^{1/p} \]

Here, \( u \) is a measure (on \( \mathbb{R}^n \) or a metric space), \( u_B = \mu(B)^{-1} \int_B u \, d\mu \) and \( v = \int_B u \, d\mu \) stands for integration. Measures satisfying the above two conditions are called \( p \)-admissible and allow a reasonable definition of weighted Sobolev spaces. One can then study weighted elliptic equations and prove many classical results about weak solutions in this setting. It is even possible to consider PDEs on metric spaces satisfying the doubling condition and the \( (1,p) \)-Poincaré inequality. Even though there are many examples of admissible weights, it is in general difficult to verify whether a given measure is \( p \)-admissible or not. I shall present some results (old and new) which make it possible to generate new admissible measures.

Wednesday 3 October 2001.
Professor Grigori Rozenblum, Chalmers,
Pseudodifferential operators with operator valued symbols and unusual index formulas

Abstract:
The index formula for pseudodifferential operators involves integration of certain differential forms, Chern-Simons characters, containing the trace of some combination of the symbol and its derivatives. When one tries to carry over the index formula to the case of operators acting on functions with values in an infinite-dimensional Hilbert space, one cannot use this expression for the integrand since it contains the trace of non-trace-class operators. The methods of non-commutative geometry enable us to find a regularisation for the characteristic classes thus constructing new, unusual index formulas for a new, rather wide class of pseudodifferential operators with operator valued symbols. Such operators arise in the analysis on manifolds with singularities.

Dr. Frank Kutzschebauch, Uppsala,
C^* - a manifold with huge symmetry group

Abstract:
We start with some general remarks about the holomorphic symmetric (\( \ast \)-automorphisms=bijective holomorphic selfmaps) of complex manifolds which of course form a group under composition.

The affine space \( \mathbb{C}^n \) for \( n \geq 2 \) is special in the sense that its group of holomorphic automorphisms is infinitely dimensional. This group is not well understood yet and there are many (often completely open) questions about it. We will talk about two of them, their historical (partial) results and even remark on their analogs in the polynomial case.

1. Linearization problem: Can any automorphism \( f \) of \( \mathbb{C}^n \) which is of finite order \( k \) (applying \( f \) a finite number \( k \) of times gives the identity map) be made linear after a suitable change of coordinates? More generally is the same true for any compact group of automorphisms?
2. Embedding problem: Given an embedding \( f : C \rightarrow \mathbb{C}^n \). Can one change coordinates so that the embedding becomes the standard one, i.e., does there exist a holomorphic automorphism \( a \) of \( \mathbb{C}^n \) such that
\[
a \circ f(t) = (1,0,0,...,0)
\]
for all \( t \) in \( \mathbb{C}^n \)?

Finally we come to discuss the negative solution to Problem 1 found by H. Derksen and the speaker using the negative solution to Problem 2 found by Forstneric, GLOBEVIK, Rosay and Rudin. This method gives a connection to the (holomorphic version of the) famous Zariski cancellation problem and one of the most challenging problems in this area arises: How to detect \( C^n \) among complex manifolds?

Wednesday 17 October 2001.

Dr. Krzysztof Marciniak, ITH, Norrköping,
From the Darboux theorem to separation of variables in bi-Hamiltonian systems
Abstract:
The well-known theorem of Darboux about local structure of Poisson manifolds states that it is (locally) always possible to choose coordinates on a Poisson manifold in such a way that the corresponding Poisson operator becomes canonical. It means that every Hamiltonian system of differential equations can be cast into a canonical form. In case of bi-Poisson manifolds (that is manifolds equipped with a pair of Poisson operators that are compatible) one can often introduce so called Darboux-Nijenhuis coordinates that cast the corresponding bi-Hamiltonian systems into a form that allows us to solve them by the method of separation of variables. I will illustrate these concepts on the example of recently investigated bi-cofactor systems of Newton equations. No prerequisites will be necessary.

Wednesday 24 October 2001.

Johan Wästlund,
Trick taking games
Abstract:
I will begin with a brief outline of the classical theory of combinatorial games. This includes the group structure of the set of all games with the normal playing convention, that is, last move wins. Then I will talk about trick taking games, which is a family of card games. These games do not in general satisfy the normal playing convention. In fact, the move order is not even alternating, since the player who wins a trick plays first in the next one. Each of these games gives rise to an abelian semigroup. I will show how some games can be analyzed and solved by investigating the algebraic structure of this semigroup. In particular, it turns out that the game of "femkort" (five-card), which is well known and popular at least in Sweden, is isomorphic to the set of integers, while two-person whist gives rise to a more complicated semigroup that among other things encodes properties of the technique known to bridge players as elimination and throw-in."

Wednesday 31 October 2001.

