Joint Mathematical Conference CSASC 2010

(XI^{th} Conference of Czech Mathematicians)

Prague, Czech Republic, January 22-27, 2010

organized by Czech Mathematical Society together with
Austrian Mathematical Society, Catalan Mathematical Society,
Slovak Mathematical Society, and Slovenian Mathematical Society

Josef Cibulka, Bernard Lidický, Marek Tesař (eds.)

Preface

Welcome to Prague!

Dear participants of CSASC 2010 - the Joint Mathematics Conference co-organized by Catalan, Slovenian, Austrian, Slovak and Czech Mathematical Societies. Welcome to Prague and to the first joint conference of this type in Central Europe. The idea to organize such a conference originated several years ago and we see the upcoming event as a culmination of long lasting efforts.

The format of several parallel sessions each presenting its topic to all participants via a plenary talk is typical for joint meetings, and in the European setting was propagated by the annual EMS Mathematical Weekends, one of which took part in Prague in 2004. Following the same pattern the Czech and Catalan Mathematical Societies organized their joint meetings in 2005 and 2006 (the former in Prague and the latter in Barcelona). The Slovak and Austrian Mathematical Societies meet in a similar way regularly already for several years. The idea of coordinating the efforts of more sociaties was discussed at the second Czech-Catalan meeting and during a memorable Slovak-Austrian conference in High Tatras in 2007. A Discrete Mathematics conference co-organized by our five societies was hosted by the Austrian Mathematical Society in Vienna in November 2008. And finally CSASC 2010 is a full scale mathematics meeting covering topics ranging from Mathematical Physics through Algebra, Geometry, Analysis, Dynamical Systems, Statistics, and Topology to Discrete Mathematics, Security, and Theoretical Computer Science.

The choice of topics is not random. Every session is organized based on existing strong collaboration among research groups in our societies. Strong research is not possible without international collaboration, yet it is pleasing to see all these links of joint research and friendship among our societies.

From the local mathematical society point of view this is the 11th Quadriannual Conference of Czech Mathematicians which traditionally concludes a four year period of its executive committee. We would like to use this opportunity to thank all its members for all the work they have done for our society in the past four years. Many of them are also session organizers or otherwise contributed to the organization of the conference. The thanks of course extend to all the session organizers, and namely to the presidents of the partner societies who helped so much to promote our joint idea among their members.

The organzation at affordable costs has been made possible, apart from the contributions of the co-organizing societies, by generosity of various research grants administered by the Czech session organizers, the Faculty of Mathematics and Physics of the Charles University in Prague which is hosting most of the sessions and all plenary talks, the Czech Technical University who is hosting the session of Discrete Dynamical Systems, and the DIMATIA Center of Discrete Mathematics and Theoretical Computer Science which is providing most of the logistics. We cordially thank all of them.

We wish all of you a pleasant and fruitful time in Prague and already look forward to a next joint meeting, wherever and whenever should it be

Jiří Fiala, Jan Kratochvíl
for the local organizers

Special sessions

Differential Geometry and Mathematical Physics
Xavier Gracia (Barcelona)
Olga Krupková (Olomouc)

Discrete Algorithms and Computational Complexity
Jan Kratochvíl (Prague)
Oriol Serra (Barcelona)

Discrete Dynamical Systems
Josef Bobok (Prague)
Armengol Gasull (Barcelona)

Enumerative and Analytic Combinatorics
Michael Drmota (Vienna)
Martin Klazar (Prague)

Function Spaces and Applications
Luboš Pick (Prague)

Mathematical Physics
Pavel Exner (Prague)
Gerald Teschl (Vienna)

Mathematics of Secret Sharing
František Matúš (Prague)
Carles Padro (Barcelona)

Stochastic Analysis
Bohdan Maslowski (Prague)
Marta Sanz-Sole (Barcelona)

Topological, Geometric and Algebraic Graph Theory
Roman Nedela (Banska Bystrica)
Tomaz Pisanski (Ljubljana)
Pavel Valtr (Prague)

Triangulated Categories
Carles Casacuberta (Barcelona)
Jiří Rosický (Brno)

Program

Friday January 22: Invited and contributed talks in parallel sessions

9:00-10:30	Enumerative and Analytic Combinatorics (S3, from 10:00) Discrete Algorithms and Computational Complexity (S4) Stochastic Analysis (S5) Function Spaces and Applications (S6) Discrete Dynamical Systems (ČVUT, Thákurova 7)
10:30-11:00	Coffee break
11:00-12:30	Enumerative and Analytic Combinatorics (S3, from 10:00) Discrete Algorithms and Computational Complexity (S4) Stochastic Analysis (S5) Function Spaces and Applications (S6) Discrete Dynamical Systems (ČVUT, Thákurova 7) Mathematical Physics (S8)
12:30-14:00	Lunch break
14:00-15:30	Enumerative and Analytic Combinatorics (S3) Differential Geometry and Mathematical Physics (S4) Stochastic Analysis (S5) Mathematical Physics (S8) Discrete Dynamical Systems (ČVUT, Thákurova 7)
15:30-16:00	Coffee break
16:00-17:30	Enumerative and Analytic Combinatorics (S3) Differential Geometry and Mathematical Physics (S4) Stochastic Analysis (S5) Discrete Dynamical Systems (ČVUT, Thákurova 7)
18:00-20:00	Business meeting of CMS

Saturday January 23: Plenary talks, all in S5

9:00-10:00	*Marta Sanz-Solé* (University of Barcelona) Hitting probabilities for solutions to stochastic partial differential equations
10:00-10:30	Coffee break
10:30-11:30	*Ilse Fischer* (Vienna University) Refined enumerations of alternating sign matrices
11:30-12:00	Break
12:00-13:00	*Bohumír Opic* (Academy of Sciences, Prague) Embeddings of Bessel-potential-type spaces into generalized Hölder spaces involving k-modulus of smoothness
13:00-15:00	Lunch break
15:00-16:00	*Joan Porti* (Universitat Autònoma de Barcelona) Ricci flow and geometrization of three manifolds
16:00-16:30	Coffee break
16:30-17:30	*Jiří Matoušek* (Charles University, Prague) Hardness of embedding simplicial complexes in $\mathbb{R}^d$
17:30-17:50	Break
17:50	Formal opening
18:00-19:00	*Jakob Yngvason* (Schroedinger Institute in Vienna) Quantum gases in fast rotation and vortices
19:00-21:00	Banquet (down in the cafeteria)

Sunday January 24: Plenary talks, all in S5

13:00-14:30	The prize session
14:30-15:00	Break
15:00-16:00	*Fernando Muro* (University of Seville) Representability of cohomology theories
16:00-16:30	Break
16:30-17:30	*Ľubomír Snoha* (Matej Bel University, Banska Bystrica) Minimal sets in discrete dynamics - results, tools, open problems
17:30-18:00	Break
18:00-19:00	*Aleksander Malnič* (University of Ljubljana) Covering space techniques in graph theory

Monday January 25: Invited and contributed talks in parallel sessions

9:00-10:30	Topological, Geometric and Algebraic Graph Theory (S3)
	Differential Geometry and Mathematical Physics (S4)
	Triangulated Categories (S5)
	Mathematics of Secret Sharing (S6)
	Discrete Dynamical Systems (ČVUT, Thákurova 7)
10:30-11:00	Coffee break
11:00-12:30	Topological, Geometric and Algebraic Graph Theory (S3)
	Differential Geometry and Mathematical Physics (S4, till 13:05)
	Triangulated Categories (S5)
	Mathematics of Secret Sharing (S6)
	Discrete Dynamical Systems (ČVUT, Thákurova 7)
12:30-14:00	Lunch break
14:00-15:30	Topological, Geometric and Algebraic Graph Theory (S3)
	Discrete Algorithms and Computational Complexity (S4)
	Triangulated Categories (S5)
15:30-16:00	Coffee break
16:00-17:30	Topological, Geometric and Algebraic Graph Theory (S3)
	Discrete Algorithms and Computational Complexity (S4)
	Triangulated Categories (S5)

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Plenary lectures

Invited and contributed lectures

Differential Geometry and Mathematical Physics

Discrete Algorithms and Computational Complexity

Discrete Dynamical Systems

Enumerative and Analytic Combinatorics

Function Spaces and Applications

Mathematical Physics

Topological, Geometric and Algebraic Graph Theory

Triangulated Categories

Plenary lectures

Hitting probabilities for solutions to stochastic partial differential equations

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We will present some results on upper and lower bounds for hitting probabilities of random fields in terms of Hausdorff measure and Bessel-Riesz capacity, respectively. Applications to several examples of stochastic partial differential equations will be discussed.

