ÖMG - DMV Congress 2013

18th ÖMG Congress and Annual DMV Meeting
University of Innsbruck, September 23 – 27, 2013

Österreichische
Mathematische
Gesellschaft

Contents

Welcome

The board of the Austrian Mathematical Society, the board of the German Mathematical Society and the local conference organizers welcome you to the joint ÖMG-DMV Congress in Innsbruck, September 23 – 27, 2013. The 18th ÖMG Congress is held jointly with the Annual Meeting of the DMV – continuing a long-standing tradition that the meetings are co-organized every four years.

The meeting takes place in the lecture halls of the University of Innsbruck, Campus "Technik", Viktor-Franz-Hess-Haus, Technikerstr. 25 and ICT-Building, Technikerstr. 21a. The joint program starts on Monday, September 23, 2013, at 9:15 a.m. in the Auditorium B, Viktor-Franz-Hess-Haus, and continues until the evening of Thursday, September 26, with an additional day on Friday, September 27, featuring the special events: Teacher's Day, Universities of the Applied Sciences Day, and – as a satellite conference – the 2nd Austrian Stochastics Day.

A public lecture is scheduled for Thursday, September 26, in Kaiser-Leopold-Saal of the Faculty of Catholic Theology, Karl-Rahner-Platz 1.

The conference also hosts a Student's Conference taking place on Monday, September 23 and Tuesday, September 24.

The conference languages are English and German.

Sponsors

We thank our sponsors who provided generous support for the conference: The Rector and the Vice-Rector for Research of the University of Innsbruck, the Center for Italian Studies and France Focus of the University of Innsbruck, Innsbruck Tourism, Tiroler Sparkasse Bank AG Innsbruck, Raiffeisen-Landesbank Tirol AG, Springer-Verlag, Wiley, Österreichischer Bundesverlag, American Mathematical Society (AMS), Deutsche Vereinigung für Mathematische Logik und für Grundlagenforschung der Exakten Wissenschaften (DVMLG), Mathematisch-Physikalische Gesellschaft Innsbruck, Additive Soft- and Hardware, On-Line Encyclopedia of Integer Sequences (OEIS).

General Information

Conference Location

The conference takes place in the lecture halls of the University of Innsbruck, Campus "Technik":

Victor-Franz-Hess-Haus, Technikerstraße 25
ICT-Building, Technikerstraße 21a
6020 Innsbruck
Austria

Conference Office

The conference office is located in the entrance hall of Victor-Franz-Hess-Haus. The opening hours are

Sunday,	September 22,	17:00 – 20:00,	
Monday,	September 23,	8:15 – 13:00,	15:00 – 18:30,
Tuesday,	September 24,	8:15 – 13:00,	
Wednesday,	September 25,	8:15 – 13:00,	
Thursday,	September 26,	8:15 – 13:00,	
Friday,	September 27,	8:45 – 11:00.	

E-Mail: `math-oemg-dmv-2013@uibk.ac.at`

Registration

Registration of participants takes place on

Sunday, September 22, 17:00 – 20:00,
Monday, September 23, 8:15 – 13:00, 15:00 – 18:30,

in the entrance hall of Victor-Franz-Hess-Haus as well as during the opening hours of the conference office from Monday – Friday.

Further information on the conference can be found at the conference webpage:

`https://math-oemg-dmv.2013.uibk.ac.at/`

Technical Equipment of the Lecture Halls

All rooms are equipped with PC and beamer. Acrobat Reader and Power Point are available. The lecture halls are equipped with large blackboards, in addition.

Internet Access during Conference

WLAN access will be available to conference participants. Access data can be found on a separate sheet in the conference bag.

Lunch and Dinner

There are various restaurants, pubs and snack shops in and around Campus "Technik", in the close vicinity of the conference location. A list of restaurants is being handed to you with the conference folder.

Coffee Breaks

Coffee is served free of charge to participants on

Monday,	10:45 – 11:15	and	15:00 – 15:30,
Tuesday,	9:45 – 10:15	and	15:00 – 15:30,
Wednesday,	9:45 – 10:15,		
Thursday,	9:45 – 10:15	and	15:00 – 15:30.

In addition, the two university cafeterias (“Mensa”, Technikerstraße 17 and “Tech-Cafe”, Technikerstraße 21a) serve coffee and snacks.

Local Transportation

Single, 4-way, 24-hours or weekly tickets for bus and tram can be purchased in the local tobacco shops, the ticket machines located at most bus stops, and the IVB Customers Center, Stainerstraße 2. Single tickets can also be bought directly from the bus driver. Please consult `http://www.ivb.at/` for detailed information.

To reach the conference location, take bus “O” from the city center to station “Technik”. In addition, bus “T” connects the campus with the southern parts of Innsbruck, bus “LK” with Kranebitten.

Information about the Congress Venue Innsbruck

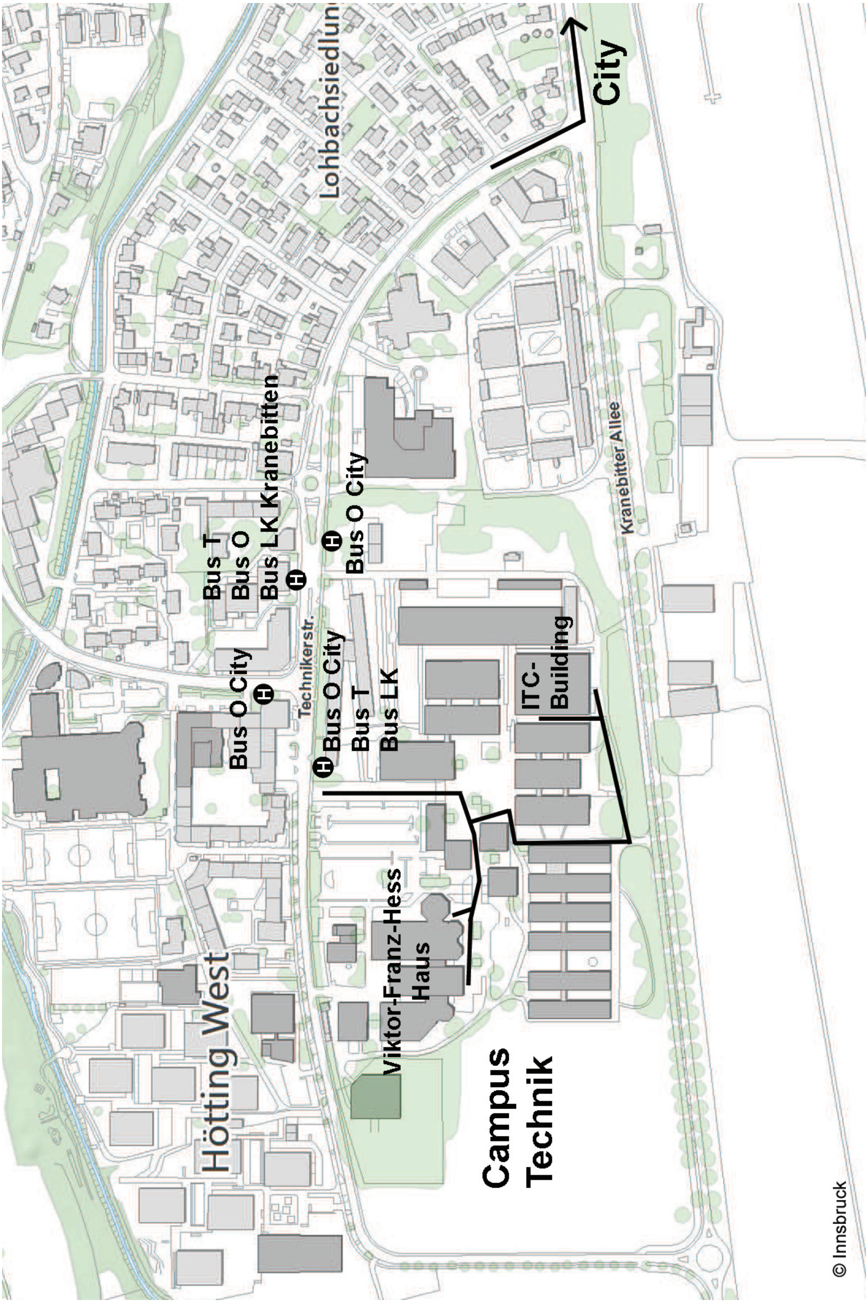
Innsbruck is the capital of Tyrol. For more information about its history and culture please visit the web page of Innsbruck Tourism:

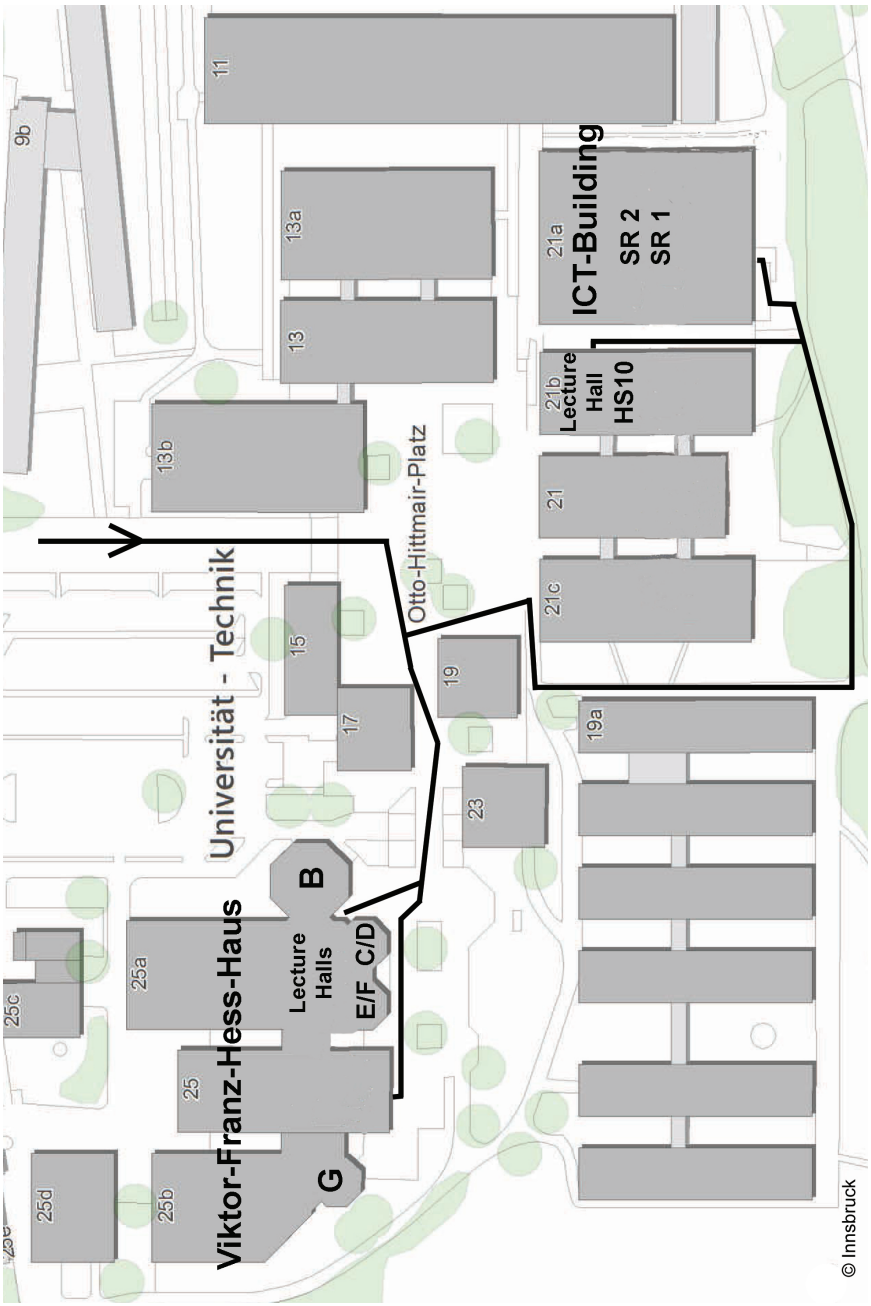
`http://www.innsbruck.at/`

Information about the University of Innsbruck

The Leopold-Franzens-University Innsbruck was founded in 1669. For more information about the university, please visit the web page:

`http://www.uibk.ac.at/universitaet/profil/`


City
Lohbachsiedlun
Bus T
Bus O
Bus LK Kranebitten
Bus O City
Technikerstr.
Kranebitter Allee
Bus O City
ITC-
Building
Bus O City
Bus T
Bus LK
Viktor-Franz-Hess-
Haus
Campus
Technik
Hötting West
© Innsbruck


Universität - Technik
Otto-Hittmair-Platz
Viktor-Franz-Hess-Haus
Lecture Halls
B
C/D
E/F
G
ICT-Building
SR 2
SR 1
21a
21b
Lecture Hall HS10
9b
11
13a
13
13b
15
17
19
19a
21
21c
23
25a
25b
25c
25d
© Innsbruck

Conference Organization and Committees

Program Committee

Michael Drmota (Wien)
Gerhard Larcher (Linz)
Peter Littelmann (Köln)
Michael Oberguggenberger (Innsbruck, chair)
Alexander Ostermann (Innsbruck)
Robert Tichy (Graz)
Katrin Wendland (Freiburg)

Local Organizing Committee

Anna Bombasaro (conference office)
Brigitte Eller (conference office)
Thomas Fetz
Manfred Husty
Wolfgang Kucher (system administrator)
Michael Oberguggenberger (chair)
Alexander Ostermann
Hans-Peter Schröcker

Coordinators of Sections

S01: Algebra, Logic and Set Theory

Martin Goldstern (Wien)
Heike Mildenberger (Freiburg)

S02: Discrete Mathematics and Theoretical Computer Science

Aart Middeldorp (Innsbruck)
Tibor Szabó (Berlin)

S03: Number Theory

Jörn Steuding (Würzburg)
Robert Tichy (Graz)

S04: Geometry and Topology

Manfred Husty (Innsbruck)
Thorsten Theobald (Frankfurt)

S05: Differential Equations and Applications

Peter Szmolyan (Wien)
Petra Wittbold (Duisburg-Essen)

S06: Functional Analysis, Real and Complex Analysis

Stephan Dahlke (Marburg)
Hans G. Feichtinger (Wien)

S07: Numerical Analysis and Scientific Computing

Michael Günther (Wuppertal)
Olaf Steinbach (Graz)

S08: Stochastics and Applications

Stefan Geiss (Innsbruck)
Peter Imkeller (Berlin)

S09: Mathematics in the Sciences and Technology

Ansgar Jüngel (Wien)
Caroline Lasser (München)

S10: History, Teaching and Popularization of Mathematics

Günter Törner (Duisburg-Essen)
Reinhard Winkler (Wien)

Organizers of Minisymposia

M1: Actuarial and Financial Mathematics

Nicole Bäuerle (Karlsruhe)
Uwe Schmock (Wien)

M2: Frames, High-dimensional Data Analysis, and Dimension Reduction

Martin Ehler (München)

M3: Mathematics of Planet Earth 2013

Gert-Martin Greuel (Kaiserslautern)
Andreas Matt (Berlin)

M4: Numbers, Graphs, Algebraic Structures and Probability –
the Graz Doctoral School in Discrete Mathematics

Wolfgang Woess (Graz)

M5: Operator Theory

Wolfram Bauer (Göttingen)
Birgit Jacob (Wuppertal)
Marko Lindner (Hamburg-Harburg)
Carsten Trunk (Ilmenau)

M6: Problems in Information and Communication in Mathematics

Wolfgang Dalitz (Berlin)
Wolfram Sperber (Karlsruhe)

M7: Spezifika der mathematischen Anfangsausbildung für Lehramtsstudierende

Günter Törner (Duisburg-Essen)
Reinhard Winkler (Wien)

Teachers' Day

Hans Humenberger (Wien)
Franz Pauer (Innsbruck)

Universities of the Applied Sciences Day

Susanne Teschl (Wien)
Karl Unterkofler (Dornbirn)

Satellite Conference: 2nd Austrian Stochastics Day

Evelyn Buckwar (Linz)
Christel Geiss (Innsbruck)
Erika Hausenblas (Leoben)

Students' Conference

Peter Eichelsbacher (Bochum)
Gerhard Kirchner (Innsbruck)

Conference Opening

Conference Opening Ceremony

Monday, September 23, 9:15 – 9:45, Auditorium B, Viktor-Franz-Hess-Haus.

Inaugural addresses will be given by

Prof. Jürg Kramer,
President of the German Mathematical Society,

Prof. Michael Drmota,
President of the Austrian Mathematical Society,

Prof. Sabine Schindler,
Vice-Rector for Research, University of Innsbruck.

The scientific program starts on Monday, September 23 at 9:45 with the plenary talk of Michael Struwe.

Evening Reception

The official evening reception takes place on Monday, September 23, 19:00, in the lobby of the ICT-Building, Technikerstraße 21a.

Meetings and Public Program

General Assembly, ÖMG

The General Assembly of the Austrian Mathematical Society will convene on Tuesday, September 24, 2013, at 18:30 in the Auditorium G. Members of the Austrian Mathematical Society are invited to participate.

General Assembly, DMV

The General Assembly of the German Mathematical Society will convene on Tuesday, September 24, 2013, at 18:30 in the Auditorium C. Members of the German Mathematical Society are invited to participate.

Award Ceremony, Reception by Springer-Verlag

The prices for the winners of the Students' Conference will be awarded on Tuesday, September 24 at 12:30 in the lobby in front of Auditorium B, Victor-Franz-Hess-Haus. The event is followed by a reception of Springer-Verlag in honor of the award winners.

Reception with Cédric Villani by France Focus

France Focus of the University of Innsbruck invites the participants of the congress to a reception on Thursday, September 26 at 17:00 in the historical hall of the palais "Claudiana", Herzog-Friedrich-Straße 3, dedicated to Cédric Villani. The event "Théorème vivant" will feature an interview of Cédric Villani by Walter Schachermayer.

Film Presentation

Within the program of Section 10, History, Teaching and Popularization of Mathematics, Agnes Handwerk and Harrie Willems will show their movie "Late Style – Yuri I. Manin Looking Back on a Life in Mathematics" on Tuesday, September 24 at 17:00, followed by reflections on the making of the film, in Auditorium E.

Public Lecture

Participants of the conference are invited to attend the public lecture on Thursday September 26, at 19:00 in Kaiser-Leopold-Saal, located in the Faculty of Catholic Theology, Karl-Rahner-Platz 1:

Karl Sigmund (Wien)

Kurt Gödel und der Wiener Kreis (Kurt Gödel and the Vienna Circle)

Kurt Gödel, einer der wichtigsten Denker des zwanzigsten Jahrhunderts, verbrachte nur fünfzehn Jahre in Wien. Der reich bebilderte Vortrag befasst sich mit Gödels glänzendem Aufstieg, seiner epochalen Entdeckung der Unvollständigkeitssätze, der wirren Zeit zwischen Hitlers Machtergreifung in Deutschland und dem "Anschluß" Österreichs, und Gödels verzweifelten Bemühungen, dem nationalsozialistischen Wien zu entkommen. Besonderes Augenmerk gilt Gödels gespaltenem Verhältnis zu den Mathematikern und Philosophen des Wiener Kreises.

The lecture is open to the general public and will be given in German.

Expositions

Exposition tables/stands will be presented during the conference by:

- Springer-Verlag
- Wiley
- Zentralblatt MATH
- Österreichischer Bundesverlag (Friday only)
- Austrian Mathematical Society
- German Mathematical Society
- American Mathematical Society
- Additive Soft- and Hardware
- On-Line Encyclopedia of Integer Sequences

Additional Program

Students' Conference

The Students' Conference takes place on September 23 – 24. It starts on Monday, September 23 at 15:15 and ends with an award ceremony on Tuesday, September 24 at 12:30 in Victor-Franz-Hess-Haus.

Teachers' Day

The Teachers' Day takes place on Friday, September 27, 9:15 – 17:00, in the lecture halls D and F in Victor-Franz-Hess-Haus.

Universities of the Applied Sciences Day

The Universities of the Applied Sciences Day takes place on Friday, September 27, 10:00 – 16:30, in SR1/2, ICT-Building.

Satellite Conference: 2nd Austrian Stochastics Day

The 2nd Austrian Stochastics Day takes place on Friday, September 27, in the lecture halls C and E in Victor-Franz-Hess-Haus.

More information about the additional program is avialable on the congress homepage: `https://math-oemg-dmv.2013.uibk.ac.at/`

Social Program

Evening Reception

The official evening reception takes place on Monday, September 23, 19:00, in the lobby of the ICT-Building, Technikerstr. 21a.

Conference Dinner

Every participant of the conference is invited to the Conference Dinner on Wednesday, September 25 at 19:00. Arrival starts at 18:00 with an aperitif, accompanied by Tyrolean music. The conference dinner takes place in Restaurant Villa Blanka, Weiherburggasse 31.

Participants of the conference excursions will be delivered directly to the restaurant at the end of the excursion.

The restaurant can be reached on foot (25 minutes from the city center), by bus "W" (departing at Marktplatz) or by using the funicular "Hungerburgbahn" from "Congress Innsbruck", Rennweg 3, to station "Alpenzoo".

After the dinner, transportation back to the city center will be arranged by bus.

Conference Excursion

The conference excursion takes place in the afternoon of Wednesday, September 25. Departure is from Campus "Technik" at 14:00, return to the city/conference dinner by 18:00.

The excursion takes us to Stift Stams, Zisterzienserabtei.

A bus will take us to the village of Stams. After a tour through the premises of the abbey we will have the chance to participate in a Schnaps tasting from the abbey's own distillery. After that we return to Innsbruck right on time for the conference dinner.

Please check your registration and find additional current information at the conference desk.

Further Excursions

In the following you will find a list of afternoon excursions offered throughout the week. The excursions will take place parallel to the scientific program.

- Monday, September 23: The Tyrolean Panorama and the Kaiserjäger Museum – the Myth of Tyrol.

  The Tyrolean Panorama was opened in 2011 and invites the visitor to a time travel through the most important stations of Tyrolean history. We start from the center of Innsbruck by tram, followed by a 20 minutes' walk to Bergisel where we can enjoy a marvelous view over Innsbruck. We devote two hours to the Panorama and the Kaiserjäger museum.

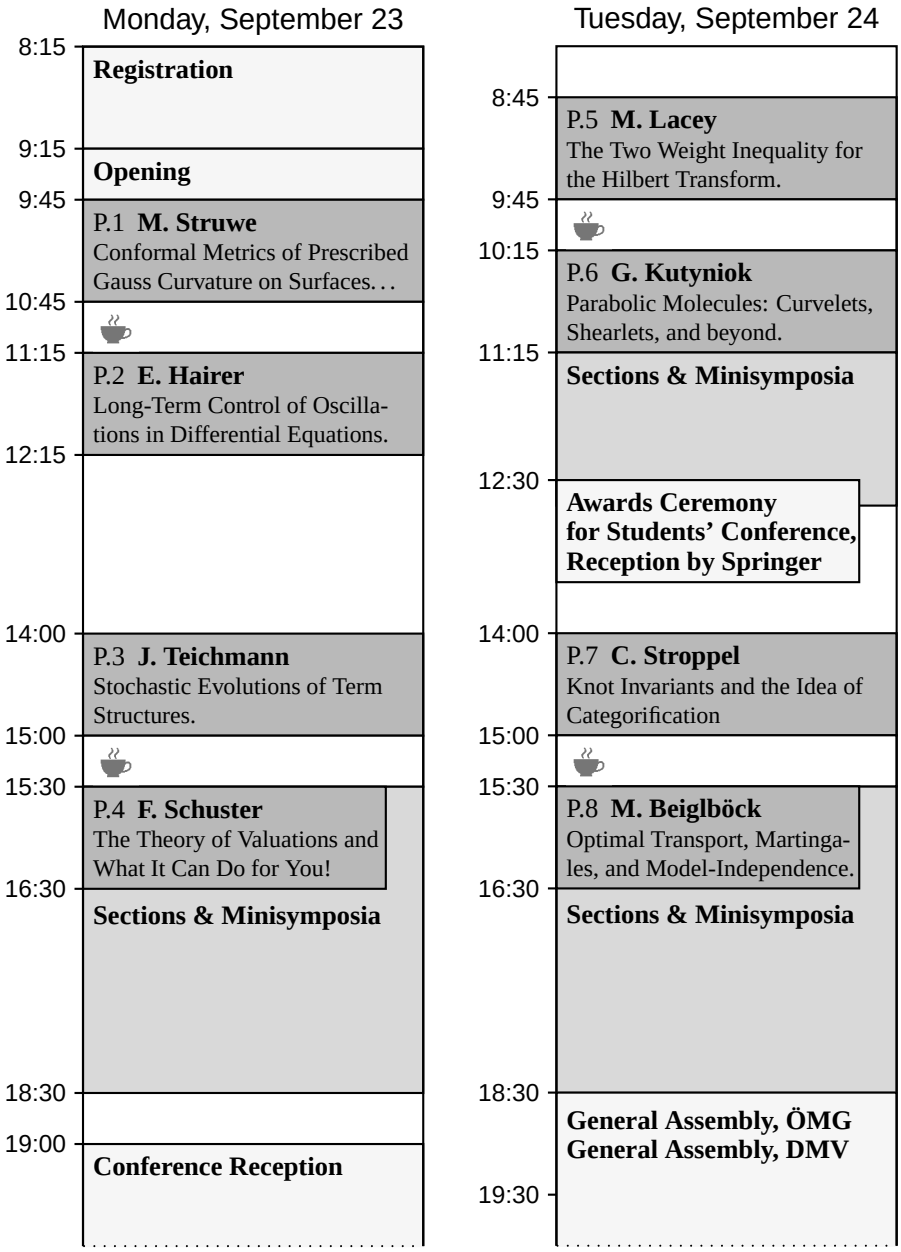
- Tuesday, September 24: Kaiserliche Hofburg Innsbruck.

  The Kaiserliche Hofburg used to be the residence of the Dukes of Tyrol. Already enlarged under the emperor Maximilian I, empress Maria Theresia transformed it into its final form as a Baroque palace. After a two-hour visit of the palace you will have the option to visit the Viennese style Café Sacher (not included).

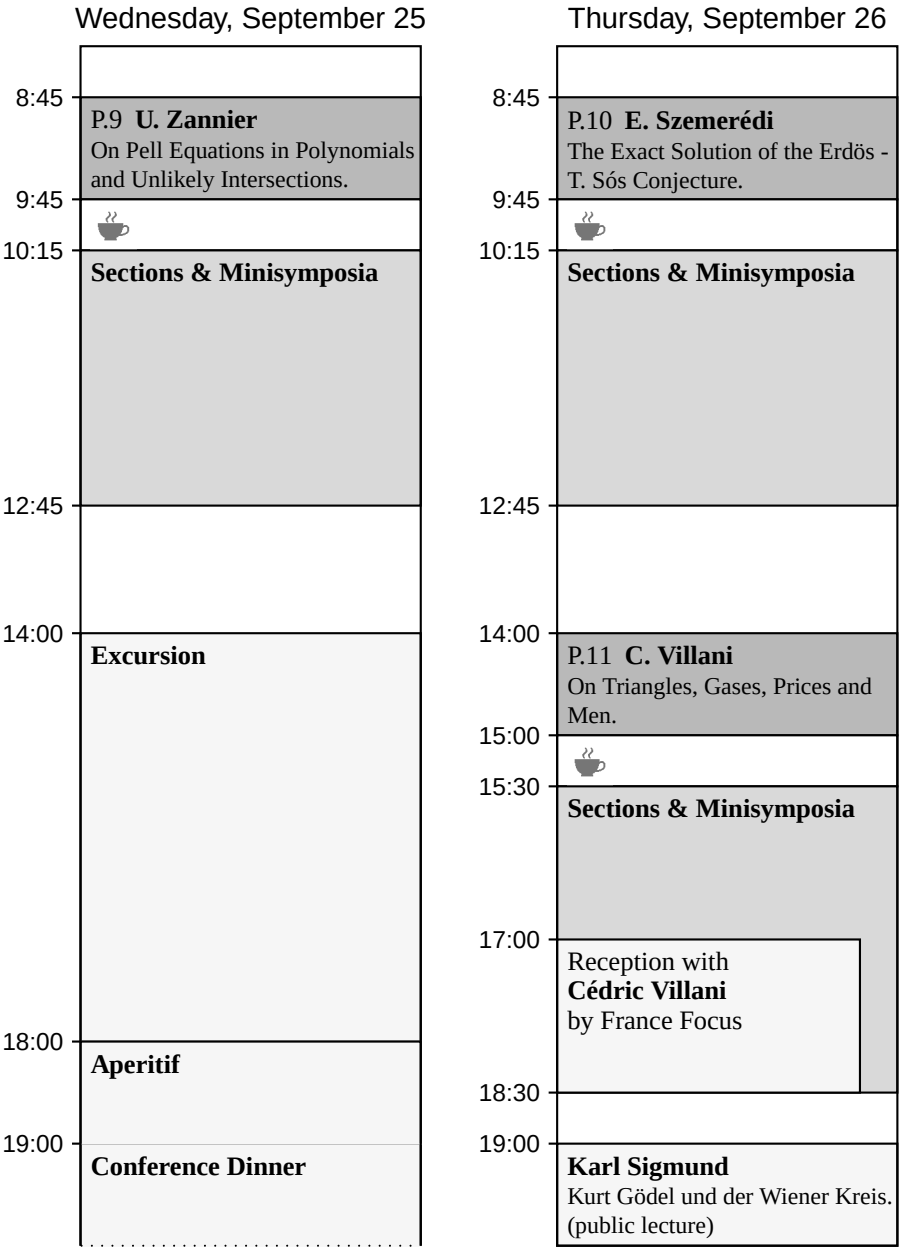
- Thursday, September 26: Innsbruck Tour – Explore Innsbruck on Foot.