Gunnar Aronsson,
On two moving boundary problems, arising in polymer processing
Abstract:
Injection moulding and compression moulding are two production processes in polymer engineering, which give rise to moving boundary problems with highly nonlinear effects. One wants to understand the flow problem, when a polymer melt expands in a more or less complicated geometry. Two asymptotic solution approaches will be briefly presented, one for each problem. Then the solution for the injection moulding case (formsprütning) will be discussed in some detail. It leads to some interesting geometric considerations. Some nice computer graphics will be shown.

Wednesday 7 November 2001.

Professor Ernie Kalnins, University of Waikato, New Zealand,
Superintegrability in classical and quantum mechanics
Abstract:
The concept of classical and quantum quadratic superintegrability is introduced. The particular properties that characterise this concept are then discussed. The problem of the classification of such systems in two dimensions is then analysed in detail giving a complete result for spaces of constant curvature. The corresponding problem on a two dimensional space of non-constant curvature follows from this result. Finally we show how to generate extra constants for a classical Hamiltonian system which can be solved by separation of variables. In so doing new families of superintegrable systems are generated.

Wednesday 14 November there were two colloquia. They were part of the GRSweden-conference.


Professor Claes Uggla, Karlstads Universitet,
Dynamical systems in Cosmology
Abstract:
The evolution of the Universe is ruled by gravity. Our best theory of gravity is general relativity (GR), and hence one uses Einstein's field equations to produce cosmological models. What scenarios are possible for the early Universe and what is the eventual fate of the Universe according to GR? To address issues like these, it has turned out to be fruitful to use a dynamical systems approach to Einstein's field equations. To illustrate how dynamical systems ideas are applied in GR, I will start by discussing spatially homogeneous and isotropic Friedmann-Lemaitre models, which have been remarkably successful in explaining many cosmological observations. First I will give a qualitative picture of the possible features such models exhibit by using simple potential diagrams. Subsequently I will use a dynamical systems approach and give a comparison between the two pictures. Thereafter I will outline how GR exhibits a hierarchical structure that allows one to build increasingly complex models using dynamical systems methods. I will finish by discussing some recent results and speculate about the generic features of cosmological models in GR at very early and late times.


Timo Koski,
A model for predictive mixtures and for classification of sequences
Abstract:
Detection of protein sequence homologies can be done by using mixtures of Dirichlet distributions. These are statistical models for motifs in multiple alignments of protein sequences. We derive this mixture using an assumption of infinite exchangeability and predictive sufficiency. By this argument it is immediate that we are dealing with predictive classification of protein sequences in the sense of predicting a portion of a sequence based on a motif. Finally a result about the distribution of the score based on an exchangeable representation is outlined.


Professor Kimmo Eriksson, Mälardals Högskola,
Lecture hall partitions
Abstract:
The theory of integer partitions is both accessible, surprising and entertaining. I will give an overview of famous partition identities, from classical results of Euler, via Rogers and Ramanujan, to modern achievements of Andrews, Bressoud and others, and ending with the so called Lecture Hall partition identities of Eriksson and Bousquet-Mélou.

Friday 30 November 2001.

Professor Mikhail Shubin, Northeastern University, Boston,
Magnetic Schrödinger operators: discreteness of spectrum and strict positivity criteria
Abstract:
Discreteness of spectrum of a self-adjoint operator means that its spectrum consists of isolated eigenvalues with finite multiplicity. Sufficient conditions of discreteness of spectrum for Schrödinger operators in \( R^n \) were given by H. Weyl (1910) for \( n=1 \) and K. Friedrichs (1934) for arbitrary \( n \). A necessary and sufficient condition for Schrödinger operators with positive
potentials in terms of the Wiener capacity was given by A. Molchanov (1953).

We give a necessary and sufficient condition for the discreteness of spectrum for the magnetic Schrödinger operators with positive scalar potential in \( \mathbb{R}^n \). It is given in terms which include energy of the magnetic field in balls of fixed radius and a capacity term characterizing the scalar potential in these balls.

We also give a necessary and sufficient condition for such operators to be strictly positive, i.e. condition that 0 is not in the spectrum of such an operator.

(This is joint work with V. Kondratiev and V. Maz'ya.)

Wednesday 5 December 2001.
Professor Mikael Passare, Stockholms universitet,
Amoebas, polytopes and integrals of rational functions
Abstract:
To any given complex polynomial one has recently associated a geometric-combinatorical concept, its so called amoeba. We shall give a verbal and visual account of (mainly two-dimensional) amoebas and their relation to Newton polytopes and moment mappings.

Wednesday 12 December 2001.
Professor Nail Ibragimov, Blekinge tekniska högskola,
Lie group analysis of differential equations
Abstract:
The talk is aimed at discussing basic methods from Lie group theory of integration, linearization and nonlinear superposition for nonlinear differential equations. Methods of modern group analysis of partial differential equations such as symmetry of fundamental solutions, group analysis in financial mathematics, approximate symmetries of equations with a small parameter, and Lie-Bäcklund transformation groups with application in celestial mechanics will be also considered.