Refined enumerations of alternating sign matrices

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Alternating sign matrices are one of those fascinating combinatorial objects that admit an exceptional simple enumeration formula while at the same time proving this formula is rather complicated. They were first defined and studied in the early 1980s by Robbins and Rumsey in connection with Dodgson's condensation method for computing determinants. The research was further stimulated after the discovery of the relation to a statistical mechanics model (six-vertex model) for "square ice". In the talk I will first give an introduction into this field and then present our approach to refined enumerations of alternating sign matrices.

Embeddings of Bessel-potential-type spaces into generalized Hölder spaces involving k-modulus of smoothness

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Classical Bessel potential spaces $H^{\sigma,p}(\mathbb{R}^n) = H^\sigma L^p(\mathbb{R}^n)$, introduced by N. Aronszajn, K. Smith and A. P. Calderón in 1961, have played a significant role in mathematical analysis and in applications for many years. These spaces are modelled upon the scale of Lebesgue spaces $L^p(\mathbb{R}^n)$ and they coincide with the Sobolev spaces $W^{k,p}(\mathbb{R}^n) = W^k L^p(\mathbb{R}^n)$ when $\sigma = k \in \mathbb{N}$ and $p \in (1, +\infty)$. However, it has gradually become clear that to handle some situations (especially limiting ones) a more refined tuning is desirable.

For this purpose, we replace the Lebesgue spaces $L^p(\mathbb{R}^n)$ by rearrangement invariant Banach function spaces $X(\mathbb{R}^n)$ and we study embeddings of Bessel potential spaces $H^\sigma X(\mathbb{R}^n)$ with order of smoothness $\sigma \in (0, n)$ into generalized Hölder spaces defined by means of the k-modulus of smoothness ($k \in \mathbb{N}$). We establish necessary and sufficient conditions for such embeddings and we present applications of our results. In particular, we obtain new and sharp embeddings of Sobolev-Orlicz spaces $W^{m+1}L^{n/m}(\log L)^\alpha(\mathbb{R}^n)$ and $W^m L^{n/m}(\log L)^\alpha(\mathbb{R}^n)$ into generalized Hölder spaces, which improve known results.

The lecture is based on a joint work with Amiran Gogatishvili and Júlio S. Neves.

Ricci flow and geometrization of three manifolds

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We give an overview of Thurston's geometrization conjecture, the Ricci flow introduced by Hamilton, and Perelman's proof.

Hardness of embedding simplicial complexes in $\mathbb{R}^d$

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It is well known that one can test in linear time whether a given graph is planar. We consider the higher-dimensional generalization of this problem: given a k-dimensional simplicial complex K and a target dimension d, does K embed into $\mathbb{R}^d$? Surprisingly, rather little seems to be known about the algorithmic aspects of this problem. (All the relevant topological notions will be defined and explained during the talk, at least on an intuitive level.) Known results easily imply that the problem is solvable in polynomial time if $k = d = 2$ or $d = 2k \geq 6$. We show that the problem is algorithmically undecidable for $k = d - 1$ and $d \geq 5$. This follows from a famous result of Novikov on the unsolvability of recognizing the 5-sphere. Our main result is NP-hardness in the range $d \geq 4$ and $d \geq k \geq (2d - 2)/3$. These dimensions fall outside the so-called metastable range of a theorem of Haefliger and Weber, which characterizes embeddability in terms of the so-called deleted product obstruction. Our reductions are based on examples, due to Segal, Spiez, Freeman, Krushkal, Teichner, and Skopenkov, showing that outside the metastable range, the deleted product obstruction is insufficient. Joint work with Martin Tancer and Uli Wagner.

Quantum gases in fast rotation and vortices

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A survey of recent mathematical results on quantum gases in fast rotation and the appearance and disappearance of vortices will be presented.

Representability of cohomology theories

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Brown and Adams representability theorems for cohomology theories originated in algebraic topology. They have been extended to other algebraic and geometric contexts, where they have been successfully applied (Grothendieck duality in algebraic geometry, Auslander-Reiten theory in representation theory, motivic cohomology?). Nevertheless, there are still many open questions with potentially striking applications. We will introduce the audience to what is known and report on recent advances.

Minimal sets in discrete dynamics – results, tools, open problems

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Discrete dynamical systems given by a continuous map on a topological (usually compact metrizable) space will be considered. Minimality of such a system/map can be defined as the density of all forward orbits. Every compact system contains at least one minimal set, i.e., a nonempty closed invariant subset such that the restriction of the map to this subset is minimal. A fundamental question in topological dynamics is the one on the topological structure of minimal sets of continuous maps in a given space (and, in particular, whether the space itself admits a minimal map or not).

We will present some known as well as new results on topology of minimal sets, some tools used in the proofs, and some open problems.

Covering space techniques in graph theory

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Graph covers emerged forty years ago in the context of maps on surfaces, appropriately adapted to reflect the discrete nature of these objects;

the primary incentive was the final solution of the long standing Heawood's Map Colour Problem.

Much around the same time these techniques became an indispensable tool in algebraic graph theory; here, the motivation came from problems related to classification of graphs and maps in terms of their symmetries. An important topic in this setting is the problem of lifting automorphisms, a problem that has long been well understood at a very general level in algebraic topology. These general results, however, are rather inadequate if we are to successfully cope with concrete examples and specific questions that arise when studying symmetry from a combinatorial point of view in the setting of graphs and maps. A number of papers dealing with the lifting problem have been published in the past fifteen years. In terms of content they range from general considerations to more concrete applications in the field of graphs and maps on surfaces, dealing with enumeration, classification and construction of infinite families of graphs with specific symmetry properties, and compiling lists of such graphs up to a certain order.

In the talk I will review some results covering this topic.

Differential Geometry and Mathematical Physics

The Cartan form and its generalizations in the calculus of variations

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We discuss possible extensions of the concept of the Cartan form of classical mechanics to higher order mechanics on manifolds, higher order field theory on jet bundles and to parametric variational problems on slit tangent bundles and on bundles of non-degenerate velocities. We present a generalization of the Cartan form, known as a Lepage form, and basic properties of the Lepage forms. Both earlier and recent examples of differential forms generalizing the Cartan form are reviewed.

Symplectic and Poisson geometry of b-manifolds

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In this talk we will try to show the hidden geometry (symplectic and Poisson) in what we call b-manifolds.

These manifolds were initially considered by Nest and Tsygan while studying formal deformations of symplectic manifolds with boundary and also by Melrose in the context of differential calculus and differential operators of manifolds with boundary.

Symplectic b-manifolds lie between the symplectic and Poisson world. In particular, it is possible to prove local and semiglobal normal forms via b-de Rham theory. This talk is based on joink work with Victor Guillemin and Ana Rita Pires.