  On this two-hour tour through the narrow streets of the old town we visit the most famous sights of Innsbruck, including the Golden Roof.

Program Overview



P: Plenary lecture.


Wednesday, September 25
8:45
P.9 U. Zannier
On Pell Equations in Polynomials and Unlikely Intersections.
9:45
10:15
Sections & Minisymposia
12:45
14:00
Excursion
18:00
Aperitif
19:00
Conference Dinner
Thursday, September 26
8:45
P.10 E. Szemerédi
The Exact Solution of the Erdös - T. Sós Conjecture.
9:45
10:15
Sections & Minisymposia
12:45
14:00
P.11 C. Villani
On Triangles, Gases, Prices and Men.
15:00
15:30
Sections & Minisymposia
17:00
Reception with
Cédric Villani
by France Focus
18:30
19:00
Karl Sigmund
Kurt Gödel und der Wiener Kreis.
(public lecture)

Detailed Program of Sections and Minisymposia

S01: Algebra, Logic and Set Theory
S02: Discrete Mathematics and Theoretical Computer Science
S03: Number Theory
S04: Geometry and Topology
S05: Differential Equations and Applications
S06: Functional Analysis, Real and Complex Analysis
S07: Numerical Analysis and Scientific Computing
S08: Stochastics and Applications
S09: Mathematics in the Sciences and Technology
S10: History, Teaching and Popularization of Mathematics

M1: Actuarial and Financial Mathematics
M2: Frames, High-dimensional Data Analysis, and Dimension Reduction
M3: Mathematics of Planet Earth 2013
M4: Numbers, Graphs, Algebraic Structures and Probability – the Graz Doctoral School in Discrete Mathematics
M5: Operator Theory
M6: Problems in Information and Communication in Mathematics
M7: Spezifika der mathematischen Anfangsausbildung für Lehramtsstudierende

Monday, September 23, Afternoon Session, Tracks 1–3

	Room B	Room C	Room D
	P: Plenary lecture **S05: Differential Equations and Applications (part 1)**	**M1: Actuarial and Financial Mathematics (part 1)**	**M3: Mathematics of Planet Earth 2013 (part 1)**
15:30	P.4 **F. Schuster** The Theory of Valuations and What It Can Do for You!	M1.1 **S. Gerhold** Local volatility models: approximation and regularization.	M3.1 **D. Kröner** Can mathematics help to control and avoid environmental stress?
15:45			
16:00		M1.2 **T. Rheinländer** Semi-static hedging of barrier options via a general self-duality.	
16:15			M3.2 **H. Weller** Atmospheric Modelling on Arbitrary Grids.
16:30	S05.1 **C. Walker** A free boundary problem for MEMS.	M1.3 **M. Scherer** Incorporating parameter risk into derivatives prices.	
16:45			
17:00		M1.4 **J. -F. Mai** Multivariate geometric distributions with latent factor structure.	
17:15			M3.3 **W. Freeden** Essential Principles of Geomathematical Modeling and Their Applications.
17:30	S05.2 **H.-C. Grunau** Estimates from above and below for biharmonic Green functions.	M1.5 **M. C. Christiansen** Deterministic optimal consumption and investment in a stochastic model with…	
17:45			
18:00	S05.3 **M. Hilschenz** Ein Integralgleichungszugang zu den Minimalvektoren von Marx und Shiffman.	M1.6 **U. Schmock** On the Existence of an Equivalent Martingale Measure in the Dalang–Morton–Willinger…	M3.4 **G. Jouvet** What mathematicians can do to save Alpine glaciers?
18:15			

Monday, September 23, Afternoon Session, Tracks 4–6

	Room E	Room F	Room G
	S10: History, Teaching and Popularization of Mathematics (part 1)	**S08: Stochastics and Applications (part 1)**	**S03: Number Theory (part 1)**
15:30	S10.1 **N. M. Krause** Schreiben Schüler mathematische Facharbeiten?	S08.1 **G. dos Reis** Root's barrier, viscosity solutions of obstacle problems and reflected FBSDEs.	
15:45			
16:00	S10.2 **J. Kurow** Vernetzung von Schule und Universität: Förderung mathematisch interessierter Schüler.		
16:15			
16:30	S10.3 **K. Roegner** Assessment standards and their stability.	S08.2 **M. Wendler** Stable Limit Theorem for U-Statistics Processes Indexed by a Random Walk.	S03.1 **M. Drmota** The Thue-Morse Sequence Along the Squares is Normal.
16:45			
17:00	S10.4 **H.-D. Janetzko** CATO - Eine deutschsprachige CA-Oberfläche.	S08.3 **L. Heinrich** A logarithmic stable limit law for the geometric mean of recurrence times of the simple…	S03.2 **P. Hellekalek** On the b-adic method in u.d.mod 1.
17:15			
17:30	S10.5 **G. Karigl** Prüfzeichencodierung: Theorie und einige populäre Anwendungen.	S08.4 **P. Ressel** A spectral representation of classical mean values and stable tail dependence functions.	S03.3 **R. Tichy** Uniform distribution and dynamical systems.
17:45			
18:00	S10.6 **H. Länger** A simple recursion for polynomials of sums of powers.		
18:15			

Monday, September 23, Afternoon Session, Tracks 7–9

	Room SR1	Room SR2	Room HS 10
	S06: Functional Analysis, Real and Complex Analysis (part 1)	**M4: Numbers, Graphs, Algebraic Structures and Probability (part 1)**	**S01: Algebra, Logic and Set Theory (part 1)**
15:30	S06.1 **M. Hanusch** Invariant and Distributional Connections on Principal Fibre Bundles.	M4.1 **J. Cuno** Random Walks on Baumslag-Solitar groups.	S01.1 **H. Brunotte** Eventually periodic and almost linear periodic matrices over quasi-max-plus algebras.
15:45			
16:00	S06.2 **F. Haslinger** Spectral properties of the $\overline{\partial}$-Neumann operator.	M4.2 **A. Bazarova** Extremal theory of dependent processes.	S01.2 **S. Friedenberg** Gamma Invariants and the Torsion-Freeness of Ext.
16:15			
16:30	S06.3 **R. Brunnhuber** Some aspects of singular Weyl-Titchmarsh-Kodaira theory for Dirac operators.	M4.3 **N. S. Haug** The minimum number of subtrees of trees.	S01.3 **W. Herfort** Near Abelian Locally Compact Groups.
16:45			
17:00	S06.4 **G. Racher** On translation invariant operators.	M4.4 **F. Lehner** Random colourings and automorphism breaking in graphs.	S01.4 **J. Tomaschek** Associative formal power series in two indeterminates.
17:15			
17:30	S06.5 **A. Klotz** Smoothness in Banach Algebras and Norm Controlled Inversion.		S01.5 **W. Wenzel** Arithmetic and Polynomials over Fuzzy Rings.
17:45			
18:00			S01.6 **D. Dorninger** Testing for classicality of a physical system.
18:15			

Tuesday, September 24, Morning Session, Tracks 1–3

	Room B	Room C	Room D
	S05: Differential Equations and Applications (part 2)	**M1: Actuarial and Financial Mathematics (part 2)**	**S04: Geometry and Topology (part 1)**
11:15	S05.4 **I. Gasser** On small Mach Number Applications related to renewable Energy Production.	M1.7 **C. Cuchiero** An HJM approach to multiple-curve modeling.	S04.1 **M. Joswig** Tropical Linear Programming.
11:30			
11:45		M1.8 **J. Sass** Regime switching, filtering and portfolio optimization.	
12:00			
12:15	S05.5 **J. Strecha** Modeling Flow Induced Vibrations of a Slender U-Beam at Low Reduced Velocities.	M1.9 **S. Thonhauser** A Bayesian Dividend Problem in Risk Theory.	
12:30			

Tuesday, September 24, Morning Session, Tracks 4–6

	Room E	Room F	Room G
	M7: Spezifika der math. Anfangsausbildung für Lehramtsstudierende (part 1)	**S08: Stochastics and Applications (part 2)**	**S03: Number Theory (part 2)**
11:15	M7.1 **G. Törner** Was sind konstitutive Merkmale einer Lehramtsausbildung Mathematik? - die internationale Perspektive.	S08.5 **C. Temmel** Structural results on one-independent point processes.	S03.4 **M. Stoll** Uniform bounds for the number of rational points on hyperelliptic curves with small Mordell-Weil rank.
11:30			
11:45		S08.6 **W. Woess** Isotropic Markov processes on Ultra-metric spaces.	
12:00			
12:15			S03.5 **R. Garunkštis** On the Speiser equivalent for the Riemann hypothesis.
12:30			

Tuesday, September 24, Morning Session, Tracks 7–9

	Room SR1	Room SR2	Room HS 10
	S06: Functional Analysis, Real and Complex Analysis (part 2)	**M5: Operator Theory (part 1)**	**S01: Algebra, Logic and Set Theory (part 2)**
11:15	S06.6 **B. Gramsch** Division of distributions with the Oka principle and small ideals of operators.	M5.1 **F. L. Schwenninger** Functional calculus estimates via admissibility.	S01.7 **P. Schuster (Leeds)** Ideal Objects for Finite Methods in Algebra.
11:30			
11:45	S06.7 **C. Bargetz** On sequence space representations of spaces of smooth functions and distributions.	M5.2 **J. Wirth** Global pseudo-differential calculus on compact Lie groups.	S01.8 **K. Schölzel** On intervals of partial clones.
12:00			
12:15	S06.8 **M. Kunzinger** An algebraic approach to microlocal analysis.		
12:30			

Tuesday, September 24, Afternoon Session, Tracks 1–3

	Room B	Room C	Room D
	P: Plenary lecture **S05: Differential Equations and Applications (part 3)**	**M3: Mathematics of Planet Earth 2013 (part 2)**	**S04: Geometry and Topology (part 2)**
15:30	P.8 **M. Beiglböck** Optimal Transport, Martingales, and Model-Independence.	M3.5 **P. Schuster (Wien)** The Mathematics of Biological Evolution.	S04.2 **J. Wallner** Geometric Modeling with polyhedral meshes.
15:45			
16:00			S04.3 **A. Alpers** Reconstruction of Polytopes from Refraction Data.
16:15		M3.6 **R. Korn** Modeling, valuation and management of economic risks.	
16:30	S05.6 **L. Diening** Lipschitz truncation and applications to non-linear PDE.		S04.4 **H.-P. Schröcker** Spatial linkages with a straight line trajectory.
16:45			
17:00			S04.5 **C. Thiel** Restricted Successive Minima.
17:15		M3.7 **V. Michel** How Mathematics can Help to Observe Climate Change – An Example.	
17:30	S05.7 **J. Merker** Very weak solutions of Poisson's equation with singular data under Neumann boundary…		S04.6 **L. L. Cristea** Distances on Sierpiński graphs and on the Sierpiński gasket.
17:45		M3.8 **G. Regensburger** Generalized mass action systems and Birch's theorem.	
18:00	S05.8 **I. Dražić** The existence theorems for 3-D flow of a compressible viscous micropolar fluid with spherical symmetry.		S04.7 **E. Hertel** Reguläre Dreieckpflasterung konvexer Polygone.
18:15			

Tuesday, September 24, Afternoon Session, Tracks 4–6

	Room E	Room F	Room G
	S10: History, Teaching and Popularization of Mathematics (part 2)	**S08: Stochastics and Applications (part 3)**	**S03: Number Theory (part 3)**
15:30			S03.6 **J. Kalpokas** Value distribution of the Riemann Zeta function on the critical line.
15:45			
16:00			S03.7 **T. Ernst** On the convergence regions for multiple q-hypergeometric functions.
16:15			
16:30		S08.7 **U. Pofahl** Using B-splines for the de-trending of tree-ring series.	S03.8 **H. Knospe** Nonstandard Analysis for Measures with Values in non-Archimedean Fields.
16:45			
17:00	S10.7 **A. Handwerk** What does a biography tell about mathematics? Reflecting on our documentary work with Yuri Manin.	S08.8 **D. Rajter-Ćirić** Viscoelastic rod with random excitation.	S03.9 **D. C. Mayer** 3-class field towers of exact length 3.
17:15			
17:30		S08.9 **T. Fetz** Limit state functions and parameter-depending uncertainty described by sets of probability measures.	S03.10 **J. Steuding** One Hundred Years Uniform Distribution Modulo One and Recent Applications to Riemann's Zeta-Function.
17:45			
18:00		S08.10 **R. Viertl** Fuzzy Probability Distributions in Bayesian Inference.	S03.11 **N. J. A. Sloane** Solved and Unsolved Problems From The On-Line Encyclopedia of Integer Sequences.
18:15			

Tuesday, September 24, Afternoon Session, Tracks 7–9

	Room SR1	Room SR2	Room HS 10
	S06: Functional Analysis, Real and Complex Analysis (part 3) **S07: Numerical Analysis and Scientific Computing (part 1)**	**M5: Operator Theory (part 2)**	**M6: Problems in Information and Communication in Mathematics (part 1)**
15:30 – 15:45	S06.9 **H. G. Feichtinger** Distribution Theory based on Time-Frequency Analysis.	M5.3 **G. Teschl** Singular Weyl-Titchmarsh-Kodaira theory for Schrödinger operators with applications	M6.1 **P. Birken** Anyone can edit Wikipedia - Ansprüche und Arbeitsweise eines (mathematischen) Content Providers.
16:00 – 16:15	S06.10 **M. Pap** Rational analytic wavelets and applications.	M5.4 **C. Seifert** On the absolutely continuous spectrum for the Kirchhoff Laplacian on radial trees.	M6.2 **O. Teschke** Neues vom Zentralblatt MATH mehr als neue Kleider.
16:30 – 16:45		M5.5 **P. Yuditskii** Kotani-Last problem and Hardy spaces on surfaces of Widom type.	M6.3 **B. Eröcal** Reproducibility, software in experimental mathematics and lmonade.
17:00 – 17:15	S07.1 **R. Pulch** Model order reduction for dynamical systems with random parameters.	M5.6 **M. Langer** Essential spectrum of block operator matrices.	M6.4 **S. Bönisch** swMATH - ein neuer Informationsdienst für mathematische Software (I): Konzept.
17:30 – 17:45		M5.7 **C. Trunk** Variational principles for self-adjoint operator functions arising from second order systems.	M6.5 **H. Chrapary** swMATH - ein neuer Informationsdienst für mathematische Software (II): Demo.
18:00 – 18:15	S07.2 **W. Auzinger** Local error structures and order conditions for exponential splitting methods.		M6.6 **M. Jost** Electronic Library of Mathematics (ELibM) in EMIS: Ein Update.

Wednesday, September 25, Morning Session, Tracks 1–3

	Room B	Room C	Room D
	S05: Differential Equations and Applications (part 4)	**S09: Mathematics in the Sciences and Technology (part 1)**	**S04: Geometry and Topology (part 3)**
10:15 – 10:30	S05.9 **E. Emmrich** Nonlinear evolution equations of second order with damping: existence and discretisation.	S09.1 **A. Arnold** Some polymeric fluid flow models: steady states & large-time convergence.	S04.8 **C. Scheiderer** Recent interaction between real and convex algebraic geometry.
10:45 – 11:00		S09.2 **K. Fellner** Mixed Volume-Surface Reaction-Diffusion Systems Describing Asymmetric Protein Localisation..	
11:15 – 11:30	S05.10 **H. Vogt** Large time behaviour of heat kernels and admissible potentials.	S09.3 **R. Eberle** Influence of ski boot and ski tail properties on ACL forces during a landing movement in…	S04.9 **G. Helmberg** Die Eisenstein-Parkettierung der komplexen Ebene.
11:45 – 12:00	S05.11 **B.-V. Matioc** Self-similarity for the thin film Muskat problem.	S09.4 **M.-T. Wolfram** Mean field game and optimal control approaches modeling pedestrian dynamics.	S04.10 **T. de Wolff** Roots of Trinomials from the Viewpoint of Amoeba Theory.
12:15 – 12:30	S05.12 **M. Nedeljkov** A class of non-classical solutions to multidimensional isentropic gas dynamics model.	S09.5 **E.-S. El-Hady** A two-variable functional equation describing a network system.	S04.11 **B. Strodthoff** Computing Layered Reeb Graphs from Boundary Representations.

Wednesday, September 25, Morning Session, Tracks 4–6

	Room E	Room F	Room G
	M7: Spezifika der math. Anfangsausbildung für Lehramtsstudierende (part 2)	**S08: Stochastics and Applications (part 4)**	**S03: Number Theory (part 4)**
10:15	M7.2 **R. Fischer** PädagogInnenbildung NEU: Die Reform der LehrerInnenbildung in Österreich.	S08.11 **E. Teufl** Uniform spanning trees on Sierpiński graphs.	S03.12 **L. Kühne** Topics around the abc-conjecture.
10:30			
10:45		S08.12 **M. Szölgyényi** Existence of Solutions of a Class of SDEs Corresponding to Threshold Dividend Strategies…	
11:00	M7.3 **B. Thaller** Erfahrungen aus einem…		
11:15	M7.4 **F. Pauer** Eine Vorlesung für fünf…	S08.13 **L. Metzner** A Signbased NARCH-Approach for Time Series in Finance.	S03.13 **F. Barroero** Counting lattice points and o-minimal structures.
11:30	M7.5 **C. Ableitinger** Lehramtsspezifische…		
11:45	M7.6 **R. Steinbauer** Zur Analysis-Ausbildung…	S08.14 **C. Pfeifer** Probability distribution on the median taken on partial sums of a simple random walk.	S03.14 **C. Frei** Rational points on some del Pezzo surfaces over imaginary quadratic fields.
12:00	M7.7 **R. Winkler** Erfahrungen aus…		
12:15	M7.8 **General Discussion**	S08.15 **R. Grübel** Combinatorial Markov chains.	S03.15 **T. Riedel** Picard-Shimura class fields corresponding to a family of hyperelliptic curves.
12:30			

Wednesday, September 25, Morning Session, Tracks 7–9

	Room SR1	Room SR2	Room HS 10
	S07: Numerical Analysis and Scientific Computing (part 2)	**M5: Operator Theory (part 3)**	
10:15	S07.3 **G. Unger** Boundary element methods for resonance problems.	M5.8 **K. Gröchenig** Differential seminorms, approximation algebras, and spectral invariance.	
10:30			
10:45		M5.9 **M. Seidel** Quasi-banded operators, convolutions and their finite sections.	
11:00			
11:15	S07.4 **H. Mena** On the LQR Problem and the associated Differential Riccati Equations.	M5.10 **N. Vasilevski** Commutative algebras of Toeplitz operators on the Bergman space.	
11:30			
11:45	S07.5 **K. Hornik** Amos-Type Bounds for Modified Bessel Function Ratios.	M5.11 **W. Bauer** Commutative Algebras generated by Toeplitz operators: structural results and applications.	
12:00			
12:15	S07.6 **P. Kandolf** Interpolation of matrix functions at Leja points.	M5.12 **D. Agbor** Product of Toeplitz operators on the Fock space.	
12:30			

Thursday, September 26, Morning Session, Tracks 1–3

	Room B	Room C	Room D
	S05: Differential Equations and Applications (part 5)	**S09: Mathematics in the Sciences and Technology (part 2)**	**S04: Geometry and Topology (part 4)**
10:15	S05.13 **G. Teschl** Peakon asymptotics for the dispersionless Camassa-Holm equation.	S09.6 **V. Bach** G, P, Q Representability Conditions and Correlation Estimates in Quantum Chemistry.	S04.12 **M. Spirova** A discrete gradient-method approach to the Fermat-Torricelli problem.
10:30			
10:45		S09.7 **M. Kowalewski** An efficient interpolation scheme for molecular potential energy surfaces.	S04.13 **P. Giordano** Theory of infinetely near points in smooth manifolds: the Fermat functor.
11:00			
11:15	S05.14 **A. Mikikits-Leitner** Periodic KdV solutions on FPU chains: existence and higher order asymptotics.	S09.8 **S. Menz** Hybrid Stochastic-Deterministic Solution of the Chemical Master Equation.	S04.14 **C. Richter** Illuminating and covering convex bodies.
11:30			
11:45	S05.15 **J. Rottmann-Matthes** Finding eigenvalues of differential operators on unbounded domains…	S09.9 **D. Matthes** Higher order parabolic equations for electron transport.	S04.15 **R. Steinbauer** The exponential map of a $C^{1,1}$-metric.
12:00			
12:15	S05.16 **F. Achleitner** Traveling wave solutions in scalar conservation laws with anomalous diffusion.	S09.10 **P. Shpartko** Drift-Diffusion model for spin-polarized electron transport in semiconductors.	S04.16 **R. Frank** Central Projections and Their Matrices.
12:30			

Thursday, September 26, Morning Session, Tracks 4–6

	Room E	Room F	Room G
	S02: Discrete Mathematics Theoretical Computer Science (part 1)	**S08: Stochastics and Applications (part 5)**	**S03: Number Theory (part 5)**
10:15	S02.1 **M. Kang** Phase transitions in random graph processes.	S08.16 **M. Grothaus** Scaling limit of interface models.	S03.16 **J. M. Thuswaldner** *S*-adic words, Rauzy fractals, and torus rotations.
10:30			
10:45		S08.17 **C. Geiss** Forward backward stochastic differential equations driven by Lévy noise: discretization.	
11:00			
11:15	S02.2 **E. Candellero** Clustering Phenomenon in Random Geometric Graphs on Hyperbolic Spaces.	S08.18 **P. Ruffino** An averaging principle for diffusions in foliated spaces.	S03.17 **C. Ambrose** Average behaviour of index and order in certain families of finite abelian groups.
11:30			
11:45	S02.3 **D. Vu** Cops and robbers on the n-dimensional torus.	S08.19 **T. Levajković** Malliavin type equations on a white noise probability space.	S03.18 **D. Balakci** Spectraldecomposition of GL_3 automorphic forms for the congruence subgroup $\Gamma_0(N)$.
12:00			
12:15	S02.4 **D. Krenn** The Width of "Canonical" Trees and of Acyclic Digraphs.	S08.20 **A. Jamneshan** Conditional set theory on L^0 and the representation of conditional preferences.	
12:30			

Thursday, September 26, Morning Session, Tracks 7–9

	Room SR1	Room SR2	Room HS 10
	S07: Numerical Analysis and Scientific Computing (part 3)		**M6: Problems in Information and Communication in Mathematics (part 2)**
10:15	S07.7 **W. Wendland** Potential methods for Stokes and semilinear Brinkman systems on Lipschitz domains.		M6.7 **M. Kohlhase** Mathematische Formelsuche - Ansatz und Prototyp.
10:30			
10:45	S07.8 **M. Wirz** Edge detection approaches in numerical methods for conservation laws.		M6.8 **N. Roy** Named Entities in der Mathematik: Identifizierung von Personen.
11:00			
11:15	S07.9 **L. Diening** Instance optimality for the maximum strategy.		M6.9 **S. Barthel** Automatische Klassifizierung mathematischer Dokumente.
11:30			
11:45	S07.10 **O. Steinbach** An energy space approach for the Cauchy problem.		M6.10 **U. Schöneberg** Textanalyse mathematischer Publikationen.
12:00			
12:15			M6.11 **M. Kohlhase** MathMap - ein interaktiver Spaziergang durch die Mathematik.
12:30			

Thursday, September 26, Afternoon Session, Tracks 1–3

	Room B	Room C	Room D
	S05: Differential Equations and Applications (part 6)	**S09: Mathematics in the Sciences and Technology (part 3)**	**S04: Geometry and Topology (part 5)**
15:30 – 15:45	S05.17 **P. Berglez** Zur Darstellung bikomplex-pseudoanalytischer Funktionen durch Integro-Differentialoperatoren.	S09.11 **G. Spielberger** ARMA processes in Structural Health Monitoring.	S04.17 **A. Zastrow** The comparison of topologies related to various concepts of generalized covering spaces.
16:00 – 16:15	S05.18 **K. Fellner** Oscillatory Solutions of Non-local Models of Cell Aggregation.	S09.12 **B. Harrach** Inverse coefficient problems and shape reconstruction.	S04.18 **J. Böhm** On a Coxeter Theorem.
16:30 – 16:45		S09.13 **C. Hartmann** Optimal control of multiscale diffusions.	S04.19 **M. Lederer** A K_T-deformation of the ring of symmetric functions.
17:00 – 17:15	S05.19 **A. D. Rendall** Dynamical properties of models for the Calvin cycle.		S04.20 **L. Wimmer** Questions Concerning Quadrilaterals in the Plane and on the Sphere.
17:30 – 17:45	S05.20 **P. Szmolyan** Multiple time scale dynamics in chemical systems.		S04.21 **P. Stadler** Curve shortening by short rulers.

Thursday, September 26, Afternoon Session, Tracks 4–6

	Room E	Room F	Room G
	S02: Discrete Mathematics Theoretical Computer Science (part 2)	**M4: Numbers, Graphs, Algebraic Structures and Probability (part 2)**	**M2: Frames, High-dimensional Data Analysis, and Dimension Reduction**
15:30	S02.5 **R. Thiemann** Certification of Termination Proofs.	M4.5 **D. Kreso** Invariants of Polynomial Decomposition.	M2.1 **G. Kutyniok** Optimal Compressive Imaging of Fourier Data.
15:45			
16:00		M4.6 **M. Minervino** Fractals arising from numeration and substitutions.	M2.2 **P. Balazs** An operator theory approach to irregular frames of translates.
16:15			
16:30	S02.6 **A. Panholzer** Analysis of strategies for the hiring problem.	M4.7 **D. Smertnig** Non-unique factorizations in maximal orders in central simple algebras.	M2.3 **D. Stoeva** Frames, dual sequences, and frame multipliers.
16:45			
17:00	S02.7 **B. Gittenberger** Enumeration of generalized *BCI* lambda-terms.	M4.8 **M. Weitzer** Shift Radix Systems - new characterization results and topological properties.	M2.4 **R. Balan** Multi-window Gabor frames in Amalgam Spaces.
17:15			
17:30	S02.8 **M. Zeiner** The Effect of Forgetting on the Performance of a Synchronizer.	M4.9 **E. Sava-Huss** Rotor-Router Walks.	M2.5 **G. Pfander** Estimation of stochastic operators with compactly supported scattering functions.
17:45			

Thursday, September 26, Afternoon Session, Tracks 7–9

	Room SR1	Room SR2	Room HS 10
	S07: Numerical Analysis and Scientific Computing (part 4)		
15:30	S07.11 **K. Chudej** Optimal Control of Load Changes for Molten Carbonate Fuel Cells.		
15:45			
16:00	S07.12 **O. Koch** Fully Discrete Splitting Methods for Rotating Bose-Einstein Condensates.		
16:15			
16:30	S07.13 **N. Krejić** Inexact Restoration approach for minimization with inexact evaluation of the objective function.		
16:45			
17:00	S07.14 **N. Krklec Jerinkić** Nonmonotone line search methods with variable sample size.		
17:15			
17:30			
17:45			

ABSTRACTS OF PLENARY LECTURES, SECTIONS AND MINISYMPOSIA

Plenary Speakers

Mathias Beiglböck (Wien, ÖMG Award Winner 2012)
Ernst Hairer (Genf)
Gitta Kutyniok (Berlin, Noether Lecturer)
Michael Lacey (Atlanta)
Franz Schuster (Wien, ÖMG Award Winner 2013)
Catharina Stroppel (Bonn)
Michael Struwe (Zürich, Cantor Laureate)
Endre Szemerédi (New Jersey)
Josef Teichmann (Zürich)
Cédric Villani (Lyon and Paris)
Umberto Zannier (Pisa)

P.8
TUE
15:30
I
16:30
B

Optimal Transport, Martingales, and Model-Independence
Mathias Beiglböck (Bonn/Wien)

We will explain a recently discovered connection between Optimal Transport and the areas of model independence / martingale inequalities in probability. This link has a number of fruitful consequences. For instance, the duality theorem from optimal transport leads to new super-replication results. Optimality criteria from the theory of mass transport can be translated to the martingale setup and allow to characterize minimizing/maximizing models in finance. Moreover, the transport viewpoint provides new insights to the classical inequalities of Doob / Burkholder-Davis-Gundy and Skorokhod embedding problem.

P.2
MON
11:15
I
12:15
B

Long-term control of oscillations in differential equations
Ernst Hairer (Section de mathématiques, Université de Genève)

Two different types of oscillations will be considered in this talk. The first type arises when Hamiltonian differential equations are discretized with linear multistep methods. One obtains so-called numerical or artificial oscillations which are due to the presence of parasitic terms in the numerical approximation. The second type of oscillations is inherent in highly oscillatory differential equations. It arises in model problems for molecular dynamics which often are nonlinear perturbations of harmonic oscillators. In both situations, the control of the oscillations over very long time intervals is the essential ingredient for getting insight into the long-time behavior of the solution.

We show that certain symmetric multistep methods, when applied to second order Hamiltonian systems, behave very similar to symplectic one-step methods (excellent long-time energy-preservation, near-preservation of angular momentum, linear error growth for nearly integrable systems). On the other hand, for multi-scale systems where harmonic oscillators with several high frequencies are coupled to a slow system, near-preservation of the oscillatory energy over long times is shown without any non-resonance condition.

For the proof of these results the technique of modulated Fourier expansions is used. The remarkable fact is that the same ideas that permit to prove the near-preservation of the total oscillatory energy in multi-scale Hamiltonian systems, can also be applied to get insight into the long-time behavior of numerical solutions obtained by symmetric linear multistep methods.