Order reduction of the Euler-Lagrange equations of higher order invariant variational problems on frame bundles

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Let $\mu : FX \to X$ be a principal bundle of frames with the structure group $Gl_n(\mathbb{R})$. It is shown that the variational problem, defined by $Gl_n(\mathbb{R})$-invariant Lagrangian on $J^r FX$, can be equivalently studied on the associated space of connections with some compatibility condition, which gives us order reduction of the corresponding Euler-Lagrange equations.

Some generalizations of the notion of Lie algebra

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There are several ways to generalize the notion of Lie algebra. For instance, one can lift the restriction of antisymmetry (obtaining the so called Loday -or Leibniz- algebras), or view a particular Lie algebra as a member of a family indexed by the points of a manifold (a kind of moduli space called Lie algebroid). Alan Weinstein has shown how any finite-dimensional Lie algebra can be put in correspondence with a closed maximal subspace of a certain construction called omni-Lie algebra. In the talk, we will describe a way of unifying those concepts through the notion of omni-Loday algebroid, presenting some simple examples.

Example of nonholonomic constraint of the second order

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The nonholonomic variational principle

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A variational principle for mechanical systems and fields subject to nonholonomic constraints is found, providing Chetaev-reduced equations as equations for extremals. Two cases are studied: first, when the constrained system arises from an unconstrained Lagrangian system defined in a neighbourhood of the constraint, and second, more general, when an "internal" constrained system on the constraint manifold is given.

Constraints in k-presymplectic field theory

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Field theories have several geometric formulations. An especially simple one is the k-symplectic formalism, since only tangent and cotangent bundles are needed in its description. Its defining elements have a close relationship with those in the symplectic formulation of mechanics. The purpose of this talk is to show that this relationship also stands in the presymplectic case, and more particularly to show that one can mimick the presymplectic con-

straint algorithm to obtain a constraint algorithm that can be applied to k-presymplectic field theory.

Generalized Stäckel transform and its applications to integrable systems

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In this work we introduce multiparameter generalized Stäckel transform – a noncanonical transformation of a special kind relating the sets of (not necessarily commuting) Hamiltonians and leaving the phase space coordinates intact. It is shown that under certain conditions the transformation in question preserves Liouville integrability, noncommutative integrability and superintegrability. For instance, when applied to an n-tuple of commuting Hamiltonians, this transformation yields a (new) n-tuple of commuting Hamiltonians. Thus, one can construct new integrable systems from the old ones and also fi

nd new links among known integrable systems using the transformation under study. In particular, we show that integrable systems associated with the so-called k-hole deformations of the separation curve of Benenti type are related to the ones associated with the original separation curve of Benenti type through an appropriately chosen multiparameter generalized Stäckel transform. The corresponding transformation for the equations of motion proves to be nothing but a reciprocal transformation of a special form, and we briefly discuss the properties of this class of reciprocal transformations, including applications to hydrodynamic-type systems.

This is joint work with Maciej Blaszak. For more details see A. Sergyeyev, M. Blaszak, Generalized Stäckel transform and reciprocal transformations for finite-dimensional integrable systems, J. Phys. A: Math. Theor. 41 (2008), paper 105205.

Maxwell equations with periodic coefficients in 1 + 1 dimensions for an optical application

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On using the Fourier transformation, the time included in the Maxwell equations can be replaced by the frequency of a component, but a simplification does not come about, in spite of the parametric approximation, when a field in a nonlinear medium is described. We encounter spatially periodic coefficients. We deal with a decomposition of a solution into the surface and volume components in the case, when the nonlinear media of different coefficients of nonlinearity alternate.

Helmholtz conditions and their generalizations

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In the paper, properties of morphisms in the variational sequence are investigated. The Euler–Lagrange morphism E_1 is well-understood. It is also known that the kernel of the Helmholtz morphism E_2 consists of locally variational dynamical forms, and is characterized by Helmholtz conditions. We study the image of E_2 and the kernel of the next morphism E_3, and solve the corresponding local and global inverse problem when a three-form comes (via a variational map) from a dynamical form, i.e., corresponds to a system of differential equations. We find identities, that are a generalization of the Helmholtz conditions to this situation, and show that the problem is closely related to the question on existence of a closed three-form. The obtained results extend known results on Lagrangins and locally variational dynamical forms to general dynamical forms, and open a new possibility to study non-variational equations by means of closed three-forms, as a parallel to extremal problems (variational equations) that are studied by means of closed two-forms (Cartan forms, symplectic geometry).

Asymptotic zero distributions of polynomials of the Heun equation

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We solve the classical (multi)spectral problem for the Heun equation suggested by E. Heine and T. Stieltjes in the 19th century. We study asymptotic behaviour of roots of both Van Vleck and Stieltjes polynomials. Existence of the asymptotic measures is proved and their supports are characterized.

Discrete Algorithms and Computational Complexity

Generalizations of interval graphs motivated by the constraint satisfaction problem

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Recently, interval graphs have naturally arisen in the context of constraint satisfaction problems. Progress in understanding what structures make CSP's tractable suggests generalizations and analogues of interval graphs. I will discuss obstruction characterizations and recognition algorithms for these generalizations. Applications to the CSP dichotomy problem will also be mentioned. This is joint work with Tomas Feder, Jing Huang, and Arash Rafiey.

On efective representation of groups, monoids and posets

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We discuss the title of the lecture in the context of graph classes. Some of the results are joint with Jan Hubička and Patrice Ossona de Mendez.

Bounds on the k-th chromatic number of generalized star colorings

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A graph has star chromatic number k if it can be colored with k colors in such a way that each color class is a stable set and the subgraph induced by any two color classes is a forest of stars. The star chromatic number can be generalized to $\chi_p(G)$, $p \geq 2$, by requiring that any $i \leq p$ classes induce a graph with treedepth at most i. Nešetřil and Ossona de Mendez proved that, for each $p \geq 1$, $\chi_p(G)$ is bounded in the class of bounded expansion graphs. By using the Local Lovász Lemma we give some specific bounds for the subclass of graphs with maximum degree Δ.

Complexity of the distance constrained labeling problem for trees

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We show a full complexity dichotomy for the distance constrained labeling problem on the class of trees.

The k-in-a-path problem for claw-free graphs

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Testing whether there is an induced path in a graph spanning k given vertices is already NP-complete in general graphs when $k = 3$. We show how to solve this problem in polynomial time on claw-free graphs, when k is not part of the input but an arbitrarily fixed integer. This is a joint work with Jiří Fiala, Marcin Kamiński and Daniël Paulusma.

On 3-Colorability of Pseudo-Triangulations

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Deciding 3-colorability for general plane graphs is known to be an NP-complete problem. However, for certain families of graphs, e.g. triangulations, polynomial time algorithms exist.

We consider the family of pseudo-triangulations, which are a generalization of triangulations, and prove NP-completeness for this class. This also holds, if we bound their face degree to four or consider exclusively pointed pseudo-triangulations with maximum face-degree five. In contrast to these completeness results we show that pointed pseudo-triangulations with maximum face-degree four are always 3-colorable. An according 3-coloring can be found in linear time.

This is a joint work with Oswin Aichholzer, Franz Aurenhammer, Thomas Hackl, Alexander Pilz and Birgit Vogtenhuber.

Unified Approach to Polynomial Algorithms on Graphs of Bounded (bi-)Rank-width

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In this paper we develop new algorithmic machinery for solving hard problems on graphs of bounded rank-width and on digraphs of bounded bi-rank-width in polynomial (XP, to be precise) time. These include, particularly, graph colouring and chromatic polynomial problems, the Hamiltonian path and c-min-leaf outbranching, the directed cut, and more generally MSOL-partitioning problems on digraphs. Our focus on a formally clean and unified approach for the considered algorithmic problems is in contrast with many previous published XP algorithms running on graphs of bounded clique-width, which mostly used ad hoc techniques and ideas. The new contributions include faster algorithms for computing the chromatic number and the chromatic polynomial on graphs of bounded rank-width, and new algorithms for solving the defective colouring, the min-leaf outbranching, and the directed cut problems.

Joint work with Robert Ganian and Jan Obdržálek.

Multivariate complexity analysis of some voting problems

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We survey some recent results on the parameterized computational complexity of NP-hard problems in the context of voting systems. These problems include Kemeny, Dodgson, and Young voting. Moreover, we consider NP-hard possible winner problems for scoring protocols.

What Makes Equitable Connected Partition Easy

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We study the EQUITABLE CONNECTED PARTITION problem: partitioning the vertices of a graph into a specified number of classes, such that each class of the partition induces a connected subgraph, so that the classes have cardinalities that differ by at most one. We examine the problem from the parameterized complexity perspective with respect to various (aggregate) parameterizations involving such secondary measurements as: (1) the number of partition classes, (2) the treewidth, (3) the pathwidth, (4) the minimum size of a feedback vertex set, (5) the minimum size of a vertex cover, (6) and the maximum number of leaves in a spanning tree of the graph. In particular, we show that the problem is W[1]-hard with respect to the first four combined, while it is fixed-parameter tractable with respect to each of the last two alone. The hardness result holds even for planar graphs. The problem is in XP when parameterized by treewidth, by standard dynamic programming techniques. Furthermore, we show that the closely related problem of EQUITABLE COLORING (equitably partitioning the vertices into a specified number of independent sets) is FPT parameterized by the maximum number of leaves in a spanning tree of the graph.

(joint work with Rosa Enciso, Michael R. Fellows, Jiong Guo, Iyad Kanj, and Frances Rosamond)

Making graph minor theory constructive

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By the Graph Minor Theorem (previously Wagner's Conjecture), every class of finite graphs that is closed under taking minors has a characterization by *finitely* many excluded minors. Moreover, every minor closed graph class has a cubic time membership test. This membership test uses the excluded minor characterization.

The proof of the Graph Minor Theorem is non-constructive, hence, unfortunately, for many minor closed classes we do not know the corresponding excluded minors! Some work has been done to overcome this non-constructiveness, but still many problems remain unsolved. In this talk we present a method to compute excluded minors from certain given information of a minor ideal. Our method uses graph minor theory, logic and automata. In particular, we show: Given two minor closed classes C and D by their excluded minor characterizations, we can effectively compute an upper bound for the size of the excluded minors of $C \cup D$.

This is joint work with Martin Grohe and Stephan Kreutzer

Testing Planarity of Partially Embedded Graphs

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We pose and study the following question: Given a (planar graph) G and a planar embedding of its subgraph H, can this be extended to a noncrossing embedding of the entire graph G? This approach follows the paradigm of completing a partial solution of a particular problem, which has been studied in many different situations before. Unlike in many cases, when the presence of a partial solution in the input makes an otherwise easy problem hard, we show that the planarity question remains polynomial-time solvable. Our algorithm is based on several combinatorial lemmas which show that planarity of partially embedded graphs performs the "oncas" behaviour - obvious necessary conditions for planarity are also sufficient. In particular, a 2-connected graph allows an extension of an embedding of its subgraph H if and only the skeleton of each node of its SPQR-tree has an embedding compatible with the give embedding of H. This implies that no dynamic programming is needed for a decision algorithm, the nodes of the SPQR-tree can be processed independently in parallel. It should be noted that though 2-connected graphs form the core situation, nontrivial steps are needed to handle the less connected cases. By refining the techniques and using appropriately adjusted data structures we manage to achieve a linear time algorithm.

On the other hand we consider several generalizations of the problem, e.g. minimizing the number of edges of the partial embedding that need to be rerouted, and argue that they already become NP-hard.

The talk is based on a joint paper with atrizio Angelini, Giuseppe Di Battista, Fabrizio Frati, Vít Jelínek, Maurizio Patrignani, and Ignaz Rutter.

Enumeration of perfect matchings

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Some recent results will be presented.

Discrete Dynamical Systems

Generalization of Sturmian Words

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Sturmian words are aperiodic words with the lowest possible complexity. No wonder they belong to the most studied infinite words and many equivalent definitions of Sturmian words havee been found out. In our contribution, we will consider the generalizations of their combinatorial definitions and properties to multiliteral alphabets. We will in particular explain the relations between such properties and we will mention interesting open questions. This is a joint work with Štěpán Starosta.

On two and three periodic Lyness difference equations

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We describe the sequences x_n given by the non-autonomous second order Lyness difference equations $x_{n+2} = (a_n + x_{n+1})/x_n$, where a_n is either a 2-periodic or a 3-periodic sequence of positive values and the initial conditions x_1, x_2 are as well positive. We also show an interesting phenomenon of the discrete dynamical systems associated to some of these difference equations: the existence of one oscillation of their associated rotation number functions. This behavior does not appear for the autonomous Lyness difference equations.

Global linearization of periodic recurrences

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We deal with m-periodic, n-th order difference equations and study whether they can be globally linearized. We give an affirmative answer when $m = n + 1$ and for most of the known examples appearing in the literature. Our main tool is a refinement of the Montgomery-Bochner Theorem. We also prove some nice features of the $(n + 3)$-periodic Coxeter difference equations.

About the connectivity of the escaping set for entire transcendental maps

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Since Eremenko's conjecture (all connected components of the escaping set for transcendental entire maps are unbounded) the study of the connectivity (or not) of the escaping set has been studied in different frameworks. Recently two main results has been proved: On one hand it has been found an example showing that the conjecture is not true even for entire maps in class B for which wall singular values are contained in a compact set (L. Rempe et al). On the other under certain hypotheses (precisely strongly subhyperbolicity) it has been shown that the escaping set is disconnected (H. Mihaljevic-Brandt). We finally discuss recent work about the connectivity of the escaping set for the complex exponential family.

The Lotka-Volterra map and some problems of the number theory.

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The Lotka-Volterra map is a transformation of the triangle with vertices (0,0),(4,0) and (4,0) given by formula $F(x,y) = (x(4-x-y), xy)$. We show that properties of interior periodic orbits are closely related to some problems of the number theory. Some of these problems are open.

Extensions without increasing the entropy as a tool for entropy bounds problem

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We show how extensions without increasing the entropy can be used to determine the infimum of topological entropies of all maps with a given property on a given space and present known as well as new results in this direction.

On nowhere differentiable measure preserving maps

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We present several known results on nowhere differentiable measure preserving interval maps and discuss their properties with respect to the topological entropy. Some open problems will also be stated.

A strongly F-invariant pinched core strip that does not contain any arc of curve

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In [1] the authors define the concept of *pinched core strip*. So far it has not been given an example of such an object that is strongly invariant under a quasi-periodic triangular function and it is not a curve. In this talk we will describe how to construct such an example.

[1] R. Fabbri, T. Jäger, R. Johnson and G. Keller, *A Sharkovskii-type theorem for minimally forced interval maps*, Topological Methods in Nonlinear Analysis, Journal of the Juliusz Shauder Center, **2005(26)**, 163–188.

Global dynamics of discrete systems through Lie Symmetries

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We use the existence of Lie Symmetries to study the discrete dynamics of some rational maps in R^n.

Enumerative and Analytic Combinatorics

The poset of bipartitions

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Bipartitional relations were introduced by Foata and Zeilberger in their characterization of relations which give rise to equidistribution of the associated inversion statistic and major index. I shall consider the natural partial order on bipartitional relations given by inclusion. This partial order gives in fact rise to a lattice which has the remarkable property that the Möbius function of any interval is 0, 1, or -1. However, to prove the latter fact, is surprisingly difficult to prove. It requires Robin Forman's Discrete Morse Theory, the main ideas of which I shall outline. This is joint work with Gabor Hetyei.