The presented results have been obtained in collaboration with Christian Lubich, David Cohen, Ludwig Gauckler, and Paola Console. An elaboration of the talk will be published in ‘Internat. Math. Nachrichten’.

Parabolic Molecules: Curvelets, Shearlets, and beyond

Gitta Kutyniok (Technische Universität Berlin)

P.6
TUE
10:15
I
11:15
B

Anisotropic representation systems such as curvelets and shearlets have had a significant impact on applied mathematics in the last decade. The main reason for their success is their superior ability to optimally resolve anisotropic structures such as singularities concentrated on lower dimensional embedded manifolds, for instance, edges in images or shock fronts in solutions of transport dominated equations. By now, a large variety of such anisotropic systems has been introduced, among which we mention second generation curvelets, bandlimited shearlets, and compactly supported shearlets, all based on a parabolic dilation operation. These systems share similar approximation properties, which is usually proven on a case-by-case basis for each different construction.

In this talk we will first provide an introduction to shearlets and discuss their sparse approximation properties. Based on this, we will then introduce the novel concept of parabolic molecules which allows for a unified framework encompassing all known anisotropic frame constructions based on parabolic scaling. The main result essentially states that all such systems share similar approximation properties. One consequence we will discuss is that at once all the desirable approximation properties of shearlets can be deduced for virtually any other system based on parabolic scaling.

The Two Weight Inequality for the Hilbert Transform

Michael Lacey (Atlanta)

P.5
TUE
8:45
I
9:45
B

The individual two weight inequality for the Hilbert transform asks for a real variable characterization of those pairs of weights (u, v) for which the Hilbert transform H maps $L^2(u)$ to $L^2(v)$. This question arises naturally in different settings, most famously in work of Sarason. Answering in the positive a deep conjecture of Nazarov-Treil-Volberg, the mapping property of the Hilbert transform is characterized by a triple of conditions, the first being a two-weight Poisson A2 on the pair of weights, with a pair of so-called testing inequalities, uniform over all intervals. This is the first result of this type for a singular integral operator. (Joint work with Sawyer, C.-Y. Shen and Uriate-Tuero)

P.4
MON
15:30
I
16:30
B

The Theory of Valuations and What It Can Do for You!

Franz Schuster (Vienna University of Technology)

A function ϕ defined on convex (or more general) compact sets in $\mathbb{R}^n$ and taking values in an Abelian semigroup is called a *valuation* if

$$\phi(K)+\phi(L)=\phi(K\cup L)+\phi(K\cap L)$$

whenever $K\cup L$ is convex. The theory of valuations on convex sets is a classical part of (convex) geometry with traditionally strong relations to integral geometry. However, there have been dynamic developments in the last 15 years that have led to enormous progress both conceptual and technical. Even the notion of valuation itself has evolved in different directions (e.g. *finitely additive* smooth functionals on smooth manifolds or operators on function spaces) and the ties of valuation theory to other areas of pure and applied mathematics have become much more diverse.

The purpose of this talk is to give a survey on the recent developments in the theory of valuations and the new connections to other branches of mathematics, like differential geometry, harmonic analysis, and the theory of isoperimetric and analytic inequalities. To be more specific, we discuss very recent *classifications of affine invariant notions of surface area* by Ludwig, Reitzner and Haberl, Parapatits, we explain how the breakthrough in the structure theory of continuous translation invariant valuations has led to what is now called *algebraic integral geometry*, and we present *new geometric inequalities* for convex body valued valuations which strengthen several classical isoperimetric and analytic inequalities. The latter results also build a bridge to harmonic analysis as these valuations are closely related to Radon, cosine, and other convolution transforms.

P.7
TUE
14:00
I
15:00
B

Knot invariants and the idea of categorification

Catharina Stroppel (Universität Bonn)

Finding good invariants of knots, braids and links is an old classical problem in mathematics with many different approaches and answers. Starting from polynomial invariants like the Jones and Alexander polynomial the talk will explain the role of quantum invariants and the recently developed idea of link homology. The classical invariants get hereby turned into Poincare-Hilbert polynomials, graded dimension formulas, Euler characteristics etc. In this way new and finer invariants can be obtained. Behind these constructions is the general idea of "categorification", a new concept initiated by Crane and Frenkel around 2000. This concept is a powerful machinery which was in the last years used in algebra, representation theory, algebraic and symplectic geometry to obtain unexpected new results and new connections. The talk will present some basic constructions of this concept.

Conformal metrics of prescribed Gauss curvature on surfaces of higher genus

P.1
MON
9:45
I
10:45
B

Michael Struwe (ETH Zürich)

Given a Riemann surface (M, g_0), viewed as a two-dimensional Riemannian manifold with background metric g_0, a classical problem in differential geometry is to determine what smooth functions f on M arise as the Gauss curvature of a conformal metric on M and whether this metric is uniquely determined by f. Focussing on the case when (M, g_0) is closed and has genus greater than 1, I will present recent multiplicity results for sign-changing functions f obtained jointly with F. Borer and L. Galimberti.

The exact solution of the Erdös - T. Sós conjecture

P.10
THU
8:45
I
9:45
B

Endre Szemerédi (Hungarian Academy of Sciences and Rutgers University)

The Erdös-T. Sós conjecture: If T_k is a fixed tree of k vertices, then every graph G_n of n vertices, and

$$e(G_n) < \frac{1}{2}(k-2)n$$

edges contains T_k.

Our main result is that if k is sufficiently large then the conjecture is true. One of the difficulties in proving this conjecture is that it would be natural to apply the Regularity Lemma, however in the sparse case, i.e. when $n >> k$ one has to use some more involved approach. We shall sketch how to prove the conjecture in the dense case and how the sparse case can be handled, how to decompose the vertex set of G_n and T_k so that the most difficult case becomes very similar to the sense case $(n = O(k))$.

Our approach will be first to prove a 'weakened' version of the conjecture and then using a series of combinatorial lemmas we will prove the conjecture. Unfortunately the proof is quite long and involved.

This is a joint work with M. Ajtai, J. Komlós and M. Simonovits.

P.3
MON
14:00
I
15:00
B

Stochastic Evolutions of Term structures

Josef Teichmann (ETH Zürich)

Common term structures in financial markets are volatility surfaces, or maturity dependent interest rates. Their stochastic evolution from day to day is hard to model beyond the restricted world of factor models. We introduce, discuss and solve a stochastic partial differential equation which describes in theory and common practice the time evolution of term structures.

Common term structures in financial markets are volatility surfaces, or maturity dependent interest rates. Their stochastic evolution from day to day is hard to model beyond the restricted world of factor models. We introduce, discuss and solve a stochastic partial differential equation which describes in theory and common practice the time evolution of term structures.

P.11
THU
14:00
I
15:00
B

On triangles, gases, prices and men

Cédric Villani (École normale supérieure de Lyon, Institut Henri Poincaré)

This talk is the story of an encounter of three distinct fields: non-Euclidean geometry, gas dynamics and economics. Some of the most fundamental mathematical tools behind these theories appear to have a close connection, which was revealed around the turn of the 21st century, and has developed strikingly since.

P.9
WED
8:45
I
9:45
B

On Pell Equations in Polynomials and Unlikely Intersections

Umberto Zannier (University of Pisa)

The classical Pell Equation has a variant for polynomial rings, studied already by Abel. In the talk we shall survey on this context and present some recent results (obtained jointly with D. Masser), proving finiteness for the solvable Pell Equations when the discriminant varies in a pencil. This is linked with a conjecture of R. Pink in the realm of Unlikely Intersections.

Section S01

Algebra, Logic and Set Theory

Martin Goldstern (Wien)
Heike Mildenberger (Freiburg)

S01.1
MON
15:30
I
16:00
HS 10

Eventually periodic and almost linear periodic matrices over quasi-max-plus algebras

Horst Brunotte

In an effort to extend a classical characterization of primitive matrices with real nonnegative coefficients to matrices with polynomial entries S. AKIYAMA and the author [1] recently introduced a new commutative dioid over the integers. A variant of this dioid, namely a so-called quasi-max-plus algebra [2], is presented here, and some periodicity properties of power sequences of square matrices over a quasi-max-plus algebra are studied. Thereby well-known results of M. GAVALEC [3] and M. MOLNÁROVÁ [4] on matrices over a max-plus algebra are generalized.

[1] S. Akiyama, H. Brunotte, *Primitive matrices over polynomial semirings*, Linear Algebra Appl., 436 (2012), 3568–3596.
[2] H. Brunotte, *Periodicity and eigenvalues of matrices over quasi-max-plus algebras*, Tsukuba J. Math., 37 (2013), 51–71.
[3] M. Gavalec, *Linear matrix period in max-plus algebra*, Linear Algebra Appl., 307 (2000), 167–182.
[4] M. Molnárová, *Generalized matrix period in max-plus algebra*, Linear Algebra Appl., 404 (2005), 345–366.

S01.2
MON
16:00
I
16:30
HS 10

Gamma Invariants and the Torsion-Freeness of Ext

Stefan Friedenberg* (Universität Duisburg-Essen)
Ulrich Albrecht (Auburn University, AL)

Ascending chains of subgroups have always been an essential tool in the study of infinite Abelian groups. This was further emphasized by Shelah's solution of the Whitehead problem and a series of related papers concerning the invariants of the divisible group $\mathrm{Ext}(A,B)$ in the case that A and B are torsion-free Abelian groups. In particular, either $\mathrm{Ext}(A,B)=0$ or $r_0(\mathrm{Ext}(A,B))=2^{\aleph_0}$ if A and B are countable. On the other hand, the Ext-group may be torsion-free without vanishing.

To simplify our notation, we denote the class of all torsion-free Abelian groups A such that $\mathrm{Ext}(A,B)=0$ by ${}^\perp B$, while ${}^* B$ consists of the groups A for which $\mathrm{Ext}(A,B)$ is torsion-free. Clearly, ${}^\perp B \subseteq {}^* B$. Moreover, since ${}^\perp B$ was successfully investigated using Eklof's Γ-invariants, it can be expected that these invariants play a similar role in the apparently related discussion of ${}^* B$. One of the consequences of our discussion is the surprising fact that this is not the case.

Near Abelian Locally Compact Groups

S01.3
MON
16:30
I
17:00
HS 10

Wolfgang Herfort⋆ (TU Wien)
Karl H. Hofmann (Darmstadt und Tulane U)
Francesco G. Russo (Palermo und IMPA Brazil)

A locally compact group is *near abelian* provided it contains a closed abelian normal subgroup A and a closed subgroup B all of whose topologically finitely generated subgroups are monothetic such that $G = AB$. We shall provide structure theorems and indicate how this can be used for classifying topologically quasihamiltonian groups. Groups with this property have been studied by Iwasawa in the 40s, later by Kümmich and Mukhin, and recently by the second and third author.

Associative formal power series in two indeterminates

S01.4
MON
17:00
I
17:30
HS 10

Jörg Tomaschek⋆ (University of Luxembourg)
Harald Fripertinger (Karl-Franzens-Universität Graz)
Ludwig Reich (Karl-Franzens-Universität Graz)
Jens Schwaiger (Karl-Franzens-Universität Graz)

The classical examples of associative formal power series are formal group laws. A one dimensional formal group law over a ring $\mathbb{A}$ is a formal power series F, $F \in \mathbb{A}[\![X,Y]\!]$ in two indeterminates of order one, such that

$$F(X,Y) = X + Y + \sum_{\alpha+\beta\geq 2} a_{\alpha,\beta} X^{\alpha} Y^{\beta}$$

and the associativity equation

$$F(F(X,Y),Z) = F(X,F(Y,Z))$$

holds, see [2]. One dimensional formal group laws as well as associative polynomials, see [3], and associative rational functions, see [1], are completely described.

For a commutative field $\mathbb{K}$ we characterize all formal power series $F \in \mathbb{K}[\![X,Y]\!]$ of arbitrary order which are associative.

[1] A. Chéritat, *Fractions rationelles associatives et corps quadratiques*, Revue des Mathématiques de l'Enseignement Superieur, 109 (1998-1999) 1025–1040.
[2] M. Hazewinkel, *Formal Groups and Applications*, Acad. Press, New York and London, 1978.
[3] J.-L. Marichal, P. Mathonet, *A description of n-ary semigroups polynomial-derived from integral domains*, Semigroup Forum 83(2) (2011) 241–249.

S01.5
MON
17:30
I
18:00
HS 10

Arithmetic and Polynomials over Fuzzy Rings

Walter Wenzel (Erlangen)

Fuzzy Rings, which are a generalization of unitary rings, were originally introduced by A.W. M. Dress. They play an important role by unifying several branches of matroid theory, particularly representable, oriented, and valuated matroids. Additionally, these fuzzy rings serve to unify classical Algebraic Geometry as well as the relatively new field of Tropical Geometry.

For these reasons, the fuzzy rings deserve a deeper study. In the talk, polynomials over fuzzy rings will be studied, and sufficient conditions are established under which these polynomials define again a fuzzy ring. To derive these results, a theorem concerning ideals in an ordinary ring R and leading coefficients of polynomials over R – in arbitrarily many variables – is of great importance.

S01.6
MON
18:00
I
18:30
HS 10

Testing for classicality of a physical system

Dietmar Dorninger (Vienna University of Technology)

Often quantum logics are algebraically modelled by orthomodular posets. The physical system described by such a quantum logic is classical if and only if the corresponding orthomodular poset is a Boolean algebra. We provide an easy testing procedure for this case. Moreover, we characterize orthomodular posets which are lattices and consider orthomodular posets which admit a full set of states and hence represent so-called spaces of numerical events. This way further test procedures are obtained.

[1] D. Dorninger and H. Länger, *Testing for Classicality of a Physical System*, Int. J. Theor. Phys., 52(4) (2013) 1141–1147.

Ideal Objects for Finite Methods in Algebra

S01.7
TUE
11:15
|
11:45
HS 10

Peter Schuster (University of Leeds)

Somewhat miraculously, transfinite methods do work in algebra for quite a few theorems of a fairly finite nature, with the corresponding ideal objects typically turning up towards a contradiction. We aim at reducing transfinite to finite methods, and thus at exhibiting the computational content of ideal objects. First case studies have proved successful in the ideal theory of commutative rings [2] and more specifically Banach algebras [1]. In a nutshell, several theorems that admit short and elegant proofs by contradiction but with Zorn's Lemma have turned out to follow in a direct way from Raoult's Open Induction. If moreover the theorem has input data of a sufficiently finite character, then a finite partial order carries the required instance of induction; whence one can get by with mathematical induction only.

This partially is joint work with F. Ciraulo, N. Gambino, M. Hendtlass, D. Rinaldi.

[1] Hendtlass, M., Schuster, P., A direct proof of Wiener's theorem. In S.B. Cooper et al. (Eds.), *How the World Computes.* Turing Centenary Conference and Eighth Conference on Computability in Europe. Proceedings, CiE 2012, Cambridge, UK, June 2012. Berlin, Heidelberg: Springer, *Lecture Notes in Computer Science* 7318 (2012), 294–303.

[2] Schuster, P., Induction in algebra: a first case study. In *2012 27th Annual ACM/IEEE Symposium on Logic in Computer Science.* Proceedings, LICS 2012, Dubrovnik, Croatia, June 2012. IEEE Computer Society Publications (2012), 581–585

On intervals of partial clones

S01.8
TUE
11:45
|
12:15
HS 10

Karsten Schölzel (Université du Luxembourg)

A partial clone on a set A is a set of partial functions $f : S \to A$ with $S \subseteq A^n$ and $n \geq 1$, which is closed under function composition and containing the projections.

We present recent work on the lattice of partial clones on a finite set A. Two problems of intervals will be handled here:

- Let C be a total clone on A. Describe the interval $I(C)$ of all partial clones X such that the total part of X is equal to C. For the Boolean case this is shown to be either finite (where the set $I(C)$ is completely described), or it has continuum cardinality.

- Let C_1, C_2 be two partial clones on A with $C_1 \subseteq C_2$. Describe the interval $[C_1, C_2]$ of all partial clones X with $C_1 \subseteq X \subseteq C_2$. For each A with $|A| \geq 2$ we give examples of countably infinite intervals of this type.

Section S02

Discrete Mathematics and Theoretical Computer Science

Aart Middeldorp (Innsbruck)
Tibor Szabó (Berlin)

S02.1
THU
10:15
I
11:15
E

Phase transitions in random graph processes

Mihyun Kang (TU Graz)

The phase transition is a fascinating phenomenon observed in mathematics and natural sciences in many different contexts. It deals with a sudden change in the properties of an asymptotically large structure by altering critical parameters. The phase transition in random graphs refers to a phenomenon that there is a critical edge density, to which adding a small amount results in a drastic change of the size and structure of the largest component. In the Erdős and Rényi random graph process, which begins with an empty graph on n vertices and edges are added randomly one at a time to a graph, a phase transition takes place when the number of edges reaches $n/2$ and a giant component emerges. Since this seminal work of Erdős and Rényi, various random graph processes have been introduced and studied. In this talk we will discuss key techniques to study the size and structure of components of random graph processes, including the classical ordinary differential equations method, partial differential equations, and singularity analysis.

S02.2
THU
11:15
I
11:45
E

Clustering Phenomenon in Random Geometric Graphs on Hyperbolic Spaces

*Elisabetta Candellero** (University of Birmingham)
Nikolaos Fountoulakis (University of Birmingham)

In this talk we introduce the concept of random geometric graphs on hyperbolic spaces, and discuss its applicability as a model for social networks.

Such model has been introduced by Krioukov et al. (see [3]), and several features have been shown for particular choices of the parameters (see [2]); more general results can be found in [1].

Here we discuss issues that are related to clustering, which is a phenomenon that often occurs in social networks: two individuals that have a common friend are somehow more likely to be friends of each other. We give a mathematical expression of this phenomenon and explore how this depends on the parameters of our model.

[1] N. Fountoulakis, On the evolution of random graphs on spaces of negative curvature, preprint (available at `http://arxiv.org/abs/1205.2923`).

[2] L. Gugelmann, K. Panagiotou and U. Peter, Random hyperbolic graphs: degree sequence and clustering, In *Proceedings of the 39th International Colloquium on Automata, Languages and Programming (A. Czumaj et al. Eds.)*, Lecture Notes in Computer Science 7392, pp 573–585.

[3] D. Krioukov, F. Papadopoulos, M. Kitsak, A. Vahdat and M. Boguñá, Hyperbolic Geometry of Complex Networks, *Phys. Rev. E* **82** (2010), 036106.

Cops and robbers on the n-dimensional torus

S02.3
THU
11:45
I
12:15
E

Dominik Vu* (University of Memphis)
Sebastian Koch (University of Cambridge)

The pursuit-evasion game *Cops and Robbers* has enjoyed some attention in both discrete mathematics and theoretical computer science. It concerns a set of cops chasing one or more robbers on a fixed graph. Natural questions to ask are those for the number of cops required to ensure capture in finite time, and for the number of steps required in this case. Previous work both asked these questions for all graphs of fixed order, as well as for certain classes of graphs where bounds may be better due to the underlying structure of the graph. Considering the n-dimensional torus, we determine the number of cops needed in order to capture a single robber and give bounds on the capture time.

The Width of "Canonical" Trees and of Acyclic Digraphs

S02.4
THU
12:15
I
12:45
E

Daniel Krenn* (TU Graz)
Clemens Heuberger (Alpen-Adria-Universität Klagenfurt)
Stephan Wagner (Stellenbosch University)

This talk is devoted to the analysis of various parameters of trees coming from prefix codes and from a problem in number theory, namely representing 1 as a sum of negative powers of a fixed integer base. Asymptotic results are given, for example mean, variance and a central limit theorem for the height and the total path length, respectively, but the main focus of this talk is on the width of such trees. We calculate the mean and show that the width satisfies a certain concentration property. The same method is then used for analyzing the width of acyclic digraphs.

Certification of Termination Proofs

S02.5
THU
15:30
I
16:30
E

René Thiemann (University of Innsbruck)

In recent years, automated termination tools became significantly more powerful, at the cost of also becoming more complex and error prone. One possible solution to still ensure high reliability of these tools is by using automated certifiers, which validate or reject the generated proofs of these tools. Here, soundness of the certifiers has to be fully proven within some trusted theorem prover like Coq, Isabelle, or PVS.

We give an overview of possible workflows for certification, and present which problems arise during the development. Furthermore, we briefly report on the outcome of using certifiers: several discovered bugs, both in published papers, as well as in current termination tools.

S02.6
THU
16:30
I
17:00
E

Analysis of strategies for the hiring problem

Alois Panholzer (Technische Universität Wien)

The hiring problem is a simple model of on-line decision making under uncertainty, which has been introduced by Broder et al. (2008) as an extension of the famous secretary problem. The employer is here looking for many candidates (e.g., to grow up a small company) rather than only one. The input is a sequence of scores of the candidates and a decision whether to hire or not must be taken for each instance depending on the subsequence examined so far, while nothing is known about the future. Here the goal is to design some hiring strategy to meet the demands of the employer, which essentially are to obtain a good quality staff at a reasonable hiring rate. We provide here an analysis of two hiring strategies, namely "hiring above the median" (where a new candidate is only hired if his score is better than the score of the median of the already hired staff) and "hiring above the m-th best" under the probabilistic model that the sequence of quality scores (i.e., ranks) of the candidates are forming random permutations.

[1] A. Helmi, C. Martínez and A. Panholzer, *Analysis of the strategy "hiring above the m-th best candidate*, submitted.

[2] A. Helmi and A. Panholzer, *Analysis of the "hiring above the median" selection strategy for the hiring problem*, Algorithmica, to appear.

S02.7
THU
17:00
I
17:30
E

Enumeration of generalized *BCI* lambda-terms

Bernhard Gittenberger* (TU Wien)
Olivier Bodini (Université Paris 13)
Danièle Gardy (Université de Versailles)
Alice Jacquot (Université Paris 13)

We study a class of enriched trees which has its origin in lambda terms which correspond to BCI logic where B, C, and I are a certain combinators used in combinatory logic, i.e. certain reduction rules for lambda calculus. Such lambda terms can be viewed as Motzkin trees where each unary node carries exactly one pointer to a leaf. Aiming at counting general lambda terms, where there is no restriction on the number of pointers, we consider the more specific problem with exactly p pointers per unary node. To compute the number $a_n^{(p)}$ of terms of size n we set up functional equations for the generating functions of $a_n^{(p)}$. As $a_n^{(p)}$ grows super-exponentially, these are only formal power series and so analytic methods do not apply. Nevertheless, we show that the functional equation admits a kind of linearisation which enables us to compute $a_n^{(p)}$ asymptotically up to a constant factor.

The Effect of Forgetting on the Performance of a Synchronizer

Martin Zeiner* (TU Wien)
Matthias Függer (TU Wien)
Alexander Kößler (TU Wien)
Thomas Nowak (École polytechnique)
Ulrich Schmid (TU Wien)

S02.8
THU
17:30
I
18:00
E

We study variants of the α-synchronizer by Awerbuch (J. ACM, 1985 – the purpose of synchronizers is to maintain a virtual (discrete) round structure) within a distributed message passing system with probabilistic message loss, i.e., we consider a fully-connected network with n processes. At time 0, every process starts in round 1. In each discrete time step every process sends its round number to all its neighbours, but these messages can get lost with probability $(1-p)$. A successfully transmitted message is stored in the recipient's memory. When a process is in round r and has received messages containing round numbers greater than or equal to r from all its neighbours then it switches to round $(r+1)$. Let $T(r)$ denote the time when the last process switches to round r, then we are interested in $\lambda = \mathbb{E}\lim_{r\to\infty}(T(r)/r)$.

We investigate how four different strategies of forgetting (i.e., resetting the processes' memory to an initial value) affect the performance λ of these synchronizers. These strategies differ in the times when processes discard part of their accumulated knowledge during execution. Such actively forgetting synchronizers have applications, e.g., in sensor fusion where sensor data becomes outdated and thus invalid after a certain amount of time.

Section S03
Number Theory

Jörn Steuding (Würzburg)
Robert Tichy (Graz)

S03.1
MON
16:30
I
17:00
G

The Thue-Morse Sequence Along The Squares is Normal

Michael Drmota* (TU Wien)
Christian Mauduit (Univ. Aix-Marseille)
Joël Rivat (Univ. Aix-Marseille)

The Thue-Morse sequence $T(n)$ is a 0-1-sequence that can be defined by $T(n) = s_2(n) \bmod 2$, where $s_2(n)$ denotes the binary sum-of-digits function of n (that is, the number of powers of 2). By definition it is clear that the letters 0 and 1 appear with the same asymptotic frequency $1/2$, however, there is certainly no consecutive block of the form 000 or 111, that is, the Thue-Morse sequence has surely not normal (actually it has linear complexity).

Recently it was shown by Mauduit and Rivat [2] that the subsequence $T(n^2)$ has the same property, namely that both letter 0 and 1 appear with the same asymptotic frequency $1/2$. This has solved a long standing conjecture by Gelfond [1].

The purpose of this talk is to show that the subsequence $T(n^2)$ is normal, too. This means that every finite 0-1-block appears with the right asymptotic frequency 2^{-k} (if k denotes the length of the block).

The proof is based on Mauduit and Rivat's work [2] but it requires a subtle Fourier analysis of certain periodic terms that appear in a correlation analysis of $s_2(n+\ell d)$, $0 \le \ell < k$.

[1] A.O. Gelfond, *Sur les nombres qui ont des propriétés additives et multiplicatives données*, Acta Arith. 13 (1967/1968) 259–265.

[2] C. Mauduit and J. Rivat, *La somme des chiffres des carrés*, Acta Math. 203(1) (2009) 107–148.

On the b-adic method in u.d. mod 1

S03.2
MON
17:00
I
17:30
G

Peter Hellekalek (Universität Salzburg)

For bases $\mathbf{b} = (b_1, \ldots, b_s)$ of s not necessarily distinct integers $b_i \geq 2$, we prove a version of the inequality of Erdös-Túran-Koksma for the hybrid function system composed of the Walsh functions in base $\mathbf{b}^{(1)} = (b_1, \ldots, b_{s_1})$ and, as second component, the $\mathbf{b}^{(2)}$-adic functions, $\mathbf{b}^{(2)} = (b_{s_1+1}, \ldots, b_s)$, with $s = s_1 + s_2$, s_1 and s_2 not both equal to 0. This type of inequality is relevant for the study of the uniform distribution of so-called hybrid point sets in the s-dimensional unit cube where the components stem from digital sequences of different type. We also address the question why this choice of a hybrid function system covers all possible cases of sequences that employ addition of digit vectors as their main construction principle.

Our technique is based on [1, 2, 3].

[1] P. Hellekalek. A general discrepancy estimate based on p-adic arithmetics. *Acta Arith.*, **139**:117–129, 2009.

[2] P. Hellekalek. Hybrid function systems in the theory of uniform distribution of sequences. In L. Plaskota and H. Woźniakowski, editors, *Monte Carlo and Quasi-Monte Carlo Methods 2010*, volume 25 of *Springer Proceedings in Mathematics and Statistics*, pages 435–449, Berlin, Heidelberg, 2012. Springer.

[3] P. Hellekalek and H. Niederreiter. Constructions of uniformly distributed sequences using the b-adic method. *Unif. Distrib. Theory*, **6**(1):185–200, 2011.

Uniform distribution and dynamical systems

S03.3
MON
17:30
I
18:00
G

Robert Tichy (Technische Universität Graz)

Using the so called von Neumann-Kakutani transformation we obtain a dynamical approach to low discrepancy sequences. By Grabner, Hellekalek, Liardet and others it is well-known that this approach leads to an analysis of van der Corput type sequences from an ergodic point of view. Recently, this approach was extended by Carbone, Iacó and Volčič to numeration systems with linear-recurring base sequences. This again reveals a dynamic system approach for describing the so-called odometer (”addition by 1 machine”). In the first part of the lecture we present an extension to the multidimensional setting. This explains the classical Halton sequences and various analogs for linear-recurring base sequences. The second part of the lecture is devoted to van der Corput sets and sets of recurrence. We give new constructions involving equidistribution of sequences of prime powers. This refines and unifies earlier results obtained by Sárkőzy, Furstenberg, Kamae and Mendés France and Bergelson and Lesigne. The proofs heavily depend on analytic machinery involving bounds for exponential sums.

S03.4
TUE
11:15
I
12:15
G

Uniform bounds for the number of rational points on hyperelliptic curves with small Mordell-Weil rank

Michael Stoll (Universität Bayreuth)

Let K be a number field and let C be a hyperelliptic curve over K of genus g such that the rank of the group of K-points on the Jacobian variety of C is at most $g-3$. We show that there is a bound on the number of K-rational points on C that depends only on the degree of K and on g. The proof is based on the Chabauty-Coleman method, the stable reduction theorem for curves over p-adic fields, and a new bound for the number of rational points in a p-adic 'annulus' contained in the curve.

S03.5
TUE
12:15
I
12:45
G

On the Speiser equivalent for the Riemann hypothesis

Ramūnas Garunkštis (Vilnius University)

Speiser showed that the Riemann hypothesis is equivalent to the absence of non-trivial zeros of the derivative of the Riemann zeta-function left of the critical line. We investigate the relationship between the non-trivial zeros of the extended Selberg class functions and of their derivatives left of the critical line. Every element of this class satisfies a functional equation of Riemann type, but it contains zeta-functions for which the Riemann hypothesis is not true. As an example, we study the relationship between the trajectories of zeros of a certain linear combination of Dirichlet L-functions and of its derivative computationally. In addition, we examine Speiser type equivalent for Dirichlet L-functions with imprimitive characters for which the Riemann hypothesis is not true and which do not satisfy a Riemann type functional equation. This is a joint work with Raivydas Šimėnas.