Families of permutations with bounded VC-dimension have almost exponential size

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A family $\mathcal{P}$ of n-permutations has VC-dimension k if k is the largest number such that the elements of $\mathcal{P}$ induce all $k!$ permutations on some k-tuple of indices. An example of a family with VC-dimension k are permutations avoiding some fixed $(k+1)$-permutation. Marcus and Tardos proved the Stanley–Wilf conjecture, which says that the number of n-permutations avoiding an arbitrary given permutation grows only exponentially in n. Raz showed that if a family of n-permutations has VC-dimension 2, then its size is at most exponential in n.

In contrary to these two results, we find a family of $2^{\Omega(n \log(\alpha(n)))}$ permutations with VC-dimension 3. On the other hand, we show the upper bound of $2^{O(n \log^\star(n))}$ for any family of permutations with constant VC-dimension.

We also study a related problem of the maximum number of 1-entries in an $n \times n$ $(0,1)$-matrix with no k-tuple of columns containing all k-permutation matrices. It is known that this number is linear in n if $k \leq 3$. For any fixed $k \geq 4$, we show bounds $\Omega(n\alpha(n))$ and $O(n 2^{\alpha^{O(1)}(n)})$.

This is a joint work with Jan Kynčl.

Generalized Thue-Morse Sequences of Squares

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Let $(t_n) = (0110100110010110...)$ be the Thue-Morse sequence. Then the letters 0 and 1 are equally likely. Interestingly, this property persists for subsequences like linear progressions (t_{an+b}). Recently, Mauduit and Rivat could settle the long standing conjecture (attributed to Gelfond) that (t_p), p prime, and (t_{n^2}) have the same property.

In our work, we consider compact group generalizations $T(n)$ of the Thue-Morse sequence. We prove that the subsequence $T(n^2)$ is uniformly distributed with respect to a proper measure, that is absolutely continuous with respect to the Haar measure. The proof is based on a generalization of the Fourier based method of Mauduit and Rivat to group representations. As an application, we show a result on the frequency of letters of subsequences of special automatic sequences.

Convergence properties of q-binomial distributions

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We investigate in two q-analogues of the binomial distribution which are connected with basic hypergeometric series (or q-series). We study Kemp's

q-binomial distribution (joint work with Stefan Gerhold) and the q-deformed binomial distribution which have applications in biology and physics. Several convergence results involving the classical binomial, the Heine, the Euler, the discrete normal, the Poisson, and the exponential distribution are established. Some of them are q-analogues of classical convergence properties (e.g. there are q-analogues of the convergence of the classical binomial distribution with constant mean to the Poisson distribution or of the binomial distribution to the normal distribution).

Parameters of integer partitions - a zoo of limit laws

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Limit laws for various parameters of integer permutations and their generalisations (where the parts are restricted to certain sets, e.g. the set of all squares or all primes) are presented. Various classical distributions (Gaussian, Rayleigh, Gumbel, Geometric) as well as more "exotic" distributions occur as limit laws in this context. For certain parameters, interesting phase transitions can be observed as well.

The degree distribution in Random Unlabelled Subcritical Graph families

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We study the distribution of node degrees in subcritical families of graphs. These are families which are block-stable, that is they are determined only by their 2-connected components, and the generating function of 2-connected components fulfills certain analytic conditions, which we call subcriticality conditions. Important subcritical families are outerplanar and series-parallel graphs. We extend recent results by Drmota, Gimenez and

Noy in the labelled case, focusing mainly on the unlabelled framework. We use a generating functions approach, taking into account symmetries evolving from unlabelling and therefore using Polya's theory on cycle index sums. By methods of singularity analysis we can prove a central limit law for the number of nodes of given degree k in a random unlabelled graph of size n in any subcritical family of graphs. Therefore we obtain a degree distribution. This results holds generally in the subcritical framework, without any further knowledge on the structure of 2-connected components.

The degree of the nodes in random increasing k-trees

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Increasing k-trees are labelled graphs which are recursively defined as follows: The k-clique formed by the nodes $1, \ldots, k$ is the only increasing k-tree with k nodes. An increasing k-tree with $n > k$ nodes is constructed by connecting a new node n to all nodes of a k-clique in an increasing k-tree with $n-1$ nodes.

For $n \geq l$, we study the probability distribution of the degree of node $l+k$ in random increasing k-trees of size $n+k$. Using a generating functions approach, we derive the exact distribution for fixed n and l. Furthermore, we fully characterize the limiting behaviour for $n \to \infty$, both for l fixed and for $l \to \infty$. As a corollary, we obtain a weak form of the well-known power law for the degree distribution in increasing k-trees for $k \geq 2$.

Function Spaces and Applications

Gehring type results for generalized (Navier-)Stokes system in 2D.

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The mean value property of harmonic functions and the Heat equation

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A class of radial measures μ on R^n is defined so that integrable harmonic functions are characterized as the solutions of $f\mu = f$. These results are applied to the investigation of some periodic solutions of the Heat equation.

A note on bilinear multipliers

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The classical result of De Leeuw (Ann. Math., 1965) states that for $1 < p < \infty$, given a continuous and bounded function such that defines a Fourier multiplier on L^p, the sequence defined by its restriction to the integers defines a Fourier multiplier in L^p in the periodic case.

A similar result for bilinear multipliers was obtained by D. Fan and S. Sato (J. Aust. Math. Soc., 2001).

We present an abstract version of a De Leeu's type result for bilinear multipliers that allows D. Fan and Sato's result to be recovered and to generalize G. Diestel and Grafakos' (Nagoya Math. Journal 2007) result also.

Calderon-type interpolation theorems and applications to sharp Sobolev embeddings

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We present a new Calderon-type interpolation theorems for operators satisfying nonstandard endpoint estimates. Using this new interpolation theorems we give a characterization of sharp Sobolev embeddings for spaces based on rearrangement invariant spaces on domains with a sufficiently smooth boundary. We show that each optimal sobolev embedding can be obtained by the real interpolation of the well-known endpoint embeddings.

Mathematical Physics

Density-Matrix Functionals: Asymptotic Behavior of the Energy

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We will show that a class of density matrix functionals introduced by Müller and others which describe correlated systems yield atomic energies which differ only by $o(Z^{5/3})$, Z the atomic number, from the infimum of the spectrum of the corresponding Schrödinger operator.

The Cauchy problem for the KdV equation with steplike finite-gap initial data

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Let $p_{\pm}(x,t)$ be two arbitrary finite-gap solutions of the the Korteweg–de Vries equation $q_t = -q_{xxx} + 6qq_x$.

By means of the inverse scattering transform we solve the initial value problem for the KdV equation with smooth initial data $q(x,0)$, which are asymptotically close to $p_{\pm}(x,0)$ in the following sense:

$$(q^{(s)}(x,0) - p_{\pm}^{(s)}(x,0))|x|^m \in L^1(\mathbb{R}_{\pm}) \quad \text{as} \quad \leq 0 \leq s \leq n.$$

If the perturbation is sufficiently smooth ($n \geq 13$) and has a sufficient number of moments finite, $8 \leq m \leq n-5$, then the classical solution $q(x,t)$ of the KdV equation exists, is unique, and belongs to the class

$$(q^{(s)}(x,t) - p_{\pm}^{(s)}(x,t))|x|^{\lfloor \frac{m}{2} \rfloor - 2} \in L^1(\mathbb{R}_{\pm}) \quad \text{with} \quad 0 \leq s \leq n-m-2.$$

In particular, this implies that the solution remains in the Schwartz class of perturbations provided the initial condition is in this class.

Joint work with Katrin Grunert and Gerald Teschl.

Long–time asymptotics for the Korteweg-de Vries equation

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One of the most famous examples of completely integrable wave equations is the Korteweg–de Vries equation, $q_t(x,t) = 6q(x,t)q_x(x,t) - q_{xxx}(x,t)$, which can be solved via the inverse scattering method. We will consider decaying initial data and show how the inverse scattering problem can be reformulated as a Riemann–Hilbert problem. Based on this we will present how to extract long-time asymptotics by using the nonlinear steepest descent method.

The Hardy inequality and the asymptotic behaviour of the heat equation in twisted domains

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In this talk we revise a recently established Hardy inequality in twisted tubes on the background of transience of the Brownian motion. We begin by recalling the classical Hardy inequality and its relation to geometric, spectral, stochastic and other properties of the underlying Euclidean space. After discussing the complexity of the problem when reformulated for quasi-cylindrical subdomains, we focus on the prominent class of tubes. As the main result, we show that the geometric deformation of twisting yields an improved decay rate for solutions of the heat equation in three-dimensional tubes of uniform cross-section. This is a joint work with Enrique Zuazua.

Spectrum of the Aharonov-Bohm Hamiltonian with constant magnetic fields in the hyperbolic plane

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We consider the Schrödinger operator H in the hyperbolic plane with the magnetic field given by the sum of a constant times the surface form and a finite number of the Dirac δ measures. Since the corresponding classical system contains both bounded orbits and unbounded ones, the spectrum of H contains both the continuous spectrum and infinitely degenerated eigenvalues (Landau levels). In the presence of the δ magnetic fields, there also exist a finite number of eigenvalues of finite multiplicity. We give an upper bound for the number of eigenvalues (counting multiplicity) between two successive Landau levels.

1-D Schrödinger operators with local point interactions

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Spectral properties of 1-D Schrödinger operators

$$\mathrm{H}_{X,\alpha} := -\frac{\mathrm{d}^2}{\mathrm{d}x^2} + \sum_{x_n \in X} \alpha_n \delta(x - x_n)$$

with local point interactions on a discrete set $X = \{x_n\}_{n=1}^{\infty}$ are well studied when $d_* := \inf_{n,k\in\mathbb{N}} |x_n - x_k| > 0$ (numerous results as well as a comprehensive list of references may be found in the monograph of Albeverio, Gesztesy, Hoegh-Krohn, Holden, *Solvable Models in Quantum Mechanics*, AMS Chelsea Publ., 2005; see also a survey of recent result given by Exner in Appendix K).

In the case $d_* = 0$, it is only known that the operator $\mathrm{H}_{X,\alpha}$ may be symmetric with nontrivial deficiency indices (the example of Shubin Christ and Stolz, *J. Math. Anal. Appl.* **184** (1994)).

The main aim of our talk is the spectral analysis of the operators $\mathrm{H}_{X,\alpha}$ in the case $d_* = 0$. We show that spectral properties of the operators $\mathrm{H}_{X,\alpha}$ correlate with the corresponding spectral properties of certain classes of unbounded Jacobi matrices. We exploit this connection to investigate self-adjointness, lower semiboundedness, and discreteness of the operators with local point interactions.

The talk is based on the joint work with Mark Malamud.

The work is supported by IRCSET Post-Doctoral Fellowship Program.

Mathematics of Secret Sharing

Ideal Hierarchical Secret Sharing Schemes

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he search of efficient constructions of ideal schemes for families of non-threshold access structures that may have useful applications has attracted a lot of attention. Several proposals have been made for access structures with hierarchical properties, in which the participants are distributed into levels that are hierarchically ordered.

Here, we study hierarchical secret sharing in all generality by providing a natural definition for the family of the hierarchical access structures. Specifically, an access structure is said to be hierarchical if every two participants can be compared according to the following natural hierarchical order: whenever a participant in a qualified subset is substituted by a hierarchically superior participant, the new subset is still qualified.

We present a complete characterization of the ideal hierarchical access structures, that is, the ones admitting an ideal secret sharing scheme. We use the well known connection between ideal secret sharing and matroids and, in particular, the fact the every ideal access structure is a matroid port. In addition, we use recent results on ideal multipartite access structures and the connection between multipartite matroids and discrete polymatroids. We prove that every ideal hierarchical access structure is the port of a representable matroid and, more specifically, we prove that every ideal structure in this family admits ideal linear secret sharing schemes over fields of all characteristics. This generalizes previous results on weighted threshold access structures. Finally, we use our results to find a new characterization of the ideal weighted threshold access structures that is more precise than the existing one.

This is a joint work with Oriol Farràs

Asymptotically good linear secret sharing with strong multiplication over any finite field

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Linear secret sharing schemes(LSSS) with an extra algebraic property known as t-strong multiplication have important cryptographic applications: multiparty computation protocols can be based upon such schemes (Cramer, Damgaard, Maurer, Eurocrypt 2000); and more recently, Ishai, Kushilevitz, Ostrovsky and Sahai have found important applications in zero knowledge (STOC 07) and correlation extractions (FOCS 09) as well. For all these uses it is crucial to study the existence of asymptotically good families of LSSSs over fixed finite fields, i.e., families of LSSSs with an unbounded number of shares and strong multiplication for a constant fraction of the shares. A series of results, which relate this problem to interesting questions in code theory and towers of algebraic function fields, were given by Chen and Cramer in Crypto 2006 and Cascudo, Chen, Cramer, Xing in Crypto 2009 and in subsequent work and will be presented in this talk.

Secret sharing on infinite structures

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Traditionally, secret sharing is restricted to finite access structures. This poses no problem in the main field of applications. For finite structures we have a complete picture, at least in the case of perfect secret sharing. When one tries to extend the results for infinitely many participants, technical difficulties arise immediately. How to define the size of the share relative to that of the secret, as entropy, in general, can only be defined for discrete random variables. Even the existence of appropriate (measurable) random variables are far from being trivial. One can easily get mislead by the analogy to the finite case. For example, if F is a finite field, then shifting the field by a random element makes a perfect homeomorphic (with respect to addition) hiding. However when the field is the set of reals, then any probability distribution leaks some information (as taught in statistics classes). One of the first geometrical secret sharing construction using projective planes by Blakley and Swanson is also problematic. While the distribution is homogenous, when taking the conditional distribution given several shares, the result is concentrated on a zero measure set.

We overcome some of the difficulties mentioned above by defining secret sharing on an infinite structure as the limit of its finite restrictions. We justify the soundness of this notion, and give examples showing the non-triviality of the notion.

Ideal secret sharing, matroids and relative entropy

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In an information-theoretical setting, a secret sharing scheme (sss) can be described by a discrete random vector with finitely many values which satisfies the constraints on Shannon entropies of subvectors corresponding to cryptographic requirements on the access to the secret. A sss is ideal if each participant has at most as much information as the dealer distributing the secret. Ideal sss's with the same access structure are known to correspond to special representations of a matroid. We will review the results and open problems on the resulting classes of representations and matroids. They are closely related to entropic polymatroids, their limits and information theoretical inequalities among Shannon entropies. Ideal sss's with a given access structure and the size of secret will be interpreted as the statistically least favorable cases of the maximum likelihood estimation problems in families of Gibbs distributions.

Stochastic Analysis

Stein's method and Malliavin calculus of Poisson functionals

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Joint work with Giovanni Peccati, *Université Paris Ouest – Nanterre*; Murad Taqqu, *Boston University*; Josep Lluís Solé, *Universitat Autònoma de Barcelona*

In a recent series of papers by Nourdin, Peccati, Réveillac and Reiner it has been shown that Stein's method can be effectively combined with Malliavin calculus on a Gaussian space in order to obtain explicit bounds for the normal and non-normal approximation of smooth functionals of Gaussian fields, mainly multiple Wiener-Itô integrals.