Value distribution of the Riemann zeta function on the critical line

Justas Kalpokas (Universtät Vilnius)

S03.6
TUE
15:30
I
16:00
G

In [3] Kalpokas and Steuding introduced a method to generalise Gram's points (at Gram's points the Riemann zeta function obtains real values on the critical). The method helps to investigate the values of the Riemann zeta function that appears from the intersection points of a straight line and the curve of the Riemann zeta function.

Recall that $e^{-i\phi}\zeta(\frac{1}{2}+it_n(\phi))$ is real, here $\phi \in [0,\pi)$ and indicates the angle of the straight line (crossing the origin) with the Real line. Hence, we may write $t_n^+(\phi)$ in place of $t_n(\phi)$ if $e^{-i\phi}\zeta(\frac{1}{2}+it_n(\phi)) \geqslant 0$ and $t_n^-(\phi)$ if $e^{-i\phi}\zeta(\frac{1}{2}+it_n(\phi)) < 0$. In [2] Kalpokas, Korolev and Steuding proved the following result.

For any $\phi \in [0,\pi)$, there are arbitrary large positive and negative values of $e^{-i\phi}\zeta(\frac{1}{2}+it_n(\phi))$. More precisely,

$$\max_{0<t_n^{\pm}(\phi)\leqslant T} \left|\zeta(\tfrac{1}{2}+it_n^{\pm}(\phi))\right| \gg (\log T)^{\frac{5}{4}}.$$

If the Riemann hypothesis is assumed then for any arbitrary small $\delta > 0$ we have

$$\max_{0<t_n^{\pm}(\phi)\leqslant T} \left|\zeta(\tfrac{1}{2}+it_n^{\pm}(\phi))\right| \gg (\log T)^{\frac{3}{2}-\delta}.$$

The separate case of the theorem can be stated as "the Riemann zeta function has infinitely many negative values on the critical line and those values are unbounded".

To prove the second part of the stated result (with the Riemann Hypothesis assumption) we used [1].

[1] T. Christ and J. Kalpokas, *Upper bounds for discrete moments of the derivatives of the Riemann zeta-function on the critical line*, Lith. Math. J., 52 (3) (2012) 233–248.

[2] J. Kalpokas, M. Korolev and J. Steuding, *Negative values of the Riemann zeta function on the critical line*, Mathematika, 59 (2) (2013) 443–462.

[3] J. Kalpokas and J. Steuding, *On the Value-Distribution of the Riemann Zeta-Function on the Critical Line*, Mosc. J. Comb. Number Theory, 1 (1) (2011), 26–42.

S03.7
TUE
16:00
I
16:30
G

On the convergence regions for multiple q-hypergeometric functions

Thomas Ernst (Department of Mathematics, Uppsala University)

By using the q-Stirling approximation

$$\Gamma_q(z) \sim \{z\}_q^{z-\frac{1}{2}}, \tag{1}$$

we find most of the convergence regions for 43 q-hypergeometric functions of $2n$ variables by the NOVA q-addition. For $q = 1$ these correspond to a preprint by Per Karlsson 1976.

[1] T. Ernst, *A comprehensive treatment of q-calculus*. Birkhäuser, 2012

[2] T. Ernst, *An umbral approach to find q-analogues of matrix formulas*, Linear Algebra Appl. 439 (2013) 1167–1182.

S03.8
TUE
16:30
I
17:00
G

Nonstandard Analysis for Measures with Values in non-Archimedean Fields

Heiko Knospe (Cologne University of Applied Sciences - Fachhochschule Köln)

The methods of nonstandard analysis are applied to measures with values in a complete non-Archimedean valued field K, e.g. the p-adic numbers $\mathbb{Q}_p$. These measures are studied in the context of p-adic analysis and also play an important role in the construction of p-adic L-functions.
Nonstandard analysis is used to extend measure spaces and to define internal measures with values in an extended field ${}^*K$. The corresponding Loeb measures have again values in K. The standard-part map between a Loeb space and a standard space is investigated and it is shown that Loeb measurable and standard measurable functions can be lifted to internal simple functions. Furthermore, a standard measure space can be described as the push forward of a hyperfinite measure space. This result is the non-Archimedean analogue of a well-known Theorem on hyperfinite representations of Radon spaces. Then standard integrable functions are related to internal S-integrable functions and integrals are represented by hyperfinite sums.

S03.9
TUE
17:00
I
17:30
G

3-class field towers of exact length 3

Daniel C. Mayer* (Naglergasse 53, 8010 Graz)
Michael R. Bush (Washington and Lee University, Lexington, Virginia, USA)
Mike F. Newman (Australian National University, Canberra, ACT)

For an algebraic number field K, let P be the Galois group of the maximal unramified pro-3 extension $\mathrm{F}_3^\infty(K)$, and $G \simeq P/P''$ be the Galois group of the second Hilbert 3-class field $\mathrm{F}_3^2(K)$. If K has 3-class group $\mathrm{Cl}_3(K) \simeq P/P'$ of type $(3,3)$ and the capitulation of K in its unramified cyclic cubic extensions $L_1,\ldots,L_4$ is of type $\varkappa(K) = (2,2,3,1)$, resp. $(1,2,3,1)$, then the 3-class numbers of $L_1,\ldots,L_4$ are $(3^c,27,27,27)$, for some $c \geq 4$, and G is isomorphic to $G_0^{c+1,c+2}(0,0,\pm 1,1)$, resp. $G_0^{c+1,c+2}(1,0,-1,1)$, [2, Thm. 1.3, p. 405], with presentation defined in [2, § 3.3.3, p. 430]. G is a metabelian 3-group of order 3^{c+2} and class c. If K is a complex quadratic field then $c \geq 5$ must be odd [2, § 3.4.2, p. 436] and P must have relation rank $r(P)$ equal to the generator rank $d(P) = 2$ [4, p. 146, eqn. (28)]. Such a group is called *balanced*. Since G has $r(G) > d(G) = 2$, the 3-class field tower of K cannot stop at the second stage. This is the first faultless disproof of the statement $P \simeq G$, claimed by Heider and Schmithals [1, p. 20] in full generality, independently from the value of c, and claimed by Scholz and Taussky [3, p. 41] at least for the particular instance $K = \mathbb{Q}(\sqrt{-9748})$, where $\varkappa(K) = (2,2,3,1)$ and $c = 5$. Furthermore, the 3-tower of K is actually of exact length 3, since the 3-tower group $P = P_{r,c}$ is given as the class-c quotient of $L/S_{r,c}$, where L is an infinite pro-3 group with five generators, whose pro-3 presentation is known explicitly, and $S_{r,c}$ is a closed subgroup generated by two elements, involving the parameter $r \in \{-1,0,1\}$ and the odd exponent $c \geq 5$ in $h_3(L_1) = 3^c$. $P_{r,c}$ is a balanced non-metabelian 3-group of derived length 3, order $3^{(3c+1)/2}$ and class c. The value of r is determined as $r = \pm 1$ for $\varkappa(K) = (2,2,3,1)$, and uniquely as $r = 0$ for $\varkappa(K) = (1,2,3,1)$.

[1] F.-P. Heider und B. Schmithals, *Zur Kapitulation der Idealklassen in unverzweigten primzyklischen Erweiterungen*, J. Reine Angew. Math. **336** (1982), 1–25.

[2] D. C. Mayer, *The distribution of second p-class groups on coclass graphs*, J. Théor. Nombres Bordeaux **25** (2013), no. 2, 401–456.

[3] A. Scholz und O. Taussky, *Die Hauptideale der kubischen Klassenkörper imaginär quadratischer Zahlkörper: ihre rechnerische Bestimmung und ihr Einfluß auf den Klassenkörperturm*, J. Reine Angew. Math. **171** (1934), 19–41.

[4] I. R. Shafarevich, *Extensions with prescribed ramification points*, Publ. Math., Inst. Hautes Études Sci. **18** (1963), 71–95 (Russian). English transl. by J. W. S. Cassels: Am. Math. Soc. Transl., II. Ser., **59** (1966), 128–149.

S03.10
TUE
17:30
I
18:00
G

One Hundred Years Uniform Distribution Modulo One and Recent Applications to Riemann's Zeta-Function

Jörn Steuding (Universität Würzburg)

Uniform distribution modulo one has been founded by Weyl and others around one hundred years ago. We discuss the very beginnings of the development of this theory and present some notes of Adolf Hurwitz from his mathematical diary on this topic. As was shown by Rademacher, Elliott, and Hlawka (more or less independently), the ordinates of the nontrivial zeros of the zeta-function $\zeta(s)$ are uniformly distributed modulo one. We conclude with recent investigations concerning the distribution of the roots of the equation $\zeta(s) = a$, where a is any complex number.

S03.11
TUE
18:00
I
18:30
G

Solved and Unsolved Problems From The On-Line Encyclopedia of Integer Sequences

Neil J. A. Sloane (The OEIS Foundation)

The *On-Line Encyclopedia of Integer Sequences* [4] contains over 200000 sequences. This talk will describe some recent sequences that have given rise to interesting problems, some solved, some unsolved. The subjects include "toothpicks" (cellular automata) [2], "curling numbers" (combinatorics on words) [3], dissections, meanders, "dismal" arithmetic [1], and some unusual recurrences.

[1] D. Applegate, M. LeBrun and N. J. A. Sloane, *Dismal Arithmetic*, J. Integer Sequences, 14 (2011), #11.9.8.

[2] D. Applegate, O. E. Pol and N. J. A. Sloane, *The Toothpick Sequence and Other Sequences from Cellular Automata*, Congress. Numerant., 206 (2010), 157–191.

[3] B. Chaffin, J. P. Linderman, N. J. A. Sloane and A. R. Wilks, *On Curling Numbers of Integer Sequences*, arXiv:1212.6102, 2012.

[4] The OEIS Foundation Inc., *The On-Line Encyclopedia of Integer Sequences*, `http://oeis.org`, 2013.

Topics around the abc-conjecture

S03.12
WED
10:15
I
11:15
G

Lars Kühne (SNS Pisa)

A survey on the abc-conjecture will be given. The strong version of this conjecture can be stated in an elementary way as follows: For each positive real $\varepsilon > 0$ there exists a positive constant $C(\varepsilon)$ such that

$$\max\{|a|,|b|,|c|\} \leq C(\varepsilon) rad(abc)^{1+\varepsilon}$$

for any three coprime positive integers a,b,c satisfying $a+b=c$. Here, for each non-zero integer n one denotes by $rad(n)$ the radical of n, i.e. the maximal square-free positive integer dividing n. Despite its elementary form, the abc-conjecture yields substantial information on how addition and multiplication in $\mathbb{Z}$ are interrelated. It is also deeply connected to a variety of (still) evolving topics, among which are Vojta's conjectures, linear forms in logarithms, Buium's arithmetic differential equations and $\mathbb{F}_1$-geometry. In addition, an intricate proof of the abc-conjecture has been recently announced by Shinichi Mochizuki but I will not dwell (much) on his many intricate new ideas. Instead, I give various versions of the abc-conjecture, explain briefly some of the above-mentioned topics and discuss closely related but rather elementary diophantine problems (e.g., Wieferich primes).

Counting lattice points and o-minimal structures

S03.13
WED
11:15
I
11:45
G

Fabrizio Barroero* (TUGraz)
Martin Widmer (Royal Halloway, London)

Let Λ be a lattice in $\mathbb{R}^n$, and let $Z \subseteq \mathbb{R}^{m+n}$ be a definable family in an o-minimal structure over $\mathbb{R}$. We give sharp estimates for the number of lattice points in the fibers $Z_T = \{x \in \mathbb{R}^n : (T,x) \in Z\}$.

Rational points on some del Pezzo surfaces over imaginary quadratic fields

S03.14
WED
11:45
I
12:15
G

Christopher Frei* (Technische Universität Graz und Universität München)
Ulrich Derenthal (Universität München)

A conjecture of Manin predicts an asymptotic formula for the number of rational points of bounded height on Fano varieties in terms of their geometric structure. We discuss recent results for some del Pezzo surfaces (i.e. Fano varieties of dimension two) over imaginary quadratic fields.

S03.15
WED
12:15
I
12:45
G

Picard-Shimura class fields corresponding to a family of hyperelliptic curves

Thorsten Riedel (Technische Universität Braunschweig)

Given a family of polarized abelian varieties with a common endomorphism structure, Shimura, Taniyama and Weil showed in the 1950's that there exist modular functions, living on the moduli space of the family, such that their values in special arguments generate abelian extensions (*Shimura class fields*) of certain number fields (*reflex fields*) both depending on the prescribed endomorphism structure. Once these functions are known, certain questions arise concerning the reflex fields, the special arguments or the size of the upcoming class fields. In this talk we discuss these questions for a particular family of abelian varieties, namely, a family of Jacobians of hyperelliptic curves of genus 3, that admit multiplication by the Gauss numbers and for which such modular functions are explicitely known.

S03.16
THU
10:15
I
11:15
G

S-adic words, Rauzy fractals, and torus rotations

J. M. Thuswaldner* (Montanuniversität Leoben)
V. Berthé (Université Paris 7)
W. Steiner (Université Paris 7)

In the late 1970s G. Rauzy observed that classical continued fraction expansions can be used to show that Sturmian words are natural codings of rotations on the one-dimensional torus $\mathbb{T}^1$ (this was originally proved by Morse and Hedlund in a different way). In 1991 Arnoux and Rauzy proposed a class of three letter words (now called Arnoux-Rauzy words) to generalize this result to higher dimensions. They conjectured that each Arnoux-Rauzy word is conjugate to a rotation on $\mathbb{T}^2$. In the meantime this conjecture could be confirmed only for "periodic examples" of Arnoux-Rauzy words (Arnoux and Ito, 2001). On the other hand, it was shown by Cassaigne, Ferenczi, and Zamboni in 2000 that there exist examples of Arnoux-Rauzy words that cannot be natural codings of rotations of $\mathbb{T}^2$.

Setting up a general theory for the geometry of S-adic sequences, we are able to prove that the conjecture of Arnoux and Rauzy is true for almost all Arnoux-Rauzy words (w.r.t. a natural measure). We also exhibit concrete non-periodic Arnoux-Rauzy words that satisfy this conjecture. Moreover, we give examples for our new theory that correspond to S-adic words defined in terms of Brun's continued fraction algorithm.

Average behaviour of index and order in certain families of finite abelian groups

S03.17
THU
11:15
I
11:45
G

Christopher Ambrose (Mathematisches Institut Göttingen)

Artin's Conjecture on Primitive Roots states that for any integer a, neither $0, \pm 1$ nor a perfect square, there are infinitely many primes p for which a generates a subgroup of index 1 in $(\mathbb{Z}/p\mathbb{Z})^*$. This motivates the question how order and index of integers are distributed in $(\mathbb{Z}/p\mathbb{Z})^*$ as p varies. In this talk we focus on the average behaviour of index and order in a larger class of families of finite abelian groups. More precisely we consider suitable families of multiplicative groups of residual rings of algebraic integers on the one hand, and of $\mathbb{F}_p$-rational points of elliptic curves over $\mathbb{F}_p$ on the other hand. We prove, partly conditionally on fairly standard hypotheses, asymptotic formulae in some cases, and mention general obstacles which prevent such formulae in the remaining cases.

Spectraldecomposition of GL_3 automorphic forms for the congruence subgroup $\Gamma_0(N)$

S03.18
THU
11:45
I
12:15
G

Deniz Balakci (Universität Goettingen)

M. Thillainatesan has computed explicitly the continous spectrum of a GL_3 form for the group $SL_3(\mathbb{Z})$ (see chapter 10.13 in Goldfeld:'Automorphic forms and L-functions for the general linear group' for an exposition of her paper).
In my work I generalize her method to obtain the continous spectrum of forms for the congruence subgroup $\Gamma_0(N)$. The strategy is to show that the constant terms associated to the parabolic subgroups hold an invariance against a suitable congruence subgroup of the lower rank group GL_2. So we can apply the well known GL_2 spectraldecomposition to this constant term.
Using the Fourierexpansions and the functionalequations of the occuring Eisensteinseries we can replace the GL_2 Eisensteinseries in the spectraldecomposition through suitable GL_3 Eisensteinseries and finally obtain the spectraldecomposition for the higher rank group GL_3.

Section S04

Geometry and Topology

Manfred Husty (Innsbruck)
Thorsten Theobald (Frankfurt)

S04.1
TUE
11:15
I
12:15
D

Tropical Linear Programming

Michael Joswig* (TU Darmstadt)
Xavier Allamigeon (École Polytechnique)
Pascal Benchimol (École Polytechnique)
Stéphane Gaubert (École Polytechnique)

A tropical linear program is a $(\max, +)$-analog of a classical linear program. Scrutinizing how the simplex method of classical linear programming works over fields of real Puiseux series yields an algorithm to solve tropical linear programs. This way a number of interesting combinatorial subtleties arise. A key motivation for this work comes from complexity issues related to mean-payoff games.

S04.2
TUE
15:30
I
16:00
D

Geometric Modeling with polyhedral meshes

Johannes Wallner (TU Graz)

Maxwell's representation of a polyhedral surface as a reciprocal force diagram leads to the well-known correspondence between convex polyhedral surfaces and spider web diagrams (planar graphs with tensile equilibrium forces in their edges, see [1]). This correspondence is helpful in various ways this talk reports on: One is a discrete version of shell equilibrium equations and the construction of a convex polyhedral "Airy potentials" for self-supporting shells, which leads to interesting connections between force systems, graph Laplacians, and discrete curvatures [2]. Another one is a shape space for polyhedral surfaces defined by quadratic constraints which is useful or geometry processing applications [3].

[1] P. Ash, E. Bolker, H. Crapo, W. Whiteley. *Convex polyhedra, Dirichlet tessellations, and spider webs.* in: Shaping space (Northampton 1984). Birkhäuser 1988, pp. 231–250.
[2] E. Vouga, M. Höbinger, J. Wallner, H. Pottmann. *Design of self-supporting surfaces*. ACM Trans. Graphics 31/4 (2012), #87, 1–11.
[3] C. Tang, X. Sun, R. Ait-Haddou, A. Gomes, J. Wallner, H. Pottmann. *Formfinding with polyhedral meshes*. 2013 (in preparation).

S04.3
TUE
16:00
I
16:30
D

Reconstruction of Polytopes from Refraction Data

Andreas Alpers (Technische Universität München)

Recent advances in tomographic imaging technology allow for a detection of certain refraction angles of X-rays that are passing through an object. (Refraction, i.e., the bending of light, can be experienced in everyday life, for instance, by observing rainbows.) Is it possible to reconstruct objects from refraction data? How many X-ray images are needed? What kind of objects are invisible in this context?

In this talk we discuss these questions for polytopes. Answers are given mainly for the 2D case. A central role plays a classic result of H. Minkowski.

Spatial linkages with a straight line trajectory

Hans-Peter Schröcker (Universität Innsbruck)

S04.4
TUE
16:30
I
17:00
D

One of the important steps in the theory of linkages was the discovery of Peaucelier's inversor in 1864. It is widely considered as the first linkage with only revolute joints and an exact straight line trajectory. But actually, it is predated by a curious invention of Sarrus [3] – a closed loop of six spatial revolute joints where the relative motion of two opposite links is a translation. While numerous *planar* straight-line linkages followed Peaucelier's inversor, Sarrus linkage remained the only *spatial* straight-line linkage until Pavlin and Wohlhart [2] produced other examples by combining planar and spherical sub-linkages.

In our contribution, we use a non-unique factorization theorem for polynomials over the ring of dual quaternions and its kinematic interpretation [1] for constructing new spatial straight-line linkages. The straight-line constraint can be satisfied by cubic motion polynomials whose factorization produces closed loops of six revolute and prismatic (translational) joints with rational relative motions. In contrast to Sarrus' linkage, not all trajectories are straight.

[1] G. Hegedüs, J. Schicho, and H.-P. Schröcker, *Factorization of rational curves in the Study quadric and revolute linkages,* Mech. Mach. Theory, 69(1) (2013) 142–152.

[2] G. Pavlin, K. Wohlhart, *On straight-line space mechanisms,* in: Proceedings of the Sixth International Conference on the Theory of Machines and Mechanisms, 241–246, Liberec, 1992.

[3] M. Sarrus, *Note sur la transformation des mouvements rectilignes alternatifs, en moevements circulaires; et réciproquement,* C. R. Akad. des Sciences, p. 1038, Paris, 1853.

Restricted Successive Minima

Carsten Thiel* (Universität Magdeburg)
Martin Henk (Universität Magdeburg)

S04.5
TUE
17:00
I
17:30
D

One of the many successful applications of Minkowski's first fundamental theorem on successive minima is the so-called "Siegel's lemma", bounding the norm of a non-trivial lattice point lying in a linear subspace. A natural generalisation, considered by Fukshansky, Gaudron and Rémond, is to impose additional conditions on the lattice point.

To this end, we give bounds on the successive minima of an o-symmetric convex body under the restriction that the lattice points realizing the successive minima are not contained in a collection of forbidden sublattices.

Our investigations extend former results to forbidden full-dimensional lattices, to all successive minima and complement former results in the lower dimensional case.

S04.6
TUE
17:30
I
18:00
D

Distances on Sierpiński graphs and on the Sierpiński carpet

Ligia L. Cristea⋆ (Technische Universität Graz)
Bertran Steinsky

The well known planar fractal called the *Sierpiński gasket* can be defined with the help of a related sequence of graphs $\{G_n\}_{n\geq 0}$, where G_n is the *n-th Sierpiński graph*, embedded in the Euclidean plane. We have proven geometric criteria that allow us to decide, whether a shortest path between two distinct vertices x and y in G_n, that lie in two neighboured elementary triangles (of the same level), goes through the common vertex of the triangles or through two distinct vertices (both distinct from the common vertex) of those triangles. In previous works, the authors construct both paths and then compare them in order to know the graph distance between the two vertices. Our results make it possible to skip this step and decide, just by the positions of the vertices, how to construct a shortest path. The results are then applied in order to construct shortest paths in the fractal or in approximations of the fractal.

S04.7
TUE
18:00
I
18:30
D

Reguläre Dreieckpflasterung konvexer Polygone

Eike Hertel (Universität Jena)

Wir geben eine vollständige Charakterisierung aller konvexen n-Ecke, die in paarweise kongruente gleichseitige Dreiecke zerlegt werden können. Außerdem wird für jedes n außer für $n = 5$ die Menge aller natürlichen Zahlen k bestimmt, für welche ein n-Eck existiert mit einer solchen Pflasterung in k gleichseitige Dreiecke.

S04.8
WED
10:15
I
11:15
D

Recent interaction between real and convex algebraic geometry

Claus Scheiderer (Universität Konstanz)

In recent years, the phrase "Convex Algebraic Geometry" has been increasingly used to describe a bundle of questions and methods in which algebraic geometry, convexity theory and real algebraic geometry meet. The motivation for many of the problems comes from optimization theory, and in particular, from semidefinite optimization. For example, given a compact real algebraic set X, one would like to know whether the convex hull of X can be written as the linear projection of a spectrahedron, and to find such a representation if one exists. By definition, spectrahedra are the feasible sets of semidefinite programs, that is, the solution sets of linear matrix inequalities. The problem of characterizing the class of all spectrahedra is challenging. It is the subject of the Generalized Lax Conjecture, on which the last years have seen considerable progress. Another prominent open problem is the Helton-Nie Conjecture, according to which every convex semi-algebraic set should be a linear projection of some spectrahedron. In approaching such questions, methods from real algebraic geometry play an important role, in particular techniques based on sums of squares of polynomials. In the talk we will try to highlight some of the recent developments.

S04.9
WED
11:15
I
11:45
D

Die Eisenstein-Parkettierung der komplexen Ebene

Gilbert Helmberg (Universität Innsbruck)

Es sei D die Menge der vier komplexen Zahlen $0, 1, \omega = e^{\frac{2\pi i}{3}}, \omega^2 = e^{\frac{4\pi i}{3}}$. Jede komplexe Zahl z lässt sich auf mindestens eine Weise in eine Reihe der Form

$$z = \sum_{k=-\infty}^{n} d_k(z)(-2)^k \qquad n \in \mathbb{N},\ d_k(z) \in D \quad (-\infty < k \le n)$$

entwickeln.

Die *Eisenstein-Menge* $\mathscr{E}_{d_n \cdots d_0, d_{-1} \cdots d_{-m}}$ [1] sei definiert durch

$$\mathscr{E}_{d_n \cdots d_0, d_{-1} \cdots d_{-m}} = \{z : d_k(z) = d_k,\ -m \le k \le n\}.$$

Die Eisenstein-Mengen $\mathscr{E}_{d_n \cdots d_0}$ $(n \in \mathbb{N},\ d_k \in D,\ 0 \le k \le n)$ parkettieren die komplexe Ebene. Sie sind selbst-ähnliche fraktale Mengen: $\mathscr{E}_{d_n \cdots d_0} = \bigcup_{d_{-1} \in D} \mathscr{E}_{d_n \cdots d_0, d_{-1}}$ ist die Vereinigung von vier auf halbe Größe verkleinerten Eisenstein-Mengen mit disjunkten offenen Kernen. Ihre Ränder haben die Hausdorff-Dimension $\frac{\log 3}{\log 2}$.

Jede Eisenstein-Menge ist aber auch die Vereinigung von drei kongruenten Krabben-Fraktalen [2] mit disjunkten offenen Kernen, die sich als flächenfüllende fraktale Kurven konstruieren lassen, und deren Ränder ebenfalls die Hausdorff-Dimension $\frac{\log 3}{\log 2}$ besitzen. Jedes Krabben-Fraktal ist wieder die Vereinigung von vier auf halbe Größe verkleinerten Krabben-Fraktalen mit disjunkten offenen Kernen. Diese Krabben-Fraktale liefern somit ebenfalls eine Parkettierung der komplexen Ebene, die eine Verfeinerung der Eisenstein-Parkettierung darstellt.

[1] G.A. Edgar, *Measure, Topology, and Fractal Geometry*. Springer, Berlin - New York 1990.

[2] G. Helmberg, *The Crab: a Connected Fractile of Infinite Connectivity*. Fractals, 19 (2011), 367–377

S04.10
WED
11:45
I
12:15
D

Roots of Trinomials from the Viewpoint of Amoeba Theory

Timo de Wolff⋆ (Universität des Saarlandes, Saarbrücken)
Thorsten Theobald (Goethe University, Frankfurt am Main)

The behavior of the modulis of roots of univariate trinomials $Z^{s+t}+pZ^t+q \in \mathbb{C}[Z]$ for fixed support $A := \{s+t,t,0\} \subset \mathbb{N}$ with respect to the choice of coefficients $p,q \in \mathbb{C}$ is a classical late 19th / early 20th century problem. Although algebraically described by P. Bohl in 1908, the geometry and topology of the corresponding parameter space $\mathbb{C}^A$ is unknown. We provide such a description yielded by a reinterpretation of this problem in terms of amoeba theory.

Given an Laurent polynomial $f \in \mathbb{C}[Z_1^{\pm 1},\ldots,Z_n^{\pm 1}]$ the *amoeba* $\mathscr{A}(f)$ (introduced by Gelfand, Kapranov, and Zelevinsky '94) is the image of its variety $\mathscr{V}(f)$ under the Log-map

$$\mathrm{Log} : (\mathbb{C}^*)^n \to \mathbb{R}^n,\ (|z_1|\cdot e^{i\cdot\phi_1},\ldots,|z_n|\cdot e^{i\cdot\phi_n}) \mapsto (\log|z_1|,\ldots,\log|z_n|)\,,$$

where $\mathscr{V}(f)$ is considered as a subset of the algebraic torus $(\mathbb{C}^*)^n = (\mathbb{C}\setminus\{0\})^n$.

Amoebas provide a natural approach to tropical geometry and occur in numerous other fields of mathematics – e.g., complex analysis and the topology of real algebraic curves.

S04.11
WED
12:15
I
12:45
D

Computing Layered Reeb Graphs from Boundary Representations

Birgit Strodthoff⋆ (Johannes Kepler University Linz)
Bert Jüttler (Johannes Kepler University Linz)

Reeb graphs are topological graphs originating in Morse theory, which represent the topological structure of a Riemannian manifold by contracting the level set components of a scalar-valued function defined on it (see [1] for an introduction). The use of more than one function leads to Reeb spaces, which are thus able to capture more features of an object [2]. We introduce the layered Reeb graph as a discrete representation for Reeb spaces of 3-manifolds (possibly with boundaries) with respect to two scalar-valued functions. After that we present a restricted class of defining functions, for which the layered Reeb graph can be computed from a boundary representation of the spatial domain of interest. This leads to substantial computational advantages if the manifold is given in a boundary description, since no volumetric representation has to be constructed. See also [3] for more details.

[1] S. Biasotti, D. Giorgi, M. Spagnuolo, B. Falcidieno, *Reeb graphs for shape analysis and applications*, Theor. Computer Science, 392(1-3) (2008) 5–22.
[2] H. Edelsbrunner, J. Harer, A. K. Patel, *Reeb spaces of piecewise linear mappings*, Proc. Sympos. on Comput. Geom. (2008) 242–250.
[3] B. Strodthoff, B. Jüttler *Layered Reeb Graphs of a Spatial Domain*, Proc. Europ. Workshop on Comput. Geom. (2013) 21–24.