In this talk we will present how these results can be extended to the approximation (in the Wasserstein distance) of functionals of Poisson measures. In particular we apply these ideas to a sequence of multiple Wiener-Itô integrals with respect to a Poisson measure.

As in the Gaussian case, the main ingredients of the analysis are the following:

1. A set of Stein differential equations, relating the normal approximation in the Wasserstein distance to first order differential operators.

2. A derivative operator D, acting on square-integrable random variables.

3. An integration by parts formula, involving the adjoint operator of D, the Skorohod integral.

4. A pathwise representation of D which, in the Poisson case, involves a difference operator.

Malliavin Calculus for Lévy Processes via Derivative Operators

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We develop a Malliavin calculus for Lévy processes based on derivative operators. This approach include the classical Malliavin calculus for Gaussian processes and the one for the Poisson process introduced by Carlen and Pardoux. As an application we analyze sufficient conditions for the absolute continuity of the law of some stochastic differential equations driven by Lévy processes.

Stochastic bilinear differential equation with fractional noise in infinite dimension

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We will study the infinite-dimensional stochastic bilinear equation with one-dimension fractional noise in the singular case $H < 1/2$.

SPDEs of reaction-diffusion type driven by Levy noise

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The topic of the talk are Spdes driven by Poisson random measure of reaction diffusion type. In the first part I will shortly outline Poisson random measures, then I will dwell shortly on the connection between Levy pro-

cesses and Poisson random measures. Moreover, I will introduce space time Levy noise respective space time Poissonian noise. Then, the stochastic integral with respect to Poisson random measures in Banach spaces will be treated and some inequalities pointed out.

In the second part of the talk Stochastic partial Differential Equations driven by Possion random measures will be considered. Here, I want to present some result concerning SPDEs driven by only continuous coefficients. In this case, one can show only the existstence of martingale solutions.

The topic of the talk rests on the following papers.

Brzezniak and Hausenblas, Maximale inequality of the stochastic convolution process, PTRF, 2008.

Brzezniak and Hausenblas, Uniqueness of the Ito integral driven by Poisson random measure, to appear in the Ascona proceedings, 2009.

Brzezniak and Hausenblas, Uniqueness of the stochastic convolution process driven by Poisson random measure, submitted, 2009.

Brzezniak and Hausenblas, SPDEs of reaction diffusion type Poisson random measure driven by Poisson random measure, submitted, 2009.

Moment inequalities for stochastic integrals in 2-smooth Banach spaces

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Stochastic wave equations

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A survey of basic and recent results in the theory of wave equations driven by Wiener processes.

Delay differential equations with hereditary drift driven by fractional Brownian motion with Hurst parameter $H > 1/2$

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We prove an existence and uniqueness result of solution for stochastic differential delay equations with hereditary drift driven by a fractional Brownian motion with Hurst parameter $H > 1/2$. We show that when the delay goes to zero the solutions to these equations converge, almost surely and in L^p, to the solution for the equation without delay.

We consider also the case of stochastic differential delay equations with reflection.

Relationships between fractional, bifractional and subfractional Brownian motions

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Statistical inference for SPDEs driven by fractional noise

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We will discuss a parameter estimation problem for a diagonalizable stochas-

tic evolution equation driven by additive noise that is white in space and fractional in time. Some asymptotic properties of the maximum likelihood estimator, as the number of the Fourier coefficients of the solution increases, will be investigated. Necessary and sufficient conditions for consistency and asymptotic normality will be presented.

Stochastic porous medium equation with fractional Brownian motion

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In this talk we study the relation between solutions to a certain type of non-linear partial differential equation and solutions to its stochastic analogy driven by a fractional Brownian motion with Hurst index $H > 1/2$. Obtained formula is used to study properties of the solution to the stochastic porous medium equation.

Ornstein-Uhlenbeck bridge

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Fractional Ornstein-Uhlenbeck processes in finite-dimensional spaces will be studied. First, known results on existence and uniqueness on solutions to linear stochastic differential equations, which define Ornstein-Uhlenbeck processes, will be recalled. Then we will introduce general Gaussian bridges and their representations. Finally, we will derive a formula for a Gaussian bridge driven by an Ornstein-Uhlenbeck process.

Reversible Reactions in Reaction-Diffusion Stochastic Simulation Algorithms

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Introduction to some mathematical models used in modelling of chemical reactions. Drawback of these models when reversible reactions are considered. Introduction to Andrew and Bray modelling of reversible reactions and related problems. Introduction and closer look on stochastic approach with implementation of probability.

LQ control for FBM-driven SPDEs

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The linear-quadratic control problem is studied for stochastic equation in infinite dimensions that is driven by the fractional Brownian motion. The existence and uniqueness of the optimal control is proved and, under more restrictive assumptions, the optimal conrtol is given in the feedback form. The results are applicable to parabolic and hyperbolic stochastic PDEs with distributed noise and to parabolic systems with boundary/pointwise noise and control.

Topological, Geometric and Algebraic Graph Theory

On almost distance-regular graphs

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Distance-regular graphs have been a key concept in Algebraic Combinatorics and have given place to several generalizations, such as association schemes and almost distance-regular graphs, which are the topic of this talk. Roughly speaking, almost distance-regular graphs have some kind of regularity that is characteristic of distance-regular graphs. An example is the concept of m-walk regularity, which is a generalization of walk-regularity, the latter defined in terms of the invariance of the number of l-walks between vertices at a given distance at most m. Other concepts are those of m-partially distance-polynomial and m-partially distance-regular graphs, characterized by the existence of polynomials with a certain degree in the adjacency matrix of the graphs, which give its corresponding distance matrices. In this talk, we give some algebraic and combinatorial characterizations of such almost distance-regular graphs, based on the so-called local spectrum and predistance polynomials of the graph. The main results can be seen as a generalization for almost distance-regular graphs of the spectral excess theorem for distance-regular graphs, which provides a quasi-spectral characterization in terms of the excess (number of vertices at maximum distance) of each of its vertices.

(joint work with E.R. van Dam, M.A. Fiol, E. Garriga, and B.L. Gorissen).

Applications of symmetries of combinatorial maps

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In 1980 combinatorial maps were introduced by A. Vince in his thesis. They are a useful tool for investigation of various combinatorial structures such as maps or abstract polytopes. Each combinatorial map admits a unique quotient "type graph". Using elementary methods related to type graphs we derive the 14 types of edge-transitive maps first studied by J. Graver and M. Watkins in 1997. Applications to abstract polytopes are also mentioned.

Vertex-transitive maps with Schläfli type 3,7

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When classifying maps with certain degree of symmetry on surfaces of small Euler characteristic the Hurwitz bounds play an important role. The equivelar maps with highest Hurwitz bounds are those whose vertices are 3-valent and whose faces are heptagons, as well as their duals. If these maps are classified, the computer time to compute the remaining equivelar maps reduces considerably. In this talk we present a procedure to classify all 3-valent vertex-transitive maps with heptagonal faces and their duals by means of smaller regular or 2-orbit maps.

Nowhere-zero flows in Cartesian bundles of graphs

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We extend the results of Imrich and Skrekovski [J. Graph Theory 43 (2003), 93-98] about nowhere-zero flows in Cartesian product graphs to "twisted" Cartesian products – Cartesian bundles. Our main result states that every Cartesian bundle of two graphs with positive minimum valency has a nowhere-zero 4-flow.

Fundamental cycles and the maximum genus of a graph

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We study the interplay between the maximum genus of a graph and the cycle basis with respect to a given spanning tree via the corresponding intersection graph. We show that different spanning trees may lead to intersection graphs with different matching numbers. This fact disproves the main result of [Sci China Ser A 52: 1920–1926 (2009)] and invalidates the algorithm for the maximum genus of a graph based on that theorem. We give some further examples to show that extending a graph with a pair of edges whose fundamental cycles intersect need not increase the maximum genus by one, and that a spanning tree with n pairs of intersecting fundamental cycles need not guarantee a 2-cell embedding of a graph in an orientable surface of genus n, contrary to what is claimed in op. cit.