A discrete gradient-method approach to the Fermat-Torricelli problem

S04.12
THU
10:15
I
10:45
D

Margarita Spirova* (TU Chemnitz)
Yaakov S. Kupitz (The Hebrew University of Jerusalem)
Horst Martini (TU Chemnitz)

The well known Fermat-Torricelli problem refers to the unique point having minimal distance sum to a given finite set of points in d-dimensional space. We give a discrete geometric (differential-free) proof of the theorem characterizing the solution of this problem. Using this discrete approach, we extend the Fermat-Torricelli problem to the case that the given points are replaced by affine flats of various dimensions.

S04.13
THU
10:45
I
11:15
D

Theory of infinitely near points in smooth manifolds: the Fermat functor

Paolo Giordano (Universität Wien)

The work [3] of A. Weil on infinitesimal prolongations of smooth manifolds had a great influence on Differential Geometry, inspiring research threads like Weil functors, Synthetic Differential Geometry, Differential Geometry over general base fields and rings, but also Grothendieck's approach to infinitesimal neighborhoods in algebraic geometry.

We present a new approach to the extension of smooth manifolds with infinitely near points which permits to formalize infinitesimal methods in Differential Geometry and has a clear geometrical meaning. In case of a smooth manifold M this extension can be easily formulated. We firstly have to introduce *little-oh polynomials* as maps $x : \mathbb{R}_{\geq 0} \longrightarrow M$ that can be written as $\varphi(x(t)) = r + \sum_{i=1}^{k} \alpha_i \cdot t^{a_i} + o(t)$, where $r, \alpha_i \in \mathbb{R}^n$, $a_i \in \mathbb{R}_{\geq 0}$ and $t \to 0^+$, in some chart (U, φ) such that $x(0) \in U$. We can hence introduce an equivalence relation between little-oh polynomials saying that $x \sim y$ iff we can write $\varphi(x(t)) = \varphi(y(t)) + o(t)$ in some chart (U, φ) such that $x(0), y(0) \in U$. The extension of M with infinitely near points is simply the quotient set ${}^\bullet M := M/\sim$. This construction applied to $M = \mathbb{R}$ gives the so-called *ring of Fermat reals* ${}^\bullet\mathbb{R}$, a non-archimedean ring with nilpotent infinitesimals, see e.g. [1, 2]. However, this construction can be generalized to any diffeological space $X \in \mathbf{Diff}$, obtaining the *Fermat functor* ${}^\bullet(-) : \mathbf{Diff} \longrightarrow {}^\bullet\mathscr{C}^\infty$ from the category **Diff** of diffeological spaces to that of *Fermat spaces* ${}^\bullet\mathscr{C}^\infty$. Since the category **Diff** is cartesian closed, complete and co-complete, and embeds the category **Man** of smooth manifolds, the whole construction can be applied also to infinite dimensional spaces like the space of all the smooth maps between two smooth manifolds and to spaces with singularities. In this setting we can define a tangent vector as an infinitesimal smooth curve $t : D \longrightarrow X$, where $D = \{h \in {}^\bullet\mathbb{R} \mid h^2 = 0\}$ is the ideal of first order nilpotent infinitesimals; we can see any vector field as an infinitesimal transformation of the space X into itself and we can prove that any vector field has a unique infinitesimal integral curve. For the case ${}^\bullet\mathscr{C}^\infty({}^\bullet M, {}^\bullet N)$ this amount to say that an infinite system of ODE has always a unique infinitesimal solution. Even if the whole construction does not need any background of Mathematical Logic, the study of the preservation properties of the Fermat functor ${}^\bullet(-)$ reveals a surprising strong connection with intuitionistic logic. In fact, this functor preserves product of manifolds, open subspaces, inclusion, inverse images, intersections and unions, intuitionistic negation and implication, intuitionistic quantifiers. Therefore, a full transfer theorem for intuitionistic formulas holds and summarizes the preservation properties of this functor.

[1] P. Giordano, The ring of fermat reals, *Advances in Mathematics* 225, pp. 2050–2075, 2010.

[2] P. Giordano, Fermat-Reyes method in the ring of Fermat reals. *Advances in Mathematics* 228, pp. 862–893, 2011.

[3] A. Weil, Théorie des points proches sur les variétés différentiables. *Colloque de Géometrie Différentielle*, Strasbourg, pp. 111–117, 1953.

Illuminating and covering convex bodies

S04.14
THU
11:15
I
11:45
D

Christian Richter⋆ (Friedrich Schiller University of Jena)
Horst Martini (Chemnitz University of Technology)
Margarita Spirova (Chemnitz University of Technology)

Given an n-dimensional convex body $K \subseteq \mathbb{R}^n$, a vector $l \in \mathbb{R}^n \setminus \{0\}$ is said to illuminate a point $x \in K$ if $x + \varepsilon l \in \mathrm{int}(K)$ for some $\varepsilon > 0$. The corresponding illumination number

$$c(K) = \min\{m : \exists l_1, \ldots, l_m \in \mathbb{R}^n \setminus \{0\}\ \forall x \in K\ \exists i\ (l_i \text{ illuminates } x)\}$$

of K is known to coincide with both the covering numbers

$$\begin{aligned} b(K) &= \min\{m : K \text{ can be covered by } m \text{ smaller homothetical copies of } K\}, \\ b'(K) &= \min\{m : K \text{ can be covered by } m \text{ translates of } \mathrm{int}(K)\}. \end{aligned}$$

We refine the concept of illumination by saying that a vector r of the unit sphere $\mathbb{S}^{n-1} \subseteq \mathbb{R}^n$ ε-illuminates [ε-t-illuminates] $x \in K$ if $x + \varepsilon r \in \mathrm{int}(K)$ [$x + \varepsilon r \in K$]. Let

$$\begin{aligned} c(K,\varepsilon) &= \min\{m : \exists r_1, \ldots, r_m \in \mathbb{S}^{n-1}\ \forall x \in K\ \exists i\ (l_i\ \ \varepsilon\text{-illuminates } x)\}, \\ i(K,\varepsilon) &= \min\{m : \exists r_1, \ldots, r_m \in \mathbb{S}^{n-1}\ \forall x \in K\ \exists i\ (l_i\ \ \varepsilon\text{-t-illuminates } x)\}. \end{aligned}$$

We shall study the behavior of the functions $c(K,\cdot), i(K,\cdot) : (0,\infty) \to \mathbb{N} \cup \{\infty\}$.

The exponential map of a $C^{1,1}$-metric

S04.15
THU
11:45
I
12:15
D

Roland Steinbauer⋆ (Universität Wien)
Michael Kunzinger (Universität Wien)
Milena Stojković (Universität Wien)

Given a Riemannian or Lorentzian metric of regularity $C^{1,1}$ on a smooth manifold, we prove that the corresponding exponential map retains the maximal possible regularity, namely that it is a bi-Lipschitz homeomorphism locally around any point. We also establish the existence of totally normal neighborhoods in an appropriate sense. The proofs are based on regularization, combined with methods from comparison geometry.

S04.16
THU
12:15
I
12:45
D

Central Projections and their Matrices

Rolfdieter Frank (Universität Koblenz-Landau)

Central projections can be described by matrices. This is well known and often applied, for example in computer vision. We treat the following problems:

1. The matrix of a central projection is given. How can one obtain its center, picture plane (or space), viewing distance and centric point?
2. Characterize the matrices which describe central projections.

The solutions are easy for square matrices, but more difficult for rectangular matrices. Among these are the 3 by 4 matrices, which are called „camera matrices“ in computer vision.

S04.17
THU
15:30
I
16:00
D

The comparison of topologies related to various concepts of generalized covering spaces

Andreas Zastrow⋆ (Universität Danzig)
Žiga Virk (Universität Ljubljana)

The idea to generalize covering-space theory beyond the class of semilocally simply connected spaces is fairly old, and apparently the first paper making already a suggestion in this direction is from the sixties. Various non-equivalent definitions for generalized covering spaces have been suggested, depending on which properties of classical covering spaces should been maintained and which can be given up. One of the concepts is the idea to use in principle the same construction as in the classical case via the "universal path space" [2], but being happy with covering spaces satisfying weaker conditions. Even for this concept of generalizing covering spaces different propositions for how to define the topology on the covering spaces have been made, which in the classical locally path-connected and semilocally simply connected case all give the topology of the classical covering spaces. The subspace of the universal path space consisting of those paths that return to the base point is the fundamental group, which, starting with a paper from 2002 by Biss ([1]) is meanwhile also considered as an object which apart from its algebraic structure has a topological structure. Biss' paper, although it contains several mistakes, may therefore be considered as influential; and the object proposed by him, the topological fundamental group, has since been discussed in several papers and has been generalized to higher dimensions, although it is by now known to be only a quasitopological group. By extending some definitions which have in literature up to this moment only been made for the topological fundamental group, we are aware of up to four different definitions for the topologizing the universal path space to obtain generalized covering spaces. The talk will mainly describe the differences between the various definitions of the topologies via constructing examples of spaces, where the definitions give different topologies. It will in particular point out that the topology proposed by [2] and [3] is the finest and thus provides the best opportunities to obtain generalized covering spaces for spaces with a wild topology, and also point out that [4]'s Lasso topology and the topology induced by the compact-open topology, although they look at first sight conceptually very different, have a similar philosophy at second sight, but, since one of them is defined via the topology of a path space, but the other via the topology of the space itself, are in general incomparable.

[1] D. Biss: *The topological fundamental group and generalized covering spaces*, Topology and its Applications **124** (2002), 355–371

[2] W.A. Bogley, A.J. Sieradski: *Universal path spaces*, preprint; http://oregonstate.edu/ bogleyw/.

[3] H. Fischer, A. Zastrow, *Generalized universal covering spaces and the shape group*, Fund. Math. **197** (2007), 167–196.

[4] N. Brodsky, J. Dydak, B. Labuz, A. Mitra, *Covering maps for locally path connected spaces*, Fundamenta Mathematicae **218** (2012).

S04.18
THU
16:00
I
16:30
D

On a Coxeter Theorem

Johannes Böhm (Friedrich-Schiller-Universität Jena)

In 1936 H.S.M. Coxeter and G. T. Bennett [1] formulated a geometric connection between elements of elliptic orthoschemes and a special configuration of semicircles over a line (Coxeter-Bennett configuration), called Coxeter Theorem. Coxeter extended these results to the $d-$dimensional elliptic case and then to the hyperbolic case. His hints to the case of a Minkowskian case find a detailed generalization of this theorem here. Thus a generalization of Napier's rule can be given. Generally for Minkowskian spaces of arbitrary dimension the connection between types of orthoschemes and permutations can be described. Such a permutation which belongs to an orthoscheme is called geometric. For proving some important assertions the knowledge of the structure of geometric permutations is used. Especially a theory for hyperbolic kernels can be established.

[1] H.S.M. Coxeter, *On Schläfli's generalization of Napiers's pentagramma mirificum*, Bull. Calcutta Math. Soc. 28, (1936) 125-144.
[2] HCh. Im Hof, *Napier cycles and hyperbolic Coxeter groups*, Bull Soc. Math. Belgique 42, (1990) 523-545.
[3] R. Kellerhals, *Scissors congruence, the golden ratio and volumes in hyperbolic 5-space*, Discrete comput. Geom. 47, (2012) 629-658.
[4] L. Schläfli, *Gesammelte math. Abh. 1*, Birkhäuser Basel 1950, p. 227 ff. (from 1852).
[5] È. B. Vinberg, *Hyperbolic reflection groups*, Russian Math. Surveys 40, (1985) 31 - 75.

S04.19
THU
16:30
I
17:00
D

A K_T-deformation of the ring of symmetric functions

Mathias Lederer* (Universität Innsbruck)
Allen Knutson (Cornell University)

Schubert calculus is the geometry of linear algebra, describing $H^\star(Gr_a(\mathbb{A}^{a+b}))$, the cohomology of the Grassmannian of a-planes in $(a+b)$-space. Canonical inclusions $Gr_a(\mathbb{A}^{a+b}) \hookrightarrow Gr_{a+1}(\mathbb{A}^{a+b+1})$ and $Gr_a(\mathbb{A}^{a+b}) \hookrightarrow Gr_a(\mathbb{A}^{a+b+1})$ induce maps on homology and cohomology, which allow to consider all Grassmannians at once,

$$H_\star := \lim_{\longrightarrow} H_\star(Gr_a(\mathbb{A}^{a+b})),\ H^\star := \lim_{\longleftarrow} H^\star(Gr_a(\mathbb{A}^{a+b})).$$

These are free $\mathbb{Z}$-modules with bases given by the classes of Schubert varieties X_λ, indexed by all partitions $\lambda = (\lambda_1 \geq \ldots \geq \lambda_m)$ of integers.

The cup product turns $H^\star$ into a ring, which is known to be isomorphic to the ring of symmetric functions [1]. On $H_\star$, the multiplication is induced from maps

$$Gr_a(\mathbb{A}^{a+b}) \times Gr_c(\mathbb{A}^{c+d}) \to Gr_{a+c}(\mathbb{A}^{a+b+c+d}) : (V,W) \mapsto V \oplus W,$$

which define a homomorphism $H_\star \otimes H_\star \to H_\star$. The rings $H^\star$ and $H_\star$ are isomorphic.

We write points in $Gr_a(\mathbb{A}^{a+b})$ as rowspan $\left[\begin{array}{c|c} A & B \end{array}\right]$ for matrices of full rank with blocks $A \in M_{a\times a}$ and $B \in M_{a\times b}$. A column-permuted version of the previous map then reads

$$(\text{rowspan}\left[\begin{array}{c|c} A & B \end{array}\right], \text{rowspan}\left[\begin{array}{c|c} C & D \end{array}\right]) \mapsto \text{rowspan}\left[\begin{array}{c|c|c|c} A & 0 & 0 & B \\ \hline 0 & C & D & 0 \end{array}\right].$$

This map is equivariant with respect to the action of the one-dimensional torus scaling the first block of matrices $\left[\begin{array}{c|c} A & B \end{array}\right]$ and leaving the second block unchanged. It therefore induces a ring structure on the torus-equivariant K-homology module

$$K^T_\star := \lim_{\longrightarrow} K^T_\star(Gr_a(\mathbb{A}^{a+b})).$$

This is a free $\mathbb{Z}[t,t^{-1}]$-module with the same basis as before. Sending $t \mapsto 1$ yields $K^T_\star \otimes_{\mathbb{Z}[t,t^{-1}]} \mathbb{Z} = H_\star$, so $K^T_\star$ is a deformation of the ring of symmetric functions.

We will give combinatorial rules describing the multiplicative structure on $K^T_\star$. These rules are inspired by, but do not follow from, Vakil's geometric Littlewood-Richardson rule [2], and the puzzle rules by Knutson and Tao [3].

[1] W. Fulton, *Young tableaux*, Cambridge University Press, Cambridge, 1997.
[2] R. Vakil, *A geometric Littlewood-Richardson rule*, Ann. of Math. (2) 164 (2006), no. 2, 371–421.
[3] A. Knutson, T. Tao, *Puzzles and (equivariant) cohomology of Grassmannians*, Duke Math. J. 119 (2003), no. 2, 221–260.

S04.20
THU
17:00
I
17:30
D

Questions Concerning Quadrilaterals in the Plane and on the Sphere

Lienhard Wimmer (NTA Isny)

When studying complex problems sometimes small, but nasty to solve questions occur. The solution of them might be as expected, but sometimes the solution surprises. In the lecture two questions of this type are proposed:

- How to calculate (and to construct) a quadrilateral from its centroid and from some data of its vertices?
- What triangle among all triangles with given height and given sum of the legs has the largest area?

  In Euclidean geometry this question is almost trivial and in spherical geometry the optimal triangle can be found with the help of calculus. But what is the geometric nature of the optimal triangle?

S04.21
THU
17:30
I
18:00
D

Curve shortening by short rulers

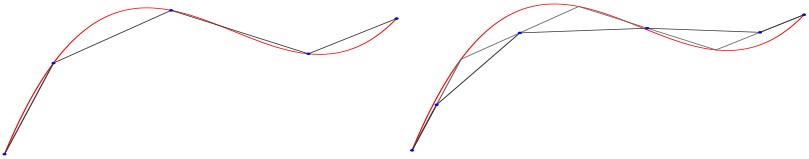
Peter Stadler (Universität Innsbruck)

We look at homomorphisms $h\colon (\mathbb{R},+) \to (G,\circ)$ on a Lie group G:

$$h(s+t) = h(s) \circ h(t), h(0) = e \text{ and } h(1) = g$$

The restriction of h to the interval $[0,1]$ is a geodesic, i.e., a locally shortest line.

The problem is to construct long geodesics. But any curve connecting starting point and end point can be shortened by using a ruler which allows to construct short geodesics.



In normed vector spaces, the curve converges to the straight line if it's shortened iterative. This result can be generalized to cylinders and planes which are curved in one direction.

Section S05

Differential Equations and Applications

Peter Szmolyan (Wien)
Petra Wittbold (Duisburg-Essen)

S05.1
MON
16:30
I
17:30
B

A free boundary problem for MEMS

*Christoph Walker** (Leibniz Universität Hannover)
Joachim Escher (Leibniz Universität Hannover)
Philippe Laurençot (Université de Toulouse)

Idealized microelectromechanical systems (MEMS) consist of a conducting rigid ground plate above which an elastic membrane, coated with a thin layer of dielectric material and clamped on its boundary, is suspended. The membrane deforms due to a voltage difference that is applied between the two components. If the voltage difference exceeds a critical value, the membrane may touch down on the ground plate. This 'pull-in' instability limits the stable operating condition of the device.

The mathematical model involves the harmonic electrostatic potential in the free domain between ground plate and membrane along with a singular evolution equation for the membrane displacement, the coupling term including the trace of the potential gradient on the membrane. We investigate the 'pull-in' instability, which is related to the existence and non-existence of steady states and to the existence and non-existence of global solutions for the dynamic problem.

Estimates from above and below for biharmonic Green functions

Hans-Christoph Grunau* (Otto-von-Guericke-Universität Magdeburg)
Frédéric Robert (Université de Lorraine, Nancy)
Guido Sweers (Universität zu Köln)

S05.2
MON
17:30
I
18:00
B

The Green function $G_{-\Delta,\Omega}$ for the Laplacian under Dirichlet boundary conditions in a bounded smooth domain $\Omega \subset \mathbb{R}^n$ enjoys in dimensions $n \geq 3$ the estimate:

$$0 \leq G_{-\Delta,\Omega}(x,y) \leq \frac{1}{n(n-2)e_n}|x-y|^{2-n}.$$

Here, e_n denotes the volume of the unit ball $B = B_1(0) \subset \mathbb{R}^n$. This estimate follows from the maximum principle, the construction of $G_{-\Delta,\Omega}$ and the explicit expression of a suitable fundamental solution.

In higher order elliptic equations the maximum principle fails and deducing Green function estimates becomes an intricate subject. We consider the clamped plate boundary value problem as a prototype:

$$\begin{cases} \Delta^2 u = f & \text{in } \Omega, \\ u = |\nabla u| = 0 & \text{on } \partial\Omega. \end{cases}$$

I shall discuss estimates for the corresponding Green function $G_{\Delta^2,\Omega}$ focussing on two aspects:

- Keeping Ω fixed, can one show – although $G_{\Delta^2,\Omega}$ is in general sign changing – that it is somehow "almost positive"?
- Removing arbitrarily small holes (with almost infinite curvature) from a fixed domain Ω prevents uniform constants in classical Green function estimates. Can one nevertheless deduce estimates for this singular family of domains which are uniform with respect to the size of the hole?

[1] H.-Ch. Grunau, F. Robert, G. Sweers, *Optimal estimates from below for biharmonic Green functions*. Proc. Amer. Math. Society **139**, 2151-2161 (2011).
[2] H.-Ch. Grunau, F. Robert, *Uniform estimates for polyharmonic Green functions in domains with small holes*. Contemporary Mathematics, to appear.

S05.3
MON
18:00
I
18:30
B

Ein Integralgleichungszugang zu den Minimalvektoren von Marx und Shiffman

Michael Hilschenz (Brandenburgische Technische Universität Cottbus-Senftenberg)

Ausgangspunkt unserer Betrachtungen ist das sogenannte Variationsproblem von Marx und Shiffman: Die Minimierung des Dirichlet-Integrals unter gewissen halbfreien, affin linearen Randbedingungen, welches in der Theorie der polygonal berandeten Minimalflächen seinen Ursprung hat. In diesem Vortrag etablieren wir einen konstruktiven Zugang zu jenen Marx-Shiffman'schen Minimalvektoren (Lösungen des obigen Variationsproblems). Dies gelingt durch einen von E. Heinz entdeckten Zusammenhang zum sog. Riemann'schen Problem der Funktionentheorie, welches seinerseits in klassischen Arbeiten von David Hilbert und Josip Plemelj behandelt wurde. Wir greifen die alten Ideen auf und entwickeln eine vollständige Lösungstheorie für das Riemann'sche Problem. Es stellt sich heraus, dass dessen Lösungsgesamtheit auf einfache Weise darstellbar ist durch endlich viele Fundamentallösungen, welche im Prinzip mittels gewisser Ansatzfunktionen und Lösungen Fredholm'scher Integralgleichungen bestimmt werden können.

On small Mach Number Applications related to renewable Energy Production

S05.4
TUE
11:15
I
12:15
B

Ingenuin Gasser⋆ (Universität Hamburg)
Maria Bauer (TU Hamburg Harburg)
Muhammad Kamboh (TU Hamburg Harburg)

We present a model to describe the power production of an Solar Updraft Tower [4] or an Energy Tower [5]. In both cases the energy source - the solar energy in the first case and the heat of evaporation in the second case - is used to induce an air flow in a tower which then powers a turbine and produces electrical energy. In both cases it is crucial to find a simple gas dynamic description of the air flow. In both cases the flow is buoyancy driven and therefore we start with a fully compressible (nonlinear PDE) model. Then we derive a small Mach number asymptotic (nonlinear mixed ODE-PDE) model which allows fast and robust numerical simulations [1, 2, 3]. Finally we present simulations and first optimization results for such power plants. In the case of a solar updraft tower we obtain good qualitative and quantitative agreement with the data of the prototype in Manzanares [4]. In the second case - due to missing experimental data - we obtain a good qualitative understanding. In addition we can conferm some conjectured dependencies on certain parameters of the power plant.

[1] M. Bauer, I. Gasser, *Modeling, asymptotic analysis and simulation of an Energy Tower*, SIAM J. Appl. Math. 72(1), (2012) 362-381.
[2] I. Gasser, *Modelling and Simulation of a Solar Updraft Tower*, Kinetic and Related Models KRM, 2(1), (2009) 191-204.
[3] I. Gasser, M Kamboh, *Modeling, asymptotic analysis and simulation of a solar Updraft Tower for high latitude*, in preparation, (2013).
[4] J. Schlaich, W. Schiel, *Solar Chimneys*, in RA Meyers (ed), Encyclopedia of Physical Science and Technology, 3rd Edition, Academic Press, London, 2001.
[5] D. Zaslavsky, *Energy Towers*. PhysicaPlus - Online magazine of the Israel Physical Society (Israel Physical Society) 7, (2006).

S05.5
TUE
12:15
I
12:45
B

Modeling Flow Induced Vibrations of a Slender U-Beam at Low Reduced Velocities.

Johannes Strecha⋆ (Technische Universität Wien)
Alois Steindl (Technische Universität Wien)
Herbert Steinrück (Technische Universität Wien)

We present findings concerning the flutter (two degree of freedom motion) of slender, prismatic bodies in cross flow. In particular, we consider configurations where the von Kármán vortex shedding frequency is equal to, or not much larger than the structural eigenfrequency. The prismatic body under consideration is a slender U-Beam with an aspect-ratio (along-wind length over frontal height) equal to 4.65. Shapes with such aspect ratios are known to perform vortex induced as well as self excited vibrations.

When the influence of the von Kármán vortices can be neglected, the critical flow velocities, where flutter occurs can be estimated by calculating the so-called aerodynamic derivatives. We present our progress in complementing the method of aerodynamic derivatives with a wake oscillator to take the von Kármán vortices into account. The wake oscillator is an additional Rayleigh-type equation modeling the behaviour of the wake. The equations of motion and the wake oscillator are coupled. For comparison simulation and experimental results are shown.

S05.6
TUE
16:30
I
17:30
B

Lipschitz truncation and applications to non-linear PDE.

Lars Diening (LMU Munich)

The Lipschitz truncation method allows to approximate a Sobolev function by Lipschitz functions with only minor modifications of the original function. This technique is closely related to the Calderón-Zygmund decomposition of a Sobolev function. The Lipschitz truncation can for example be used to indentify the non-linear stress for Non-Newtonian fluids although only weak converge is at hand. In the time-dependent case the problem becomes much more difficult due to the presence of the pressure. This problem can be solved by introducing a solenoidal Lipschitz truncation. Another application of the Lipschitz is a direct proof of the so called harmonic and caloric approximation lemmas.

S05.7
TUE
17:30
I
18:00
B

Very weak solutions of Poisson's equation with singular data under Neumann boundary conditions and the pressure-Poisson formulation for non-Newtonian fluids

Jochen Merker* (Universität Rostock)
Jean-Michel Rakotoson (University of Poitiers)

The problem to find a very weak solution $u \in L^1(\Omega)$ of Poisson's equation

$$-\Delta u = f$$

in a smooth bounded domain $\Omega \subset \mathbb{R}^N$ under Dirichlet boundary conditions $u = 0$ for inhomogeneities f satisfying $f(\cdot)\,\mathrm{dist}(\cdot,\partial\Omega) \in L^1(\Omega)$ but not necessarily $f \in L^1(\Omega)$ has its origins in the work of BREZIS [1]. Optimal regularity results for very weak solutions have been obtained by DÍAZ and RAKOTOSON [2]. In the talk, corresponding results for the Neumann boundary problem and singular data f are presented [3].

Such problems arise in the pressure-Poisson formulation for non-Newtonian fluids governed by incompressible Navier-Stokes equations

$$\frac{\partial b(u)}{\partial t} + \mathrm{div}(b(u)\otimes u) = -d\pi + \mathrm{div}(a(\nabla^{\mathrm{sym}} u)) + f\,, \qquad \mathrm{div}(u) = 0\,,$$

where not only the viscous stress tensor $a(\nabla^{\mathrm{sym}} u)$ is allowed to depend nonlinearly on the symmetric part $\nabla^{\mathrm{sym}} u$ of the derivative of the velocity vector field u, but also the momentum $b(u)$ may depend nonlinearly on u (e.g. due to a background porous medium). In the talk, some results about these equations are presented [4], the pressure π is shown to satisfy a Poisson equation under Neumann boundary conditions with singular data, and finally open questions are discussed.

[1] H. Brezis, T. Cazenave, Y. Martel, A. Ramiandrisoa, *Blow-up for $u_t - \Delta u = g(u)$ revisited*, Adv. Differ. Equ. 1 (1996) 73–90.

[2] J.I. Díaz, J.-M. Rakotoson, *On the differentiability of very weak solutions with right-hand side data integrable with respect to the distance to the boundary*, J. Funct. Anal. 257 (2009) 807–831.

[3] J. Merker, J.-M. Rakotoson, *Very weak solutions of Poisson's equation with singular data under Neumann boundary conditions*, submitted to Calc. Var.

[4] J. Merker, *Extinction of weak solutions of doubly nonlinear Navier-Stokes equations*, submitted to EJDE

S05.8
TUE
18:00
I
18:30
B

The existence theorems for 3-D flow of a compressible viscous micropolar fluid with spherical symmetry

Ivan Dražić⋆ (Faculty of Engineering, University of Rijeka, Rijeka, Croatia)
Nermina Mujaković (Department of Mathematics, University of Rijeka, Rijeka, Croatia)

We consider nonstationary 3-D flow of a compressible viscous heat-conducting micropolar fluid in the domain to be the subset of $\mathbf{R}^3$ bounded with two concentric spheres that present the solid thermoinsulated walls. In thermodynamical sense fluid is perfect and polytropic. Assuming that the initial density and temperature are strictly positive we will prove that for smooth enough spherically symmetric initial data there exists a uniqe spherically symmetric generalized solution locally in time, as well as for arbitrary time interval $[0,T]$, $T>0$.

S05.9
WED
10:15
I
11:15
B

Nonlinear evolution equations of second order with damping: existence and discretisation

Etienne Emmrich (Technische Universität Berlin)

We study different classes of nonlinear evolution equations of second order in time that also include first order terms. Two typical situations are:

i) nonlinear damping term that is a monotone, coercive, and bounded operator together with a linear zero-order term that is symmetric, strongly positive, and bounded;

ii) linear damping term that is symmetric, strongly positive, and bounded together with a nonlinear, bounded zero-order term that is the Gâteaux derivative of a possibly nonconvex, weakly coercive potential.

Our focus is on the (weak) convergence of approximate solutions constructed from a simple semi- or full discretisation, which implies existence of generalized solutions. Techniques from the theory of monotone operators and compactness arguments based on suitable a priori estimates and combined with stability properties of the numerical scheme are the basic ingredients. Examples arise, in particular, in solid mechanics and nonlinear elastodynamics.

This is joint work with Mechthild Thalhammer (Innsbruck) and David Šiška (Liverpool).

Large time behaviour of heat kernels and admissible potentials

Hendrik Vogt (TU Hamburg-Harburg)

S05.10
WED
11:15
I
11:45
B

Let T be a positivity improving selfadjoint C_0-semigroup on $L_2(\Omega,\mu)$ with generator $-H$. This framework encompasses all irreducible semigroups coming from Dirichlet forms as well as suitable perturbations thereof. It includes, in particular, Laplacians on connected manifolds, metric graphs and discrete graphs. The following two questions are going to be addressed in the talk:

- Assuming the semigroup operators $T(t)$ have integral kernels p_t, what is the long time behaviour of $p_t(x,y)$, given $x,y \in \Omega$?
- For a measurable potential $V\colon \Omega \to [0,\infty)$, when does the initial value problem

$$u'(t) + Hu(t) = Vu(t) \quad (t>0), \qquad u(0) = u_0$$

have a positive *exponentially bounded* solution, given a positive initial value $u_0 > 0$?

The talk is based on joint work with M. Keller, D. Lenz and R. Wojciechowski.

S05.11
WED
11:45
I
12:15
B

Self-similarity for the thin film Muskat problem

Bogdan-Vasile Matioc* (Universität Wien)
Philippe Laurençot (Université de Toulouse)

We discuss the asymptotic behavior of globally defined non-negative weak solutions of the thin film approximation

$$\begin{cases} \partial_t f &= \partial_x \left(f \partial_x \left((1+R) f + Rg \right) \right), \\ \partial_t g &= R_\mu \partial_x \left(g \partial_x \left(f + g \right) \right), \end{cases} \qquad (t,x) \in (0,\infty) \times \mathbb{R},$$

of the two-phase Muskat problem. The setting corresponds to a strongly coupled degenerate parabolic system consisting of two equations for the thicknesses f and g of two thin fluids layer that move under the influence of gravity, and it can also be interpreted as the two-phase generalization of the classical Porous Medium Equation

$$\partial_t f = \Delta(f^2).$$

The existence of globally defined non-negative weak solutions is established by interpreting the system of evolution equations as a gradient flow for the L_2-Wasserstein distance. The first step in the study of the asymptotic behaviour of the solutions is made by classifying all self-similar solutions of the problem. Then, introducing self-similar variables, it is shown that any non-negative global solution converges in the large towards a self-similar solution of the problem.

[1] Ph. Laurençot and B.-V. Matioc, *A gradient flow approach to a thin film approximation of the Muskat problem*, Calc. Var. Partial Differential Equations, 47 (2013) 319–341.
[2] Ph. Laurençot and B.-V. Matioc, *Self-similarity in a thin film Muskat problem*, preprint.

A class of non-classical solutions to multidimensional isentropic gas dynamics model

S05.12
WED
12:15
I
12:45
B

Marko Nedeljkov (University of Novi Sad)

The aim of using so called shadow wave solutions to 1-D conservation law systems is to incorporate a class of non-classical waves containing a delta function (delta shocks or singular shocks, for example) as new building block for solving the system (besides shocks, rarefaction waves and contact discontinuities). The inspiration for its definition is the famous Wave Front Tracking algorithm. Their strong points are possibility of using the Lax entropy-entropy flux admissibility criteria and one can treat a wave interaction problem in a relatively simple way. The present talk is a description of an (early) attempt for extending shadow wave concept to a multidimensional environment. The chosen system is the pressureless gas dynamics system for which one expect that some initial data give solutions containing delta function as in 1-D case. Also, the main example is radially symmetric initial data that has some similarities with an 1-D case.

Peakon asymptotics for the dispersionless Camassa-Holm equation

S05.13
THU
10:15
I
11:15
B

Gerald Teschl* (Universität Wien)
Jonathan Eckhardt (Universität Wien)

We discuss direct and inverse spectral theory for the isospectral problem of the dispersionless Camassa-Holm equation, where the weight is allowed to be a finite signed measure. In particular, we prove that this weight is uniquely determined by the spectral data and solve the inverse spectral problem for the class of measures which are sign definite. The results are applied to deduce several facts for the dispersionless Camassa-Holm equation. In particular, we show that initial conditions with integrable momentum asymptotically split into a sum of peakons as conjectured by McKean.

S05.14
THU
11:15
I
11:45
B

Periodic KdV solutions on FPU chains: existence and higher order asymptotics

Alice Mikikits-Leitner⋆ (Technische Universität München)
Gero Friesecke (Technische Universität München)
Michael Leitner (Technische Universität München)

In this talk we will consider a one-dimensional system of infinitely many coupled oscillators with generic nearest-neighbour interaction potential. Such FPU type chains are in general non-integrable. However, via a fixed point argument we have shown [1] that there exist periodic travelling waves with near-sonic speed, which converge to a KdV cnoidal wave in the continuum limit of long-wavelength (scaling $1/\varepsilon$) and small-amplitude (scaling ε^2). The convergence is seen to be of order ε^2. This is a periodic generalization of the result derived earlier for the single soliton case [2]. Finally, we present a scheme which allows to explicitly determine higher order asymptotic terms of the limit.

[1] G. Friesecke and A. Mikikits-Leitner, *Cnoidal Waves on Fermi–Past–Ulam Lattices*, preprint arXiv:1208.2805.
[2] G. Friesecke and R. Pego, *Solitary waves on FPU lattices: I. Qualitative properties, renormalization and continuum limit*, Nonlinearity, 12:1601–1627, 1999.

S05.15
THU
11:45
I
12:15
B

Finding eigenvalues of differential operators on unbounded domains using boundary value problems and contour integrals

Jens Rottmann-Matthes⋆ (Universität Bielefeld)
Wolf-Jürgen Beyn (Universität Bielefeld)
Yuri Latushkin (University of Missouri)

The stability analysis of nonlinear waves typically requires to show that there is no spectrum with positive real part of certain linear or nonlinear eigenvalue problems for differential operators on the real line. This is often done by a numerical Evans function calculation.

We propose to detect and approximate the point spectra of such operators by calculating contour integrals of solutions to boundary value problems which approximate the problem on the whole real line. The approach is based on Keldysh' theorem and extends a method from [1]. We show that errors due to the approximation are well-controlled. In particular, our approach provides a stable and robust alternative to evaluate and compute the zeros of the Evans function.

[1] W.-J. Beyn, *An integral method for solving nonlinear eigenvalue problems*, Linear Algebra and Its Applications, 436(10) (2012) 3839–3863.

Traveling wave solutions in scalar conservation laws with anomalous diffusion

S05.16
THU
12:15
I
12:45
B

Franz Achleitner⋆ (Vienna University of Technology)
Carlota Cuesta (University of the Basque Country)
Sabine Hittmeir (Vienna University of Technology)
Christian Schmeiser (University of Vienna)

We consider scalar conservation laws with anomalous diffusion,

$$\partial_t u + \partial_x f(u) = \partial_x \mathscr{D}^\alpha u, \quad (t,x) \in \mathbb{R}_+ \times \mathbb{R}, \tag{1}$$

for a density $u : \mathbb{R}_+ \times \mathbb{R} \to \mathbb{R}$, $(t,x) \mapsto u(t,x)$, a smooth flux function $f(u)$, a constant $0 < \alpha < 1$ and a non-local operator

$$(\mathscr{D}^\alpha u)(x) = \frac{1}{\Gamma(1-\alpha)} \int_{-\infty}^{x} \frac{u'(y)}{(x-y)^\alpha} dy. \tag{2}$$

We prove the global solvability for the Cauchy problem to (1) in L^∞, i.e. the existence of a unique mild solution for the Cauchy problem with essentially bounded initial datum, by following the analysis of Droniou, Gallouet and Vovelle in case of an anomalous diffusion realized by a fractional Laplacian. The crucial property is the non-negativity of the semigroup generated by $\partial_x \mathscr{D}^\alpha$, which is a consequence of its interpretation as an infinitesimal generator of an $(\alpha+1)$-stable Levy process, and allows to prove a maximum principle for solutions of the Cauchy problem.

A traveling wave solution of (1) - connecting different far-field values - satisfies a nonlinear Volterra integral equation on an unbounded interval. Assuming (even a bit less than) convexity of the flux function and that the solutions of the associated linear Volterra integral equation form a one-dimensional subspace of $H^2(\mathbb{R}_-)$, we can show the existence and uniqueness of monotone solutions satisfying the entropy condition for classical shock waves of the underlying inviscid conservation law. This requires to extend the well known results for the existence of viscous shock profiles, which solve (local) ordinary differential equations.

Moreover, we prove the dynamic nonlinear stability of the traveling waves under small perturbations, similarly to the case of the standard diffusive regularization, by constructing a Lyapunov functional. For more details, we refer to our article [1].

Finally, we will provide an example of a single layer shallow water flow, where the pressure is governed by a nonlinear conservation law with the aforementioned non-local diffusion term and additional dispersion term and report on our recent progress in the analysis of smooth shock profiles [2].

[1] F. Achleitner, S. Hittmeir and Ch. Schmeiser, On nonlinear conservation laws with a nonlocal diffusion term, *Journal of Differential Equations*, **250(4)** (2011), pp. 2177 – 2196.

[2] F. Achleitner, C. Cuesta and S. Hittmeir, Existence and Stability of travelling wave solutions in Korteweg-de Vries-Burgers equation with nonlocal diffusion, work in progress.

S05.17
THU
15:30
I
16:00
B

Zur Darstellung bikomplex-pseudoanalytischer Funktionen durch Integro-Differentialoperatoren

Peter Berglez (Technische Universität Graz)

Wir betrachten eine Klasse von bikomplexen pseudoanalytischen Funktionen, die der Bers-Vekua Gleichung

$$Dv = cv^* \quad \text{mit} \quad c = \gamma^{-1}(D\gamma)$$

genügen, wobei D den verallgemeinerten Cauchy-Riemann Operator und γ eine geeignete Lösung der Differentialgleichung

$$DD^*w - \frac{n(n+1)}{(z+z^*)^2}w = 0\,, \;\; n \in \mathbb{N}$$

bezeichnet.
Mit Hilfe einer Bäcklund-Transformation gelingt es für die Funktionen v explizite Darstellungen unter Verwendung von Integro-Differentialoperatoren herzuleiten. Diese Operatoren wirken dabei auf bikomplex-analytische Funtionen. Einige Spezialfälle, in denen die Funktion γ eine besondere Form besitzt, werden genauer untersucht.

Oscillatory Solutions of Non-local Models of Cell Aggregation

S05.18
THU
16:00
I
17:00
B

Klemens Fellner⋆ (University of Graz)
Barry Hughes (University of Melbourne)

We study non-local evolution equations for a density of individuals, which interact through a given symmetric potential. Such models appear in many applications such as swarming and flocking, opinion formation, inelastic materials, ... In particular, we are interested in interaction potentials, which behave locally repulsive, but aggregating over large scales, see e.g. [1, 2]. A particular example for such potentials was recently given in models of the alignment of the directions of filaments in the cytoskeleton.

We consider a family of prototypical repulsive-aggregating interaction potentials, where the repulsion in made more and more singular [3]. In this limit, highly oscillatory solutions occur, which can be studied in terms of a second order differential equations with a non-local integral term, which is responsible for the oscillatory behaviour.

[1] K. Fellner, G. Raoul, *Stability of stationary states of non-local interaction equations*, Mathematical and Computer Modelling 53 (2011) 1436Ñ1450.
[2] K. Fellner, G. Raoul, *Stable stationary states of non-local interaction equations*, Mathematical Models and Methods in Applied Sciences 20 (2010) 2267Ñ2291.
[3] B. Hughes, K. Fellner, *Continuum models of cohesice stochastic swarms: the effect of motility on aggregation patterns*, to appear in Physics D.

Dynamical properties of models for the Calvin cycle

S05.19
THU
17:00
I
17:30
B

Alan D. Rendall⋆ (Universität Mainz)
Juan J. L. Velázquez (Universität Bonn)

Modelling the Calvin cycle of photosynthesis leads to various systems of ordinary differential equations. We examined the dynamical behaviour of some of the models in the literature and proved that there are cases, with mass-action or Michaelis-Menten kinetics, where there are solutions for which all variables tend to infinity at late times. The asymptotics of these solutions were determined in detail and in one case there are two different time scales. In another model, where the concentration of ATP is explicitly included, it was shown that all solutions remain bounded.

[1] A. D. Rendall and J. J. L. Velázquez *Dynamical properties of models for the Calvin cycle*, Preprint arXiv:1303.3621.

S05.20
THU
17:30
I
18:00
B

Multiple time scale dynamics in chemical systems

Peter Szmolyan⋆ (Technische Universität Wien)
Ilona Kosiuk (Leipzig)
Christian Kühn (Technische Universität Wien)

In many applications multiple time scale dynamics occurs due to the presence of variables and parameters of very different orders of magnitudes. Situations with a clear "global" separation into fast and slow variables governed by singularly perturbed ordinary differential equations in standard form have been investigated in great detail. For multi-scale problems depending on several parameters it can already be a nontrivial task to identify meaningful scalings. Typically these scalings and the corresponding asymptotic regimes are valid only in certain regions in phase-space or parameter-space. Another issue is how to match these asymptotic regimes to understand the global dynamics.

In this talk I will show for several biochemical models that geometric methods based on invariant manifold theory and in particular the blow-up method provide a powerful approach to problems of this type.

[1] I. Gucwa (Kosiuk) , P. Szmolyan, Geometric singular perturbation analysis of an Autocatalator model, Discrete and Continuous Dynamical Systems S, 2 (4) (2009) 783–806.
[2] I. Kosiuk, P. Szmolyan, Scaling in singular perturbation problems: blowing-up a relaxation oscillator, SIAM Journal on Applied Dynamical Systems, 10 (4) (2011) 1307–1343.
[3] I. Kosiuk, P. Szmolyan, A new type of relaxation oscillations in a model for the mitotic oscillator, preprint (2013)
[4] C. Kuehn, P. Szmolyan, Multiscale geometry of the Olsen model and non-classical relaxation oscillations, preprint (2013)

Section S06

Functional Analysis, Real and Complex Analysis

Stephan Dahlke (Marburg)
Hans G. Feichtinger (Wien)

S06.1
MON
15:30
I
16:00
SR1

Invariant and Distributional Connections on Principal Fibre Bundles

Maximilian Hanusch (Universität Paderborn)

In quantum gauge field theories, symmetries usually are represented by Lie groups of automorphisms of the underlying principal fibre bundle. The corresponding invariant connections serve as a starting point for the construction of a reduced quantum configuration space. Alternatively, one might aim at a corresponding symmetry reduction directly on quantum level. In this talk we introduce an algebraic characterisation of invariant connections that often allows for explicit calculations. In particular, we go beyond the respective classical result by Wang as we drop the assumption of fibre-transitivity. Second, by means of C^*-dynamical systems we lift the classical symmetry directly to the quantum level. It turns out that in general quantization and reduction do not commute. This will be discussed for the case of loop quantum gravity.

S06.2
MON
16:00
I
16:30
SR1

Spectral properties of the $\overline{\partial}$-Neumann operator

Friedrich Haslinger (Universität Wien)

We consider the $\overline{\partial}$-Neumann operator

$$N : L^2_{(0,q)}(\Omega) \longrightarrow L^2_{(0,q)}(\Omega),$$

where $\Omega \subset \mathbb{C}^n$ is bounded pseudoconvex domain, and

$$N_\varphi : L^2_{(0,q)}(\Omega, e^{-\varphi}) \longrightarrow L^2_{(0,q)}(\Omega, e^{-\varphi}),$$

where $\Omega \subseteq \mathbb{C}^n$ is a pseudoconvex domain and φ is a plurisubharmonic weight function. Using a general description of precompact subsets in L^2-spaces we obtain a characterization of compactness of the $\overline{\partial}$-Neumann operator, which can be applied to related questions about Schrödinger operators with magnetic field and Pauli and Dirac operators and to the complex Witten Laplacian. In addition, the spectrum of the $\overline{\partial}$-Neumann Laplacian on the Fock space $L^2(\mathbb{C}^n, e^{-|z|^2})$ is explicitly computed. It turns out that it consists of positive integer eigenvalues each of which is of infinite multiplicity.

[1] F. Haslinger, *Compactness for the $\overline{\partial}$-Neumann operator - a functional analysis approach*, Collectanea Mathematica 62 (2011), 121–129.

[2] F. Haslinger, *Spectrum of the $\overline{\partial}$-Neumann Laplacian on the Fock space*, J. of Math. Anal. and Appl. 402 (2013), 739–744.

Some aspects of singular Weyl–Titchmarsh–Kodaira theory for Dirac operators

S06.3
MON
16:30
I
17:00
SR1

Rainer Brunnhuber* (Alpen-Adria Universität Klagenfurt)
Jonathan Eckhardt (University of Vienna)
Aleksey Kostenko (University of Vienna)
Gerald Teschl (University of Vienna)

Weyl–Titchmarsh–Kodaira theory has originally been developed for Schrödinger operators with at least one regular endpoint and has thereafter been generalized to other classes of operators including Dirac operators. It is nowadays an inherent part in the field of spectral theory for Sturm–Liouville and Dirac operators. In [3] it was shown that certain aspects of the classical theory also hold in the case of Schrödinger operators with two singular endpoints. These results have been extended to Dirac operators in [1] and [2].

The aim of the present talk is to show how classical Weyl–Titchmarsh–Kodaira theory can be generalized to the case of one-dimensional Dirac operators with two singular endpoints.

In particular, we will show how to define a (singular) Weyl function in this case. Furthermore, we will establish an associated spectral transformation which maps our one-dimensional Dirac operator to a multiplication operator and we will show how essential supports for the Lebesgue decomposition of the spectral measure can be obtained from the boundary behavior of the singular Weyl function. Moreover, we will derive an integral representation for the singular Weyl function and give a criterion when it is a generalized Nevanlinna function. If the endpoint a is limit circle, the singular Weyl function will turn out to be a Herglotz–Nevanlinna function.

[1] R. Brunnhuber, *Weyl–Titchmarsh–Kodaira Theory for Dirac Operators with Strongly Singular Potentials*, diploma thesis, University of Vienna, 2012. http://othes.univie.ac.at/20726/
[2] R. Brunnhuber, J. Eckhardt, A. Kostenko, G. Teschl, *Singular Weyl–Titchmarsh–Kodaira theory for Dirac operators*. http://arxiv.org/abs/1305.3099v1
[3] A. Kostenko, A. Sakhnovich, G. Teschl, *Weyl–Titchmarsh theory for Dirac operators with strongly singular potentials*, Int. Math. Res. Not. **2012**, 1699–1747 (2012).

On translation invariant operators

S06.4
MON
17:00
I
17:30
SR1

Gerhard Racher (Universität Salzburg)

We present some conditions under which non-zero translation invariant operators over locally compact groups either exist or do not exist.

S06.5
MON
17:30
I
18:00
SR1

Smoothness in Banach Algebras and Norm Controlled Inversion

Andreas Klotz* (TU Wien)
Karlheinz Gröchenig (Universität Wien)

Generalizing an approach of Nikolski, we say that a subalgebra $\mathscr{A}$ of a unital Banach algebra $\mathscr{B}$ admits *norm controlled inversion*, if there is a positive function h that satisfies

$$\|a^{-1}\|_{\mathscr{A}} \leq h(\|a\|_{\mathscr{A}}, \|a^{-1}\|_{\mathscr{B}})$$

for all invertible elements of $\mathscr{B}$.

The prototype of norm-controlled inversion is the quotient rule for the algebra C^1 of continuously differentiable functions, which leads to an estimate for the C^1-norm of $1/f$, namely

$$\|\tfrac{1}{f}\|_{C^1} \leq 2\|f\|_{C^1}\|\tfrac{1}{f}\|_\infty^2 .$$

We show that smoothness implies norm controlled inversion. Smooth subalgebras of not necessarily commutative Banach algebras are obtained using classical constructions of approximation theory and resemble spaces of differentiable functions, Besov spaces or Bessel potential spaces, or ultra-smooth Dales-Davie algebras. Furthermore, based on work of Baskakov, we derive explicit norm control estimates for infinite matrices with polynomial off-diagonal decay.

[1] K. Gröchenig and A. Klotz. Noncommutative approximation: inverse-closed subalgebras and off-diagonal decay of matrices. *Constr. Approx.*, 32(3) : 429 – 466, 2010.
[2] K. Gröchenig and A. Klotz. Norm-controlled inversion in smooth Banach algebras, II. *ArXiv e-prints*, math.FA 1211.2974, 2012.

Division of distributions with the Oka principle and small ideals of operators

Bernhard Gramsch (Universität Mainz)

S06.6
TUE
11:15
|
11:45
SR1

The complex homotopy principle of Oka - Grauert - Gromov (cf.,e.g. Ann. of Math. 175 (2012) 45 - 69) in the version of Bungart and Leiterer (cf.: Banach algebras, de Gruyter 1998, 189 - 204) is applied to the parameter dependent factorisation for operator valued distributions:

$B(t) = D(t)T(t)$ (1)

where B and D are distributions and T an (analytic) Fredholm function depending continuously on a parameter t (cf. e.g.: Kaballo : Indag Math. 23 (2012) 970 - 994). Despite classical counterexamples in the scalar valued case, some sufficient conditions can be given for (1) with T(t,z), z one complex variable. For several variables the situation is much more complicated. In some cases " the quotient D" of B and the multiplication with T has the form :

$D(t) = B(t)A(t) + S(t)$ (2)

with a multiplication operator A(t) and an operator distribution S(t) with values in small ideals with fast decreasing approximation numbers, respectively eigenvalues. These small ideals have been considered by Grothendieck, Rotfeld and Rosenberger (cf. Bull. Lond. M. S. 44 (2012) 1085 - 1102; Math. Z. 133 (1973) 219 - 242). (1) and (2) can be applied to the Hörmander classes of pseudodifferential operators as Fréchet algebras with submultiplicativity and spectral invariance. (cf. Lauter, NIstor, e.g.: J. Funct.Anal. 169 (1999) 81 - 120; J. Math. Jussieu 4 (2005) 65 - 82 ; Schrohe, e.g. Math. Nachr. 199 (1999), 145 - 185. There are some possibly new results for scalar distributions on regions in the complex plane. Problems related to (1) and (2) are mentioned.

S06.7
TUE
11:45
I
12:15
SR1

On sequence space representations of spaces of smooth functions and distributions

Christian Bargetz (Universität Innsbruck)

The Valdivia-Vogt structure table

$$\begin{array}{ccccccccccccccc}
\mathscr{D} & \subset & \mathscr{S} & \subset & \mathscr{D}_{L^p} & \subset & \dot{\mathscr{B}} & \subset & \mathscr{D}_{L^\infty} & \subset & \mathscr{O}_C & \subset & \mathscr{O}_M & \subset & \mathscr{E} \\
\| & & \| & & \| & & \| & & \| & & \| & & \| & & \| \\
\mathbb{C}^{(\mathbb{N})}\widehat{\otimes}_\iota s & \subset & s\widehat{\otimes}s & \subset & \ell^p\widehat{\otimes}s & \subset & c_0\widehat{\otimes}s & \subset & \ell^\infty\widehat{\otimes}s & \subset & s'\widehat{\otimes}_\iota s & \subset & s'\widehat{\otimes}_\pi s & \subset & \mathbb{C}^{\mathbb{N}}\widehat{\otimes}s
\end{array}$$

presented in [1, 3] contains the most prominent spaces of smooth functions occurring in the theory of distributions together with their sequence space representations. Analogously its "dual version"

$$\begin{array}{ccccccccccccccc}
\mathscr{E}' & \subset & \mathscr{S}' & \subset & \mathscr{D}'_{L^p} & \subset & \mathscr{D}'_{L^\infty} & \subset & \mathscr{O}'_M & \subset & \mathscr{O}'_C & \subset & \mathscr{D}' \\
\| & & \| & & \| & & \| & & \| & & \| & & \| \\
\mathbb{C}^{(\mathbb{N})}\widehat{\otimes}s' & \subset & s'\widehat{\otimes}s' & \subset & \ell^p\widehat{\otimes}s' & \subset & \ell^\infty\widehat{\otimes}s & \subset & s\widehat{\otimes}_\iota s' & \subset & s\widehat{\otimes}_\pi s' & \subset & \mathbb{C}^{\mathbb{N}}\widehat{\otimes}s'
\end{array}$$

contains the most prominent spaces of distributions together with their sequence space representations. We show that there is an isomorphism $\Phi\colon \mathscr{E} \to \mathbb{C}^{\mathbb{N}}\widehat{\otimes}s$ such that every restriction to any other space in the strucutre table provides an isomorphism between this space and its sequence space representation, i.e., using Φ, we can interpret the Valdivia-Vogt structure table as a commutative diagram.
We use Φ to construct an isomorphism $\Psi\colon \mathscr{D}' \to \mathbb{C}^{\mathbb{N}}\widehat{\otimes}s'$ which allows us to interpret the "dual Valdivia-Vogt table" as a commutative diagram. We discuss some applications of this commutativity results that provide structural insights into these spaces or new sequence space representations of spaces of smooth functions or distributions.

[1] C. Bargetz, *A sequence space representations of L. Schwartz' space $\mathscr{O}_C$*, Arch. Math., 98(4) (2012) 317–326

[2] C. Bargetz, *Commutativity of the Valdivia-Vogt table of sequence space representations of spaces of smooth functions*, Preprint. To appear in "Mathematische Nachrichten".

[3] N. Ortner and P. Wagner, *Explicit representations of L. Schwartz' spaces $\mathscr{D}_{L^p}$ and $\mathscr{D}'_{L^p}$ by the sequence spaces $s\widehat{\otimes}\ell^p$ and $s'\widehat{\otimes}\ell^p$, respectively, for $1 < p < \infty$*, J. Math. Anal. Appl., 404(1) (2013) 1–10.

An algebraic approach to microlocal analysis

S06.8
TUE
12:15
|
12:45
SR1

Michael Kunzinger* (Universität Wien)
Shantanu Dave (Universität Wien)

We present a unified approach to measuring regularity in various settings. The underlying concept is that of a singularity structure, a triple (A,X,Y) consisting of a filtered algebra A and graded Fréchet A-modules X and Y. In this minimal setting we measure the regularity of polynomially tame (linear or nonlinear) mappings $\phi : X \to Y$ and give abstract definitions of wavefront sets, distributions, and propagation of singularities. Classical examples that can be described algebraically in this approach are singular support and wavefront sets of Schwartz distributions, as well as microlocal ellipticity.

[1] Dave, S., Kunzinger, M., Singularity structures for noncommutative spaces, *Trans. Amer. Math. Soc., to appear*

Distribution Theory based on Time-Frequency Analysis

S06.9
TUE
15:30
|
16:00
SR1

Hans G. Feichtinger (Universität Wien)

The goal of this presentation is to give a short summary of basic facts concerning time-frequency analysis, in particular Gabor analysis. It provides the possibility of expanding functions (and in fact tempered distributions) as unconditionally convergent double sums of time-frequency shifted atoms, typically some non-zero Schwartz function, like the Gauss function.

For the analysis of the various mappings (e.g. from the signal to the sampled short-time Fourier transform) various requirements have to be made, and a certain Segal algebra $S_0(R^d)$ turned out to be a versatile tool in this context.

We will indicate that this space is also quite useful for the context of classical Fourier analysis. Furthermore we point out how it can be used to establish a so-called Banach Gelfand triple, consisting of the space $S_0(R^d)$, the Hilbert space $L^2(R^d)$ and the dual space, each one contained in the next one. Among others one can view the Fourier transform as a unitary Banach Gelfand triple automorphism of this triple, mapping pure frequencies into Dirac measures (and being uniquely determined by this property).

S06.10
TUE
16:00
I
16:30
SR1

Rational analytic wavelets and applications

Margit Pap (University of Pécs)

Analyzing continuous-time systems is of great significance especially in association with high precision control applications. The approximation and identification of transfer functions of a continuous-time-invariant system is an important part of system identification. The transfer function of such systems belongs to the Hardy space of the upper half plane. Recently H. G. Feichtinger and M. Pap in [2] introduced a new example of multiresolution analysis which gives an efficient approximation for the functions from the Hardy space of the upper half plane. The resolution levels are spanned by rational analytic wavelets, namely by the Malmquist-Takenaka system for the upper half plane, with a special localization of the poles. These wavelets can be considered as a solution to a question formulated by Y. Meyer connected to the construction of analytic wavelets.

T. Eisner and M. Pap in [1] proved the discrete orthogonality of the Malmquist-takenaka system for the upper half plane. Based on the discrete orthogonality of the Malmquist-Takenaka system we introduce new rational interpolation operators for the upper half plane and lower half plane as well. Combining this two interpolations we can give exact interpolation for a large class of rational functions among them for Runge test function.

[1] T. Eisner, M. Pap, Discrete orthogonality of the Malmquist-Takenaka system of the upper half plane and rational interpolation, JFAA, accepted.

[2] H. G. Feichtinger, M. Pap, Hyperbolic Wavelets and Multiresolution in the Hardy Space of the Upper Half Plane, Blaschke Products and Their Applications, Fields Institute Communications Volume 65, 2013, pp 193-208.

[3] B. Király, M. Pap, A. Pielgermayer, Sampling and rational interpolation for non-band-limited signals.

Section S07

Numerical Analysis and Scientific Computing

Michael Günther (Wuppertal)
Olaf Steinbach (Graz)

S07.1
TUE
17:00
I
18:00
SR1

Model order reduction for dynamical systems with random parameters

Roland Pulch⋆ (Bergische Universität Wuppertal)
E. Jan W. ter Maten (Technische Universiteit Eindhoven)

The mathematical modelling of electric circuits, mechanical multibody dynamics or chemical reactions often yields time-dependent systems consisting of ordinary differential equations or differential-algebraic equations. The involved physical parameters exhibit uncertainties due to measurement errors or imperfections of a manufacturing process, for example. We replace the parameters by random variables for an uncertainty quantification (UQ). Both the dimension of the state space and the number of random variables are large in practical applications.