Construction of Hamilton cycles in (2,s,3)-Cayley graphs

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A path (cycle) containing every vertex in a graph is called a Hamilton path (Hamilton cycle, respectively). A graph is called vertex-transitive if for any pair of vertices u and v there exists an automorphism mapping u to v. In 1969, Lovász asked whether every finite connected vertex-transitive graph has a Hamilton path. With the exception of the complete graph on two vertices, only four connected vertex-transitive graphs that do not have a Hamilton cycle are known to exist. These four graphs are the Petersen graph, the Coxeter graph and the two graphs obtained from them by replacing each vertex by a triangle. The fact that none of these four graphs is a Cayley graph has led to a folklore conjecture that every Cayley graph has a Hamilton cycle. (A Cayley graph is a graph whose automorphism group admits a regular subgroup.) Both of these two problems are still open. However, a considerable amount of partial results are known. In this talk a special emphasis will be given to recent results concerning the existence of Hamilton cycles in cubic Cayley graphs arising from groups having (2,s,3)-presentation.

Pseudo-distance-regular graphs around a set and the local spectrum of its subconstituents

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Pseudo-distance-regularity around a set of vertices generalizes the notion of completely regular code to non-necessary regular graphs. In this talk we will study some quasi spectral characterizations of pseudo-distance-regularity around a set of vertices. These characterizations are obtained through the study of the local spectrum of a set of vertices, which play a similar role to that of the spectrum of the whole graph when it is seen from that set of vertices. We will also discuss the relation between the local spectrum of a set of vertices and that of its subconstituents, paying special attention to its antipodal set.

On the ascending subgraph decomposition problem for bipartite graphs

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The Ascending Subgraph Decomposition (ASD) Conjecture asserts that every graph G with $\binom{n+1}{2}$ edges admits an edge decomposition $G = H_1 \oplus \cdots \oplus H_n$ such that H_i has i edges and is isomorphic to a subgraph of H_{i+1}, $i = 1, \ldots, n-1$. In this talk we summarize some known results about this conjecture and give necessary and sufficient conditions for a bipartite graph so that it admits an ascending subgraph decomposition in which each part is a star forest.

On cubic biabelian graphs

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A biabelian graph is a finite simple graph which admits a semiregular automorphism group with two

orbits of equal size. In particular we speak of a bicirculant graph if the semiregular automorphism group is cyclic. A classification of cubic bicirculant graphs was given recently by T. Pisanski [A classification of cubic bicirculants, Discrete Math. 307 (2007), 567-578]. In this talk we discuss similar results for cubic biabelian graphs.

Recognizing string graphs on surfaces in NP

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We show that graphs representable as intersection graphs of strings in any fixed surface S can be recognized in NP. We also show that the crossing number of a minimal string representation in S is bounded by 2^{cn^k} for some constants c, k where k does not depend on the genus of S. This improves the double exponential upper bound given by Schaefer, Sedgwick and Štefankovič and also generalizes their result for the planar case.

Archimedean solids of higher genera

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We will deal with vertex-transitive and polyhedral maps embeded into orientable surfaces of higher genera. These maps naturally generalise the spherical maps associated with classical Archimedean solids. Therefore we call them Archimedean maps. The main idea is based on the fact that each Archimedean map projects onto one-vertex (or two-vertex) quotient map. For given genus g there are just finitely many quotients and all Archimedean maps of genus g can be reconstructed from these quotients. We will also show the sketch of method of construction of unoriented "Archimedean maps" of higher genera.

Skew-morphisms of groups and regular maps

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Skew-morphism of a group is a generalization of a group automorphism. Skew-morphisms were investigated in connection of regular embeddings of graphs. In the present talk we survey some results on this interesting relationship. Further, we present some results on skew-morphisms of cyclic groups.

Coding and Counting Arrangements of Pseudolines

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Arrangements of lines and pseudolines are important and appealing objects for research in discrete and computational geometry. We show that there are at most $2^{0.66n^2}$ simple arrangements of n pseudolines in the plane. This improves on previous work by Knuth who proved an upper bound of $3^{\binom{n}{2}} \cong 2^{0.79n^2}$ in 1992 and S. Felsner who obtained $2^{0.69n^2}$ in 1997. The argument uses surprisingly little geometry. The main ingredient is a lemma that was already central to the argument given by Knuth. Joint work with Stefan Felsner.

Triangulated Categories

Combinatorial model categories

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The talk will survey some results and open problems concerning combinatorial model categories. Above all, the conjecture of J. H. Smith about model structures determined by a set of morphisms and my problem of generalized Brown representability will be discussed. In addition, the concept of a class-combinatorial model category (introduced in my joint work with B. Chorny) will be mentioned.

Representability theorems for well generated triangulated categories

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Let S be a triangulated subcategory of a triangulated category T. A contravariant functor from S to the category of abelian groups is representable if it is the restriction to S of a functor of the form $Hom(-, X)$, for X in T. We discuss some conditions on T and S that ensure that cohomological functors as above that send coproducts in S to products are representable.

Properness in the Bousfield Localisation of Model Categories

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The purpose of this talk will be to discuss the relevance of the property of (left) properness in the (left) Bousfield localisation of model categories. The Bousfield localisation of a model category at a set of morphisms is known to exist for the left proper cellular model categories and the left proper combinatorial model categories. The main result of the talk will say that the Bousfield localisation of a well-behaved cofibrantly generated model category exists iff the candidate class of trivial cofibrations is cofibrantly closed. This result will be presented as an application of the various known facts about combinatorial model categories, that will be briefly reviewed.

A homotopy theory for comodules and coalgebras

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We construct a Quillen model category structure on the categories of comodules and comonoids in certain monoidal model categories.

Decompositions of p-local spaces

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A ring is called semi-perfect if the identity 1 can be (uniquely) decomposed as a sum of orthogonal local idempotents. When G is a p-local H-space, there is a unit-reflecting homomorphism from $[G, G]$ into some semi-perfect ring. Unique decomposition of 1 as a sum of local idempotents then implies unique decomposition of G as a product of indecomposable p-local H-spaces. Also, a straightforward dualization of this argument gives a decomposition for p-local coH-spaces. This proof is much shorter than the original proof given by C. Wilkerson.

Cellularization of structures in triangulated categories

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We describe the formal properties of cellularization and nullification functors in triangulated categories. We give sufficient conditions for cellularization functors to preserve ring structures and module structures in stable homotopy categories. As an example, we compute some cellularizations of Eilenberg-Mac Lane objects in the homotopy category of spectra.

Singly generated ideals and coideals in monoidal triangulated categories

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In joint work with Gutiérrez and Rosický, we show that Vopěnka's Principle implies that localizing ideals are coreflective and colocalizing coideals are reflective in homotopy categories of stable monoidal combinatorial model categories. We also prove that every localizing ideal is singly generated under Vopěnka's Principle. In this talk we will outline the arguments in our proofs and give some evidence that the statement that colocalizing coideals are singly generated might fail to be true in general.

Fibrations up to an equivalence and homotopy colimits

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Both quasifibrations and local homology fibrations behave nicely with respect to homotopy colimits. We give conditions on a class H of continuous maps (with examples being weak equivalences and homology equivalences as above) that determine a theory of fibrations up to an equivalence from H that has similar properties. Slight variations of these, universal H-fibrations, behave nicely with respect to pullbacks. We will also give a classification result for H-fibrations up to a natural notion of their equivalence.