We investigate approaches for model order reduction (MOR) to decrease the complexity of these stochastic systems. In intrusive methods for UQ, the stochastic Galerkin technique yields an even larger coupled system satisfied by the coefficients of a polynomial chaos expansion. Thus we apply MOR schemes to reduce the state space of this huge system. In non-intrusive methods for UQ, the deterministic dynamical systems have to be resolved many times due to the curse of dimensionality. Therein, parameterised model order reduction (PMOR) saves computational effort, see [1] for this idea. Furthermore, we can use a sensitivity analysis to reduce the set of random parameters by neglecting inessential random variables such that the required number of deterministic solves becomes lower, see [2]. Results of numerical simulations are presented for test examples.

[1] E.J.W. ter Maten, R. Pulch, W.H.A. Schilders, and H.H.J.M. Janssen, *Efficient calculation of uncertainty quantification*, submitted to: Progress in Industrial Mathematics at ECMI 2012, Mathematics in Industry series, Springer.
http://www.win.tue.nl/analysis/reports/rana12-38.pdf

[2] R. Pulch, E.J.W. ter Maten, F. Augustin, *Sensitivity analysis and model order reduction for random linear dynamical systems*, Preprint BUW-IMACM 13/07 (2013).
http://www.imacm.uni-wuppertal.de/imacm/research/preprints.html

Local error structures and order conditions for exponential splitting methods

S07.2
TUE
18:00
I
18:30
SR1

*Winfried Auzinger** (Technische Universität Wien)
Wolfgang Herfort (Technische Universität Wien)

For the numerical solution of evolution equations of the type

$$u' = A(u) + B(u), \quad u(0) \text{ given},$$

a natural approach is to use operator splitting. A general s-stage splitting method has the form (with time step h)

$$u_{n+1} = \mathscr{S}(h,u_n) = \mathscr{S}_s(h,\mathscr{S}_{s-1}(h,\dots\mathscr{S}_1(h,u_n)))$$

with

$$\mathscr{S}_j(h,v) = \mathscr{E}_B(b_j h,\mathscr{E}_A(a_j h,v))$$

where $\mathscr{E}_A$ and $\mathscr{E}_B$ denote the subflows associated with A and B. The splitting scheme has order at least 1 iff $a_1+\dots+a_s = b_1+\dots+b_s = 1$; this is the basic consistency requirement. Conditions for higher order are usually obtained by a rather complicated explicit, recursive application of the Baker-Campbell-Hausdorff formula. Here we follow a different approach: A representation for the derivatives $\mathscr{L}^{(k)}(0,\cdot) = \frac{d^k}{dt^k}\mathscr{L}(t,\cdot)|_{t=0}$ of the local error operator

$$\mathscr{L}(t,\cdot) = \big(\mathscr{S}(t,\cdot) - \mathscr{E}_{A+B}(t,\cdot)\big)$$

can be evaluated by a simple recursive computer code relying on evolution equations satisfied by the stages $\mathscr{S}_j(t,\cdot)$. We study the structure of the resulting conditions for order p,

$$\mathscr{L}(0,\cdot) = \mathscr{L}'(0,\cdot) = \dots = \mathscr{L}^{(p-1)}(0,\cdot) = 0$$

in terms of Lie-commutators of A and B, and we show how a minimal, non-redundant set of order conditions, in the form of algebraic equations for the coefficients a_j and b_j, can be extracted from the terms $\mathscr{L}^{(k)}(0,\cdot)$ in a systematic way. The theoretical foundation for this procedure is discussed together with its consequences.

S07.3
WED
10:15
|
11:15
SR1

Boundary element methods for resonance problems

Gerhard Unger⋆ (TU Graz)
Olaf Steinbach (TU Graz)

We reduce resonance problems in acoustics and electromagnetics to the boundary of the computational domain by using eigenvalue problem formulations in terms of boundary integral equations and we apply boundary element methods for their numerical approximation. Eigenvalue problem formulations for resonance problems which are based on standard boundary integral equations exhibit besides the resonances additional eigenvalues which are eigenvalues of a related "interior" eigenvalue problem [1]. For some typical applications it is hard to extract the resonances in practical computations when using standard boundary integral formulations. In this talk we present regularized combined boundary integral formulations which only exhibit resonances as eigenvalues. We provide a numerical analysis of the boundary element approximations of these eigenvalue problem formulations and give numerical examples.

[1] O. Steinbach, G. Unger: Convergence analysis of a Galerkin boundary element method for the Dirichlet Laplacian eigenvalue problem. SIAM J. Numer. Anal., 50 (2012), 710-728.

S07.4
WED
11:15
|
11:45
SR1

On the LQR Problem and the associated Differential Riccati Equations

Hermann Mena (Universität Innsbruck)

The numerical treatment of linear quadratic regulator problems for parabolic partial differential equations requires solving large-scale Riccati equations. In the finite time horizon case, the Riccati differential equation (RDE) arises. We show that within a Galerkin projection framework the solutions of the finite-dimensional RDEs converge in the strong op- erator topology to the solutions of the infinite-dimensional RDEs. Moreover, we briey review efficient numerical methods for solving RDEs capable of exploiting the structure on the problem. Typically, the coefficient matrices of the resulting equations have a given structure (e.g. sparse, symmetric, low rank). Numerical experiments show the performance of the proposed methods.

Amos-Type Bounds for Modified Bessel Function Ratios

S07.5
WED
11:45
I
12:15
SR1

Kurt Hornik⋆ (WU Wirtschaftsuniversität Wien)
Bettina Grün (Johannes Kepler Universität Linz)

Statistical inference for spherical data using von Mises-Fisher distributions involves inverting ratios $R_\nu = I_{\nu+1}/I_\nu$ of modified Bessel functions and computing their antiderivatives (equivalently, I_ν and its logarithm). Lower and upper bounds for R_ν by functions of the form $G_{\alpha,\beta}(t) = t/(\alpha + \sqrt{t^2+\beta^2})$ were first introduced by Don Amos in 1974, and subsequently re-established and extended in several publications. These bounds are very attractive because they allow both for explicit inversion and integration. We systematically investigate these bounds for the cases where R_ν is positive for all $t > 0$, or equivalently, where $\nu \geq -1$ or ν is a negative integer. For $\nu \geq -1$, we explicitly describe the set of lower bounds and show that it has $G_{\nu+1/2,\nu+3/2}$ as its greatest element, and characterize the set of upper bounds and its minimal elements, which are tangent to R_ν in exactly one point $0 \leq t \leq t^*_\nu(\alpha^*_\nu) \leq \infty$, and for $\nu \geq -1/2$ have R_ν as their lower envelope. If ν is a negative integer, we explicitly describe the sets of lower and upper bounds, and give their greatest and least elements, respectively. Finally, we indicate how these bounds are used for statistical inference using von-Mises Fisher distributions, and can be employed for obtaining asymptotic approximations for modified Bessel functions.

Interpolation of matrix functions at Leja points

S07.6
WED
12:15
I
12:45
SR1

Peter Kandolf⋆ (Universität Innsbruck)
Alexander Ostermann (Universität Innsbruck)
Stefan Rainer (Universität Innsbruck)
Marco Caliari (Università di Verona)

Exponential integrators require a reliable and efficient implementation of the action of the matrix exponential and related φ functions. In this work we consider the Leja method for performing this task. We give an overview on recent developments with a closer look on a new a posteriori error estimate. A numerical comparison of a revised implementation to other methods from the literature is presented.

For the new error estimate we define the notion of a residual based estimate where the residual is obtained from differential equations defining the φ functions. For the numerical investiagtion of the newly defined error estimate as well as the comparision of the Leja interpolation, we rely on test examples from spatial discretizations of time dependent partial differential equations. The experiments show that our new error estimate is robust and that Leja interpolation performs very well in comparison to other methods.

S07.7
THU
10:15
I
10:45
SR1

Potential methods for Stokes and semilinear Brinkman systems on Lipschitz domains

Wolfgang Wendland (Universität Stuttgart)

The layer potential method and Schauder's fixed point theorem are employed to show the existence of solutions for the Poisson problem associated to a semilinear Brinkman system on Lipschitz domains in $\mathbb{R}^n (n \geq 2)$ with Dirichlet or Robin boundary condition and given data in Sobolev and Besov spaces.

This is joint work with Mirela Kohr and Massimo Lanza de Cristoforis.

S07.8
THU
10:45
I
11:15
SR1

Edge detection approaches in numerical methods for conservation laws

Martina Wirz (Technische Universität Braunschweig)

The detection of discontinuities in the numerical solution of a given conservation law is an important tool to handle shocks or discontinuous initial data appropriately. We will focus on an edge detector based on the conjugated Fourier partial sum which can be written as the convolution of a function f and the conjugated Dirichlet kernel and has the property to converge pointwise to the jump height of f. A generalized partial sum and thus an acceleration of the convergence rate can be achieved by considering generalized kernels instead of the Dirichlet kernel as proposed in [1]. The convergence rate for this generalized sums is improved away from the discontinuity, which has been validated in the context of spectral methods in one dimension and extended to the quasi-two-dimensional approach in [2]. We will show that this edge detection technique can be extended to the fully two-dimensional case considering the (generalized) conjugated Fourier partial sums in two variables, compare [4] in the classical case. Furthermore, we give different approaches to apply this edge detector efficiently in the context of general high order methods where nodal or modal coefficients are given, e.g. for the Spectral-Difference- or Discontinuous-Galerkin-method on triangles [3]. Several testcases show superior results of the Fourier-based detector compared to a common coefficient-based shock indicator.

[1] A. Gelb, E. Tadmor, *Detection of Edges in Spectral Data*, Applied and Computational Harmonic Analysis **7**, 101-135 (1999)

[2] A. Gelb, E. Tadmor: Spectral reconstruction of one- and two-dimensional piecewise smooth functions from their discrete Data. Mathematical Modeling and Numerical Analysis 36, 155-175 (2002)

[3] A. Meister, S. Ortleb, Th. Sonar, M. Wirz: An extended Discontinuous Galerkin and Spectral Difference Method with modal filtering. ZAMM 93 (6-7), 459-464 (2013)

[4] F. Móricz: Extension of a Theorem of Ferenc Lukács from Single to Double Conjugate Series. Journ. Math. Analysis and Appl. 259, 582-592 (2001)

Instance optimality for the maximum strategy

S07.9
THU
11:15
|
11:45
SR1

Lars Diening⋆ (LMU Munich)
Rob Stevenson (University of Amsterdam)
Christian Kreuzer (University of Bochum)

We study the adaptive finite element approximation of the Dirichlet problem

$$-\Delta u = f$$

with zero boundary values using linear Ansatz functions and newest vertex bisection. Our approach is based on the minimization of the corresponding Dirichlet energy. We show that the maximums strategy attains every energy level with a number of degrees of freedom, which is proportional to the optimal number. As a consequence we achieve instance optimality of the error.

An energy space approach for the Cauchy problem

S07.10
THU
11:45
|
12:15
SR1

Olaf Steinbach⋆ (TU Graz)
Than Phan Xuan (TU Hanoi)

In this talk we discuss the Cauchy problem of the Laplace equation where the complete Cauchy data are given on some part of the boundary, but are unknown on the remainder. For the solution of this inverse problem we consider a tracking type functional for the given Neumann datum while the unknown Dirichlet datum enters as a regularisation. For both we consider the related energy norms which can be realised by using Steklov–Poincaré or boundary integral operators. We present a detailed numerical analysis of our approach, and we give some numerical results also in comparison to more standard approaches when using more convenient norms.

S07.11
THU
15:30
I
16:00
SR1

Optimal Control of Load Changes for Molten Carbonate Fuel Cells

Kurt Chudej⋆ (Universität Bayreuth)
Armin Rund (Universität Graz)

Stationary power plants working with molten carbonate fuel cells are a promising technology for the future. To enhance service life, a detailed knowledge of their dynamical behaviour is essential. The possiblity of fast and save load changes is important for daily operation of these power plants. To predict the dynamical behaviour a hierachical family of mathematical models has been developed in the past.

We present a mathematical model (optimal control s.t. p.d.e.s) together with numerical results.

[1] A. Rund, K. Chudej, *Optimal control for a simplified 1D fuel cell model*, Mathematical and Computer Modelling of Dynamical Systems, 18, 4 (2012) 379–396.
[2] A. Rund, K. Chudej, J. Kerler, H.J. Pesch, K. Sternberg: *Optimal control of coupled multiphysics problems: Guidelines for real-life applications demonstrated for a complex fuel cell model*, GAMM-Mitteilungen, 35, 2 (2012) 136–174.

S07.12
THU
16:00
I
16:30
SR1

Fully Discrete Splitting Methods for Rotating Bose-Einstein Condensates

Othmar Koch⋆ (Technische Universität Wien)
Winfried Auzinger (Technische Universität Wien)
Harald Hofstätter (Technische Universität Wien)
Mechthild Thalhammer (Universität Innsbruck)

We analyze the convergence of a full discretization of the Gross-Pitaevskii equation with rotation term modelling a rotating Bose-Einstein condensate. The spatial discretization is based on a Fourier-Laguerre-Hermite pseudospectral method and time integration is performed by high-order splitting methods. We show the spectral accuracy in space and classical nonstiff order in time under natural regularity assumptions on the exact solution. Numerical experiments illustrate the theoretical results and demonstrate the feasibility of adaptive time stepping based on estimates of the local time-stepping error based on either embedded splitting formulae or a defect correction approach.

Inexact Restoration approach for minimization with inexact evaluation of the objective function

S07.13
THU
16:30
I
17:00
SR1

Nataša Krejić⋆ (University of Novi Sad)
José Mario Martínez (State University of Campinas)

A new method is introduced for minimizing a function that can be computed only inexactly, with different levels of accuracy. The challenge is to evaluate the (potentially very expensive) objective function with low accuracy as far as this does not interfere with the goal of getting high accuracy minimization at the end. For achieving this goal the problem is reformulated in terms of constrained optimization and handled with an inexact Restoration technique. Convergence is proved and numerical experiments motivated by Electronic Structure calculations are presented, which indicate that the new method overcomes current approaches for solving large-scale problems.

Nonmonotone line search methods with variable sample size

S07.14
THU
17:00
I
17:30
SR1

Nataša Krklec Jerinkić⋆ (Faculty of Sciences, University of Novi Sad)
Nataša Krejić (Faculty of Sciences, University of Novi Sad)

Unconstrained minimization of the objective function in the form of mathematical expectation is considered. The sample average is used in order to approximate the objective function. The sample size is allowed to vary during the optimization process. At each iteration, the candidate sample size is obtained by comparing two measures of progress Ð the lack of precision and the function decrease. Additional safeguard rule is imposed to prohibit unproductive decrease of the sample size. We analyze different nonmonotone line search strategies and compare them on a few test problems.

Section S08

Stochastics and Applications

Stefan Geiss (Innsbruck)
Peter Imkeller (Berlin)

S08.1
MON
15:30
I
16:30
F

Root's barrier, viscosity solutions of obstacle problems and reflected FBSDEs

Gonçalo dos Reis[⋆] (Technische Universität Berlin)
Harald Oberhauser (Technische Universität Berlin)

Following work of Dupire (2005), Carr–Lee (2010) and Cox–Wang (2011) on connections between Root's solution of the Skorokhod embedding problem, free boundary PDEs and model-independent bounds on options on variance we propose an approach with viscosity solutions. Besides extending the previous results, it gives a link with reflected FBSDEs as introduced by El Karoui et. al. (1997) and allows for easy convergence proofs of numerical schemes via the Barles–Souganidis (1991) method.

[1] G. Barles and P. E. Souganidis. *Convergence of approximation schemes for fully nonlinear second order equations*. Asymptotic Anal., 4(3):271–283, 1991

[2] P. Carr and R. Lee. *Hedging variance options on continuous semimartingales*. Finance and Stochastics, 14(2):179–207, 2010

[3] A. M. G. Cox and J. Wang. *Root's Barrier: Construction, Optimality and Applications to Variance Options*. To appear in Annals of Applied Probability, April 2011

[4] B. Dupire. *Arbitrage bounds for volatility derivatives as free boundary problem*. Presentation at PDE and Mathematical Finance, KTH, Stockholm, 2005

[5] N. El Karoui, C. Kapoudjian, E. Pardoux, S. Peng and M. C. Quenez. *Reflected solutions of backward SDE's, and related obstacle problems for PDE's*. The Annals of Probability, 25(2):702–737, 1997.

S08.2
MON
16:30
I
17:00
F

Stable Limit Theorem for U-Statistics Processes Indexed by a Random Walk

Martin Wendler* (Ruhr-Universität Bochum, Germany)
Brice Franke (Université de Brest, France)
Françoise Pène (Université de Brest, France)

Let $(S_n)_{n\in\mathbb{N}}$ be a random walk in the domain of attraktion of an α-stable Lévy process and $(\xi_n)_{n\in\mathbb{N}}$ a sequence of i.i.d. random variables (called scenery). Kesten and Spitzer studied the random walk in random scenery, that is the process $\sum_{k=1}^{n}\xi(S_k)$, and showed that it converges to a long range dependent self similar process.

In the talk, we want to investigate U-statistics indexed by the random walk S_n, that is

$$U_n := \sum_{1\le i<j\le n} h(\xi(S_i),\xi(S_j))$$

for some symmetric bivariate function h. In the case of finite fourth moments, Guillotin-Plantard and Ladret showed weak convergence of the sequential U-statistic process indexed by S_n. Adapting techniques for U-statistics with stable laws from Heinrich and Wolf, we can avoid this moment condition. This leads to a greater variety of possible limit processes, as the $h(\xi(i),\xi(j))$ might be in the domain of attraction of an β-stable random variable for different β.

Our aim is to prove the weak convergence of U-statistic process indexed by S_n towards stable, long-range dependent, selfsimilar processes without the fourth moment condition. Addtitionally, under the assumption of finite second moments, we will establish a law of the iterated logarithm for the U-statistic U_n.

[1] P. CABUS, N. GUILLOTIN-PLANTARD, Functional limit theorems for U-statistics indexed by a random walk, *Stochastic Processes and their Application* **101** (2002) 143-160.

[2] B. FRANKE, F. PÈNE, M. WENDLER, Stable Limit Theorem for U-Statistic Processes Indexed by a Random Walk, *preprint* (2013) arXiv:1212.2133.

[3] N. GUILLOTIN-PLANTARD, V. LADRET, Limit theorems for U-statistics indexed by a one dimensional random walk, *ESAIM* **9** (2005) 95-115.

[4] L. HEINRICH, W. WOLF, On the convergence of U-statistics with stable limit distribution, *Journal of Multivariate Analysis* **44** (1993) 266-278.

[5] H. KESTEN, F. SPITZER, A limit theorem related to an new class of self similar processes, *Zeitschrift für Wahrscheinlichkeitstheorie und verwandte Gebiete* **50** (1979) 5-25.

S08.3
MON
17:00
I
17:30
F

A logarithmic stable limit law for the geometric mean of recurrence times of the simple symmetric random walk in $\mathbb{Z}^2$

Lothar Heinrich* (Universität Augsburg)
Mirjam Appelt (stud. math., Universität Ulm)

We first recall some basis facts on the simple symmetric random walk on the $d-$dimensional integer lattice $\mathbb{Z}^d$ starting in the origin **o** and moving in each step to one of the $2d$ nearest neighbours with probability $1/2d$. According to a famous result of G. Pólya, see [1], this random walk is recurrent only for $d=1$ and $d=2$ but for both cases the recurrence time τ_i (= even number of steps between the $(i-1)$st and ith return to **o**) has infinite mean. Our aim is to study the asymptotic behaviour of the i.i.d. sequence $\{\tau_i, i \geq 1\}$. Whereas for $d=1$ the τ_i's belong to the domain of attraction of the stable r.v. $S_{1/2,1}$ with characteristic exponent $\alpha = 1/2$ and skewness parameter $\beta = 1$, see [2] (p. 171), the situations is completely different for $d=2$. A thourough study of the characteristic function $\mathbf{E}\exp\{it\tau_1\}$ for small $|t|$ provides the relation $\mathbf{P}(\log\tau_1 \geq x) = \pi/x + \mathscr{O}(x^{-2})$ as $x \to \infty$. This implies that $\log\tau_1$ belongs to the domain of attraction of the stable r.v. $S_{1,1}$ (with $\alpha = 1$ and $\beta = 1$) having the characteristic function $\mathbf{E}\exp\{itS_{1,1}\} = \exp\{-\pi|t|/2 + it\log(1/|t|)\}$ for all real t. Finally, after some lenghty calculation we get the following limit in distribution

$$\frac{1}{\pi n}\sum_{i=1}^{n}\log\tau_i - \log n - \frac{C}{\pi} \underset{n\to\infty}{\Longrightarrow} S_{1,1} \quad \text{or} \quad n^{-\pi}\sqrt[n]{\tau_1\cdots\tau_n} \underset{n\to\infty}{\Longrightarrow} \exp\{\pi S_{1,1} + C\},$$

where $C := \delta - \log 2 - \pi(1 + \log\pi - \gamma)$ with Euler-Mascheroni constant $\gamma \approx 0.5772...$ and $\delta = \lim_{n\to\infty}\left[\sum_{k=2}^{n}\mathbf{P}(\tau_1 = 2k)\log k - \pi\log\log n\right] \approx -8.7$.

Note that current value of the constant δ is still preliminary and can be subject to changes. Rates of convergence has been obtained in analogy to results in [3].

[1] G. Pólya, *Über eine Aufgabe der Wahrscheinlichkeitsrechnung betreffend die Irrfahrt im Straßennetz*, Math. Annalen, 84 (1921) 149–160.

[2] W. Feller, *An Introduction to Probability Theory and Its Applications*, Wiley & Sons, New York, 1971.

[3] L. Heinrich, *Rates of Convergence in Stable Limit Theorems for Sums of Exponentially ψ-Mixing Random Variables with an Application to Metric Theory of Continued Fractions*, Math. Nachrichten, 131 (1987) 149–165.

A spectral representation of classical mean values and stable tail dependence functions

S08.4
MON
17:30
I
18:00
F

Paul Ressel (Katholische Universität Eichstätt-Ingolstadt)

The classical power mean values $M_t(x) := \left(\frac{1}{d}\sum_{i=1}^{d} x_i^t\right)^{1/t}$, with M_0 the geometric mean, $M_{-\infty}(x) := \min x_i$, $M_\infty(x) := \max x_i$, have interesting multivariate monotonicity properties. They are distribution functions on $[0,1]^d$ iff $t \in \left[-\infty, \frac{1}{d-1}\right] \cup \left\{\frac{1}{d-2}, \ldots, \frac{1}{2}, 1\right\}$, and for all $t \geq 1$ they turn out to be socalled co-survival functions.

We determine unique integral representations of these mean values within the simplex of all normalized homogeneous distribution resp. co-survival functions. The extreme points are of a simple nature: $\min(a_i x_i)$ resp. $\max(a_i x_i)$ with $a_i \geq 0$.

The result for co-survival functions improves the known integral representation for stable dependence functions of multivariate extreme value distributions.

Structural results on one-independent point processes

S08.5
TUE
11:15
I
11:45
F

Christoph Temmel (Vrije Universiteit Amsterdam)

We investigate the class of one-independent and simple point processes on a complete separable metric space with given intensity measure. If the intensity measure is small enough, there exists a unique point process within this class, whose avoidance function lower-bounds the avoidance function of each other process in this class. This generalises a construction by Shearer for Bernoulli random fields on graphs. We give several sufficient conditions on the intensity measure and space to allow the existence of this particular point process and the uniform lower bound. These are analogues to the classic Lovàsz Local Lemma. Via an algebraic relation they also correspond to lower bounds by Ruelle and Dobrushin on the radius of absolute and uniform convergence of cluster expansions of general hard-sphere models.

S08.6
TUE
11:45
I
12:45
F

Isotropic Markov processes on Ultra-metric spaces

Wolfgang Woess⋆ (Technische Universität Graz)
Alexander Bendikov (Universität Innsbruck)
Alexander Grigor'yan (Universität Bielefeld)
Christophe Pittet (Université d'Aix-Marseille I)

In an ultra-metric space, the usual triangle inequality is replaced by the ultra-metric inequality $d(x,y) \leq \max\{d(x,z), d(z,y)\}$. We consider proper ultra-metric spaces (where closed balls are compact-open). Typical examples are • direct limits of finite groups, • the field of p-adic numbers, • the Cantor set, • the set of all rooted (finite or infinite) trees with degrees bounded by some finite D, • the boundary of a locally finite, infinite tree.

We construct a very natural class of isotropic Markov semigroups on ultra-metric spaces. The transparence of the approach leads to a good understanding and very detailed results on the semigroup and the associated Markov process. This leads to a variety of new results and to an improved and simplified approach to various previous constructions of processes on ultra-metric spaces. Among other, the results concern recurrence/transience, transition kernel estimates, a full description of the Markov generator and its spectrum, and the Liouville property for harmonic functions.

S08.7
TUE
16:30
I
17:00
F

Using B-splines for the de-trending of tree-ring series

Ulrich Pofahl⋆ (Eberswalde)
Wolfgang Beck (Thünen-Institute Eberswalde)

Let's have a look at a tree producing nearly without fault a tree-ring every year. This ring is dependent on several factors, e.g. climate or competition. But can we describe the width of this tree-ring with all its influences?

To investigate this we used selected forest trees and sampled two orthogonal increment cores. Tree-rings are measured following standard procedures and the means calculated resulting in individual tree chronologies and, in a second step, site chronologies. The growth reflected in this chronology includes information on the mean growth trend of the site and can be described by deterministic growth models. However, the sequencing is not monotonous! Therefore deterministic models are unsuitable. An alternative is the use of nonparametric methods, for example Kernel estimation, spline approximation, or exponential smoothing. This resulting in an indexed series which is de-trended. For the nonparametric procedures the smoothing spline and especially the B-splines was selected fitting the mean tree-ring series.

S08.8
TUE
17:00
I
17:30
F

Viscoelastic rod with random excitation

Danijela Rajter-Ćirić⋆ (Faculty of Science, University of Novi Sad)
Teodor Atanacković (Faculty of Technical Sciences, University of Novi Sad)
Stevan Pilipović (Faculty of Science, University of Novi Sad)

Let m be the mass of a body attached to the rod. The length of a rod is L and its axis, at the initial time moment as well as during the motion, coincides with the $\bar{x}$ axis. Let x denote a position of a material point of a rod at the initial time $t_0 = 0$. The position of this point at the time $t > 0$ is $x + u(x,t)$. The equations of motion of the system rod-body are

$$\frac{\partial}{\partial x}\sigma(x,t) = \rho\frac{\partial^2}{\partial t^2}u(x,t), \quad \varepsilon(x,t) = \frac{\partial}{\partial x}u(x,t), \ x \in [0,L], \ t > 0,$$
$$\int_0^1 \phi_\sigma(\gamma)\, {}_0\mathrm{D}_t^\gamma \sigma(x,t)\,\mathrm{d}\gamma = \mathscr{E}\int_0^1 \phi_\varepsilon(\gamma)\, {}_0\mathrm{D}_t^\gamma \varepsilon(x,t)\,\mathrm{d}\gamma, \ x \in [0,L], \ t > 0,$$
$$u(x,0) = 0, \quad \frac{\partial}{\partial t}u(x,0) = 0, \quad \sigma(x,0) = 0, \quad \varepsilon(x,0) = 0, \ x \in [0,L],$$
$$u(0,t) = 0, \quad -A\sigma(L,t) + F(t) = m\frac{\partial^2}{\partial t^2}u(L,t), \ t > 0.$$

In equations above we use σ, u and ε to denote stress, displacement and strain, respectively, depending on the initial position x and time t. Also ρ denotes the density of the material, $\mathscr{E}$ is a generalized Young modulus (positive constant having the dimension of stress), ϕ_σ and ϕ_ε are given constitutive functions or distributions; ${}_0\mathrm{D}_t^\gamma$ is the left Riemann-Liouville fractional derivative operator of order $\gamma \in (0,1)$.

We consider the equations of motion of the system rod-body in the case when axila force F has constant part F_0 and stochastic part given by the white noise. The solutions in some special cases are obtained. Also, some properties of the solution are considered.

S08.9
TUE
17:30
I
18:00
F

Limit state functions and parameter-depending uncertainty described by sets of probability measures

Thomas Fetz (Universität Innsbruck)

The presentation is devoted to the modeling of uncertainties in limit state functions using sets of probability measures (credal sets) focused on the case where the uncertainties may depend on the basic variables (e.g. material properties) of the limit state function. This takes into account that limit state functions may be more reliable for certain ranges of the basic variables than for other ones. The use of sets of probability measures opens the possibility to use classical probability distributions, intervals, random sets or fuzzy sets as well for modeling aleatoric and epistemic uncertainties in limit state functions and their variables. As a result one obtains upper bounds on the probability of failure. We present computational formulas for the upper probability of failure for three different levels at which uncertainties in the limit state functions can be described.

S08.10
TUE
18:00
I
18:30
F

Fuzzy Probability Distributions in Bayesian Inference

Reinhard Viertl (Technische Universität Wien)

In der Bayes'schen statistischen Analyse ist sowohl a-priori Information häufig unscharf, und Daten kontinuierlicher Größen sind immer mehr oder weniger unscharf. Für eine realistische statistische Analyse muss diese Unschärfe (nicht zu verwechseln mit Fehlern) quantitativ mathematisch beschrieben werden. Dies ist möglich und entsprechende statistische Methoden existieren. Dabei wird unscharfe a-priori Information durch sogenannte "fuzzy probability distributions" beschrieben, und unscharfe Daten durch sogenannte unscharfe Zahlen bzw. unscharfe Vektoren. Einzelheiten werden im Vortrag erläutert.

[1] R. Viertl, *Statistical Methods for Fuzzy Data*, Wiley, Chichester, 2011.

Uniform spanning trees on Sierpiński graphs

S08.11
WED
10:15
I
10:45
F

Elmar Teufl⋆ (Eberhard Karls Universität Tübingen)
Masato Shinoda (Nara Women's University)
Stephan Wagner (Stellenbosch University)

In this talk we study spanning trees on Sierpiński graphs (i.e., finite approximations to the Sierpiński gasket) that are chosen uniformly at random. We prove existence of a limit measure and derive a number of structural results, for instance on the degree distribution. The connection between uniform spanning trees and loop-erased random walk is then exploited to prove convergence of the latter to a continuous stochastic process. Some geometric properties of this limit process, such as the Hausdorff dimension, are derived as well. Finally, we investigate the limit of the graph metric given by a uniform spanning tree. The main tool behind these results is a multi-type Galton-Watson process which yields a useful description of uniform spanning trees on Sierpiński graphs.

Existence of Solutions of a Class of SDEs Corresponding to Threshold Dividend Strategies in Risk Theory

S08.12
WED
10:45
I
11:15
F

Michaela Szölgyényi⋆ (Johannes Kepler University Linz)
Gunther Leobacher (Johannes Kepler University Linz)
Stefan Thonhauser (University of Lausanne)

For solving the valuation problem of an insurance portfolio we follow the approach of maximizing its expected discounted future dividend payments. Our analysis is based on a diffusion model for the portfolio's surplus, which incorporates, in contrast to classical contributions, an unobservable drift parameter.
Numerical results suggest an ε-optimal dividend strategy to be of so-called threshold type, which raises the question of admissibility of such strategies. Due to the application of classical filtering techniques the evolution of the surplus controlled by a threshold-strategy is governed by a system of SDEs which comprises a singular diffusion coefficient and a discontinuous drift function.
In this talk we are going to present a result on the existence of solutions to such systems of stochastic differential equations.

S08.13
WED
11:15
I
11:45
F

A Signbased NARCH-Approach for Time Series in Finance

Dr. Lars Metzner (PPI AG Informationstechnologie, Hamburg)

The calculation of the loss risk of a single asset or whole portfolios is one of the most essential tasks in risk management of financial institutions. Normally the calculations are based on some parametric modell (ARMA, GARCH), the corresponding parameters are estimated by solving certain optimizing problems with respect to the available time series. Nonparametric models are rarely used due to the complexity of the calculations. The general NARCH(p,q)-model (Nonparametric AutoRegressive Conditional Heteroscedasticity) for the time series $\{Y_t\}$ is defined as

$$Y_t = \mu(Y_{t-1},...,Y_{t-p}) + \sigma(Y_{t-1},...,Y_{t-q})\varepsilon_t, t = 1,...,T$$

with innovations $\{\varepsilon_t\} \sim iid(0,1)$ and unknown functions μ (trend) and σ (volatility). The outstanding feature of the approach in this paper is: there is no need to fix the values of p and q for modeling and calculating the trend and the volatitlity functions.

Base of the model are certain sign tests often used in regression for measuring the fit of approximated regression functions $\hat{\mu}$ to data: the series of the signs of the residuals $r_t = Y_t - \hat{\mu}_t$ from data and regression function should not be distinguishable from the natural result of a n times independendly repeated one-dimensional bernoulli experiment. Classical criterion is the maximum run length

$$\left| \sum_{j=0}^{d_n(\alpha)} \operatorname{sign}(r_{i+j}) \right| \leq d_n(\alpha), 1 \leq i \leq n - d_n(\alpha)$$

with a certain α-quantile $d_n(\alpha)$. Other criteria such as partial sums or multiresolution are also applicable.

We invert this test so as to let the resulting functions fulfill the chosen sign criterion. Furthermore we assume the trend function μ and the volatility function σ to be sufficiently smooth in an appropriate way.

The NARCH-model together with the sign criteria und smooth function assumption produce a robust model not only for the approximation of trend and volatility. We are able to estimate the distribution of the innovations ε_t and come up to a well-founded prediction of the market trend und hence the current risk.

KEYWORDS: nonlinear time series, NARCH, heteroscedasticity, signbased regression, nonparametric regression
AMS Classification: 62G07, 62G08, 62G35

S08.14
WED
11:45
I
12:15
F

Probability distribution on the median taken on partial sums of a simple random walk.

Christian Pfeifer (Institut für Statistik, Universität Innsbruck)

Let us assume that Y_i are independent indentically distributed Bernoulli random variables

$$Y_i \in \{-1,1\} \qquad \text{with} \quad p = 1/2 \quad 1 \leq k \leq m.$$

Then the series of partial sums

$$(S_k = \sum_{i=1}^{k} Y_i)_{0 \leq k \leq m}$$

denotes a simple random walk starting at $S_0 = 0$ and ending at S_m. In this presentation, we give the probability distribution of the median taken on the partial sums

$$\text{median}(S_k | 0 \leq k \leq m).$$

We give the probabilities for the case of even m using two theorems from Feller and Wendel. Further on we calculate these probabilities for odd m. (See also the sequences A137272, A146205, A146206 A146207 in the On-Line Encyclopedia of Integer Sequences.)

Finally we present an example in economics, wherein the median is interpreted as the price of a security in an informationally inefficient market.

[1] W. Feller, *An Introduction to Probability Theory and its Applications I*, Wiley, New York, 1984.

[2] C. Pfeifer et al., *On the negative value of information in informationally inefficient markets. Calculations for large number of traders*, European Journal of Operational Research 195 (2009) 117–126.

[3] C. Pfeifer, *Probability distribution on the median taken on partial sums of a simple random walk*, Stoch. Anal. Appl. 31 (2013) 31–46.

[4] C. Pfeifer, *A137272, A146205, A146206 A146207*, in: N.J.A. Sloane (Ed.), The On-Line Encyclopedia of integer Sequences (2009) `http://www.research.att.com/~njas/sequences/`.

[5] J.G. Wendel, *Order Statistics of Partial Sums*, Ann. Math. Stat. 31 (1960) 1034–1044.

S08.15
WED
12:15
I
12:45
F

Combinatorial Markov chains

Rudolf Grübel (Leibniz Universität Hannover)

Markov chains are an important tool in the analysis of random discrete structures. Such structures arise, for example, as output of algorithms for sorting and searching if the input is random.

In the lecture we will explain compactifications of the state space of transient Markov chains, we present the 'boundary theory approach' to the analysis of functionals of such chains, and we demonstrate the use of algorithms in connection with the derivation and enhancement of state space compactifications for binary search trees.

S08.16
THU
10:15
I
10:45
F

Scaling limit of interface models

Martin Grothaus* (TU Kaiserslautern)
Torben Fattler (TU Kaiserslautern)
Robert Voßhall (TU Kaiserslautern)

Starting point is the dynamical wetting model, also known as Ginzburg–Landau dynamics with pinning and reflection competing on the boundary, on a bounded set. From the abstract point of view this is a distorted Brownian motion with sticky, reflecting boundary condition. Scaling limits of the corresponding invariant measures have been studied by Deuschel, Giacomin and Zambotti. In this talk we consider the scaling limit of the dynamics in the critical regime.

Forward backward stochastic differential equations driven by Lévy noise: discretization

S08.17
THU
10:45
I
11:15
F

Christel Geiss* (Universität Innsbruck)
Alexander Steinicke (Universität Innsbruck)

Let $L=(L_t)$ be a Lévy process, and denote by W the Brownian motion and by $\tilde{N}$ the compensated Poisson random measure associated to L. If the terminal condition ξ of the backward stochastic differential equation

$$\begin{aligned} Y_t &= \xi + \int_t^T f\left(s, L_s, Y_s, \int_{\mathbb{R}} Z_{s,x}\mu(dx)\right)ds - \sigma\int_{(t,T]} Z_{s,0}dW_s \\ &\quad - \int_{(t,T]\times\mathbb{R}} Z_{s,x}x\tilde{N}(dt,dx), \quad 0\le t\le T \end{aligned}$$

is given by $\xi = g(L_{t_1},...,L_{t_m})$ and f is Lipschitz, then conditions on the chaos expansion of ξ are known such that the convergence

$$\sup_{t\in[0,T]} \mathbb{E}|Y_t - Y_t^n|^2 + \int_{[0,T]\times\mathbb{R}} \mathbb{E}|Z_{s,x} - Z_{s,x}^n|^2 ds\mu(dx) \le cn^{-1}$$

holds. The pair $(Y_s^n, Z_{s,\cdot}^n)_{s\in[0,T]}$ is a discrete-time approximation of the solution $(Y_s, Z_{s,\cdot})_{s\in[0,T]}$. The talk will concern the question how and under which conditions $\xi = g(L_{t_1},...,L_{t_m})$ can be generalized such that ξ is a function of X_T, while X solves an SDE driven by L.

An averaging principle for diffusions in foliated spaces

S08.18
THU
11:15
I
11:45
F

Paulo Ruffino* (University of Campinas, Brasil)
Ivan Gonzales-Gargate (University of Campinas, Brasil)

Consider an SDE on a foliated manifold whose trajectories lay on compact leaves. We investigate the effective behaviour of a small transversal perturbation of order ε. An average principle is shown to hold such that the component transversal to the leaves converges to the solution of a deterministic ODE, according to the average of the perturbing vector field with respect to invariant measures on the leaves, as ε goes to zero. An estimate of the rate of convergence is given. These results generalize the geometrical scope of previous approaches, including completely integrable stochastic Hamiltonian system.

S08.19
THU
11:45
I
12:15
F

Malliavin type equations on a white noise probability space

Tijana Levajković (University of Belgrade, Serbia)

We consider stochastic differential equations involving genaralized operators of the Malliavin calculus on a white noise probability space. In order to obtain explicit solutions of initial value problems, we apply chaos expansion method. In particular, we solve the Skorokhod integral equation and state necessary and sufficient conditions for their solutions. This integral equation is transformed to an equivalent system of one Malliavin differential equation and one equation involving the Ornstein-Uhlenbeck operator. The generalized solution belongs to the space of processes of Kondratiev type. As an example, we describe in detail the Gaussian processes and Gaussian solutions of this type of equations.

S08.20
THU
12:15
I
12:45
F

Conditional set theory on L^0 and the representation of conditional preferences

Asgar Jamneshan* (Humboldt Universität Berlin)
Samuel Drapeau (Humboldt Universität Berlin)
Martin Karliczek (Humboldt Universität Berlin)
Michael Kupper (Universität Konstanz)

Let $(\Omega, \mathscr{F}, \mathbb{P})$ be a probability space and L^0 denote the algebra of real-valued random variables where two of them are identified if they agree $\mathbb{P}$-almost surely. In this talk I develop a conditional set theory on L^0 which shows that L^0 is conditionally a completely ordered field. Next I endow L^0 with a natural conditional topology. The topologized set L^0 shares conditionally the same topological properties as the real line, that is it is a conditionally separable and connected space. This allows to prove a conditional version of Debreu's Gap Lemma which in the classical case is pivotal for the continuous representation of preferences. Analogously, the conditional version of this Lemma permits to represent conditional preferences. The set L^0 is an example of a conditional set and its topology an example of a conditional topology. If time permits I introduce the general concept of a conditional set together with its concept of a conditional topology.

Section S09

Mathematics in the Sciences and Technology

Ansgar Jüngel (Wien)
Caroline Lasser (München)

S09.1
WED
10:15
I
10:45
C

Some polymeric fluid flow models: steady states & large-time convergence

Anton ARNOLD (Vienna University of Technology)

We consider a dumbbell model for a dilute solution of polymers in a homogeneous fluid. In a micro-macro model, the incompressible Navier-Stokes equation for the fluid flow is coupled to a Fokker-Planck equation for the (microscopic) distribution of the polymeric chains.

First we analyze the linear Fokker-Planck equation for Hookean dumbbells, and in the case of finite extension nonlinear elasticity (FENE) steady states and large-time convergence using entropy methods. In the FENE case the stationary problem is degenerate elliptic, requiring to use weighted Sobolev spaces. In the coupled Hookean case we also show exponential convergence to a homogeneous stationary flow.

[1] A. Arnold, J.A. Carrillo, C. Manzini, *Refined long-time asymptotics for some polymeric fluid flow models*, Comm. Math. Sc. 8, No. 3 (2010) 763–782.

[2] A. Arnold, C. Bardos, *Stable steady states of a FENE-dumbbell model for polymeric fluid flows*, preprint, 2013.

S09.2
WED
10:45
I
11:15
C

Mixed Volume-Surface Reaction-Diffusion Systems Describing Asymmetric Protein Localisation

Klemens Fellner* (University of Graz)
Tang Quoc Bao (University of Graz)
Stefan Rosenberger (University of Graz)

For certain types of stem cells, differentiation into specialised tissues occurs via the asymmetric localisation of proteins, so called cell-fate determinants, into just one of the two daughters cells upon mitosis.

Based on [1, 2], we present a model system of reaction-diffusion equations describing the concentration of the protein Lgl in the cytoplasm and the cell-cortex. We consider both volume-diffusion in the cytoplasm as well as surface-diffusion on the cell-cortex.

The coupling between cortex and cytoplasm is modelled via Robin boundary conditions. We study the well-posedness of the models system and derive an entropy entropy-dissipation estimate showing exponential convergence to the equilibrium state in the large-time-behaviour.

[1] B. Mayer, G. Emery, D. Berdnik, F. Wirtz-Peitz, and J. Knoblich. *Quantitative analysis of protein dynamics during asymmetric cell division.* Curr. Biology, 15 (2005) 1847–1854.

[2] F. Wirtz-Peitz, T. Nashimura, and J. Knoblich. *Linking cell cycle to asymmetric division: Aurora-A phosphorylates the Par complex to regulate numb localization.* Cell, 135 (2008) 161–173.

S09.3
WED
11:15
I
11:45
C

Influence of ski boot and ski tail properties on ACL forces during a landing movement in downhill skiing: a study with musculoskeletal multibody simulation

Robert Eberle⋆ (Universität Innsbruck)
Dieter Heinrich (Universität Innsbruck)
Ton van den Bogert (Cleveland State University)
Peter Kaps (Universität Innsbruck)
Werner Nachbauer (Universität Innsbruck)

Anterior cruciate ligament (ACL) injuries are the most frequent diagnoses in World Cup Alpine Skiing. Bere et al. [1] identified three main categories of ACL injury mechanisms: slip-catch, landing back-weighted and dynamic snowplow. We set the focus of our studies on the landing back-weighted case. This case occurs during the landing movement after a jump in downhill skiing. We used a planar multibody model for the skier consisting of 7 rigid segments, 6 joints and 16 muscles (Heinrich et al. [2]). The muscles were modelled by a three element Hill-type model. Each muscle was described by a first order ODE for activation and contraction dynamics. In state space form the equation of motion is a system of second order ODE's. The movement of the skier was formulated as optimal control problem which was solved by direct collocation. The objective function includes a term for fitting the generalized coordinates of the segment model to a measured reference jump and a term for low muscle excitation values. In the first step a reference simulation was obtained. Then, the initial orientation of the trunk and the joint angles were randomly disturbed to obtain solutions for dangerous landing situations with large ACL forces. For these simulations the influence of different ski boot and ski tail properties on ACL forces was investigated by Monte Carlo simulations. Initial trunk orientation and joint angles were randomly disturbed and the skier tried a recovery movement aiming at the reference situation. The simulations showed that a stiffer ski boot and a softer ski tail increase the risk of injuries.

[1] T. Bere et al. *Mechanisms of Anterior Cruciate Ligament Injury in World Cup Alpine Skiing*, The American Journal of Sports Medicine, 39(7) (2011) 1421–1429.

[2] D. Heinrich et al. *Relationship between Jump Landing Kinematics and Peak ACL Force During a Jump in Downhill Skiing: a Simulation Study*, submitted to Scandinavian Journal of Medicine and Science in Sports.

S09.4
WED
11:45
I
12:15
C

Mean field game and optimal control approaches modeling pedestrian dynamics

Marie-Therese Wolfram⋆ (Universität Wien)
Martin Burger (Universität Münster)
Marco Di Francesco (University of Bath)
Peter A. Markowich (KAUST)

In this talk we present an optimal control approach modeling fast exit scenarios in pedestrian crowds. In particular we consider the case of a large human crowd trying to exit a room as fast as possible. The motion of every pedestrian is determined by minimizing a cost functional, which depends on his/her position, velocity, exit time and the overall density of people. This microscopic setup leads in the mean-field limit to a parabolic optimal control problem.
We discuss the modeling of the macroscopic optimal control approach and show how the optimal conditions relate to Hughes model for pedestrian flow. Furthermore we provide results on the existence and uniqueness of minimizers and illustrate the behavior of the model with various numerical results.

S09.5
WED
12:15
I
12:45
C

A two-variable functional equation describing a network system

El-Sayed El-Hady⋆ (Universität Innsbruck)
Wolfgang Förg-Rob (Universität Innsbruck)
Hamed Nassar (Universität Suez Canal)

Functional equations have applications in many fields such as Communications, Network, and Information theory. We study a two-variable functional equations which naturally arises from modeling two-queue queueing systems. This functional equations could be solved by reduction to a boundary value problem, most notably to a Riemann, or Riemann-Hilbert boundary value problems. However, the exact form of the solutions for this equation are rarely obtained. We manage to solve a challenged two-variable functional equation arising from a gateway queueing model by trial and error. There we got many solutions which do not make sense with the system under consideration of the application.

S09.6
THU
10:15
I
10:45
C

G,P,Q Representability Conditions and Correlation Estimates in Quantum Chemistry

Volker Bach (TU Braunschweig)

It is shown that the *G*-Condition and the *P*-Condition from representability imply fermion correlation estimates from which, in turn, are known to yield nontrivial bounds on the accuracy of the Hartree-Fock approximation for large Coulomb systems.

An efficient interpolation scheme for molecular potential energy surfaces

Markus Kowalewski (Division of Scientific Computing, Department of Information Technology, Uppsala University)

S09.7
THU
10:45
I
11:15
C

When investigating quantum processes in molecular dynamics a possible approach is to solve the time dependent Schrödinger equation in a reduced coordinate system. Under the assumption of the Born-Oppenheimer approximation the motion of the electrons can be separated from the motion of the nuclei resulting in a set of two equations. The eigenvalues for the electronic part provide then the potential for the nuclear equation. However, to obtain the potential energy surface (PES) an electronic structure calculation has to be carried out to obtain the energy for a single given nuclear configuration (single data point on PES). Since those calculations are on time scales ranging from seconds to hours for a single point it is crucial to minimize the number of calculations.

In this contribution an adaptive interpolation method for low dimensional problems is presented. A radial basis function approach combined with a partition of unity approach is used to interpolate the PES. A preferable choice for the radial basis functions are polyharmonic splines. The weights for the partitions are obtained by shepards method using compactly supported C^2 Wendland functions. The adaptive node refinement allows for reducing the number of function evaluations and at the same time provides an error estimate for the interpolant. The partitioning scheme allows to introduce sparsity in the interpolant and moreover for an effiecient parallel implementation. First results demonstrating the method for two and three-dimensional functions will be presented.

S09.8
THU
11:15
I
11:45
C

Hybrid Stochastic–Deterministic Solution of the Chemical Master Equation

Stephan Menz⋆ (Universität Potsdam)
Juan C. Latorre (Freie Universität Berlin)
Christof Schütte (Freie Universität Berlin)
Wilhelm Huisinga (Universität Potsdam)

The chemical master equation (CME) is the fundamental evolution equation of the stochastic description of biochemical reaction networks, accounting for the discrete and random nature of reaction processes as, e.g., observed in cells. In most applications, however, it is impracticable to directly solve the CME due to its high dimensionality. Instead, it is common practice to approximate a solution of the CME by Monte Carlo (MC)-simulations of the underlying Markov jump process. Apart from the problem of determining the required number of realizations to meet a certain accuracy, such indirect approaches become numerically inefficient when applied to systems that include rapidly firing reactions or species with high copy numbers. In hybrid stochastic–deterministic approaches, such parts of the reaction network are approximated as continuous–deterministic processes, motivated by T.G. Kurtz's results on the thermodynamic limit [1]. Current hybrid approaches, however, almost exclusively rely on MC-simulations of the Markov process associated with the discrete–stochastic subsystem.

After a brief introduction to the stochastic and the deterministic modeling approaches for biochemical reaction networks and their relationship, I outline the common concept of hybrid stochastic–deterministic approaches. I present the derivation of a novel hybrid stochastic–deterministic approach to directly solve the CME, based on a multi-scale expansion using the Wentzel–Kramers–Brillouin (WKB)-ansatz in combination with Laplace's method of integral approximation, and its application to model systems of biological relevance [2].

[1] T.G. Kurtz, *The Relationship between Stochastic and Deterministic Models of Chemical Reactions*, J. Chem. Phys., 57(7):2976–2978, 1972.

[2] S. Menz, J.C. Latorre, C. Schütte, and W. Huisinga. *Hybrid Stochastic–Deterministic Solution of the Chemical Master Equation.* Multiscale Model. Simul., 10(4), 1232–1262, 2012.

Higher order parabolic equations for electron transport

Daniel Matthes⋆ (Technische Universität München)
Mario Bukal (University of Zagreb)
Ansgar Jüngel (Technische Universität Wien)

First, we sketch an approach to derive fluid-type equations for electron transport — e.g. in semiconductors — using a variant of the quantum moment method introduced by Degond and Ringhofer [1]. This method produces evolution equations with a non-local spatial differential operator. An asymptotic expansion in terms of the Planck constant to zeroth, first and second order yields, respectively, a classical second-order drift diffusion equation, a quantum drift diffusion equation with the fourth order Bohm potential, and an equation with an additional correction of sixth order.

Second, we present analytical results about existence, (non-)uniqueness and long-time behaviour of weak solutions of the fourth [2] and sixth [3] order equations. The proofs are based on the use of appropriate energy/entropy functionals and regularization techniques. We also discuss the equations non-obvious gradient flow structure.

[1] P. Degond and C. Ringhofer, *Quantum moment hydrodynamics and the entropy principle*, J. Statist. Phys. 112(3-4) (2003) 587–628.

[2] A. Jüngel and D. Matthes, *The Derrida-Lebowitz-Speer-Spohn equation: existence, nonuniqueness, and decay rates of the solutions*, SIAM J. Math. Anal. 39(6) (2008) 1996–2015.

[3] M. Bukal, A. Jüngel, and D. Matthes, *A multidimensional nonlinear sixth-order quantum diffusion equation*, Ann. Inst. H. Poincaré Anal. Non Linéaire 30(2) (2013) 337–365.

S09.10
THU
12:15
I
12:45
C

Drift-Diffusion model for spin-polarized electron transport in semiconductors

Ansgar Jüngel (Vienna University of Technology)
Polina Shpartko* (Vienna University of Technology)

The presented work studies the matrix Drift-Diffusion model proposed in [1]. The model in [1] was derived from the Boltzmann equation for spin polarized transport and applied to transport of the electrons in nonhomogeneous ferromagnetic structures. In the presented work the application of this model to electron transport in semiconductors is considered. The model for semiconductors involves a parabolic cross-diffusion system for the charge density and the spin density vector coupled to the Poisson equation for the electric potential. The global-in-time existence of weak solutions to the model for semiconductors was proved assuming a constant magnetization vector. The idea of the proof is to exploit different variables: the projection of spin density vector on the direction of magnetization and spin-up and spin-down densities.

Some preliminary numerical simulations of the model for 1D semiconductor multilayer structures will also be presented.

[1] S. Possanner and C. Negulescu. *Diffusion limit of a generalized matrix Boltzmann equation for spin-polarized transport*, Kinetic Related Models, 4 (2011), 1159-1191.

S09.11
THU
15:30
I
16:00
C

ARMA processes in Structural Health Monitoring

Georg Spielberger* (Universität Innsbruck)
Alexander Ostermann (Universität Innsbruck)

The increased demands on civil infrastructure under the effects of aging, deterioration and other influences have given rise to a big variety of methods for structural health monitoring. Within the class of vibration based monitoring methods autoregressive moving average processes (ARMA processes) have more and more been used recently.

We start from a white noise excited underdapmed model and show that the uniformly sampled components make up ARMA processes. We investigate the connection between eigenfrequencies and the parameters of the ARMA process and then compare ARMA processes with FFT-based methods for the determination of eigenfrequencies of simulated as well as measured data. Moreover, we explain how ARMA processes can be used for damage detection and shortly introduce a damage detection scenario with measured data from an off-duty railway bridge.

Inverse coefficient problems and shape reconstruction

Bastian Harrach (Universität Stuttgart)

S09.12
THU
16:00
I
16:30
C

Novel imaging methods commonly lead to the inverse problem of determining one or several coefficient function(s) in a partial differential equation from (partial) knowledge of its solutions. Arguably, the most famous such problem is the Calderón problem, where the diffusion coefficient in an elliptic PDE is to be reconstructed from the Neumann- and Dirichlet-boundary data of its solutions.

The mathematical challenges behind inverse coefficient problems reach from theoretical uniqueness questions to the construction of convergent numerical algorithms and stability issues. In this talk we will present recent work on these subjects that is based on combining monotony relations between the coefficients and the Neumann/Dirichlet-data with so-called localized potentials. We will show how to derive simple uniqueness results, avoid non-linearity effects in the context of shape-reconstruction, and deal with imprecisely known background media and measurement noise.

S09.13
THU
16:30
I
17:00
C

Optimal control of multiscale diffusions

Carsten Hartmann⋆ (Institut für Mathematik, Freie Universität Berlin)
Juan Latorre (Institut für Mathematik, Freie Universität Berlin)
Wei Zhang (Konrad-Zuse-Zentrum für Informationstechnik Berlin (ZIB))
Grigorios Pavliotis (Department of Mathematics, Imperial College)

Stochastic differential equations with multiple time scales appear in various fields of applications, e.g. biomolecular dynamics, material sciences or climate modelling. The separation between the fastest and the slowest relevant timescales poses severe difficulties for control and simulation of such systems. If fast and slow scales are well separated, asymptotic techniques for diffusion processes are a means to derive simplified reduced order models that are easier to simulate and control. In certain situations, the limit theorems of averaging and homogenization theory provide bounds on the approximation error, e.g. for the relevant slow degrees of freedom. The situation becomes more difficult if the system is subject to additional control variables that are chosen so as to maximize or minimize a given cost functional. One of the questions here is whether an optimal (feedback) control computed from a reduced model is a reasonable approximation of the optimal control obtained from the full system, the computation of which is often infeasible. It turns out that very few reduced models are "backward stable" in the aforementioned sense, even though they are forward stable, in that they give good approximations when the control is known in advance. For a certain class of stochastic control systems that are linear-quadratic in the control variables—the dependence on the state variables may still be nonlinear—we analyze the backward stability of singular perturbation approximations. Our approach rests on the fact that the corresponding Hamilton-Jacobi-Bellman equations can be transformed into a control-free linear PDE by a suitable transformation of the underlying probability measure. The analysis of the backward error then consists in the singular perturbation analysis of the linear PDE. We illustrate the backward error analysis of linear and nonlinear singularly perturbed control systems with various examples and counterexamples and discuss the extension to deterministic control problems.

Section S10

History, Teaching and Popularization of Mathematics

Günter Törner (Duisburg-Essen)
Reinhard Winkler (Wien)

S10.1
MON
15:30
I
16:00
E

Schreiben Schüler mathematische Facharbeiten?

Nils M. Krause (Martin-Luther-Universität Halle-Wittenberg)

Mittlerweile verfassen nahezu alle Schüler in der gymnasialen Oberstufe eine Facharbeit. Welche Rolle mathematische Themen dabei spielen ist kaum erforscht. Es gibt keine Untersuchungen dazu, wie die Einstellungen der Abiturienten gegenüber mathematischen Facharbeiten sind und wie viele Schüler ihre Facharbeit in dieser Disziplin schreiben. Ebenfalls unerforscht ist der Einfluss des Mathematikbilds in diesem Kontext. Um diese Fragen zu klären, wurde eine Fragebogenuntersuchung durchgeführt, an der 930 Schüler teilnahmen. Dabei zeigte sich, dass Mathematik als Facharbeitsdisziplin tendenziell abgelehnt wird und unter den Befragten nur etwa 2% eine mathematische Facharbeit verfasst haben. Ein Grund hierfür kann das Mathematikbild der befragten Schüler sein, denn die Studie ergab, dass dieses oft nicht kompatibel mit dem Entschluss ist, eine mathematische Facharbeit zu schreiben. Deshalb ist die Veränderung des Mathematikbilds ein Ansatzpunkt, damit mehr Schüler eine mathematische Facharbeit schreiben.

S10.2
MON
16:00
I
16:30
E

Vernetzung von Schule und Universität: Förderung mathematisch interessierter Schüler

Jenny Kurow (Martin-Luther-Universität Halle-Wittenberg)

Seit dem letzten Jahrzehnt wird die Vernetzung von Schule und Universität im Bereich der Mathematik als ein neuer Weg der Förderung von Schülerinnen und Schülern besonders vorangetrieben. Es haben sich an den Hochschulen verschiedene Ansätze zur Realisierung entwickelt. Der Fokus liegt dabei vorrangig auf mathematisch begabten Schülerinnen und Schülern. Dagegen werden für Schüler mit einem geringer ausgeprägten Mathematikinteresse bisher nur vereinzelte Angebote für eigenständiges, offenes und kreatives Arbeiten gemacht. Was sind geeignete Ansätze zur Förderung dieser Schülerinnen und Schüler? Wie gelingt es ihnen ein tragfähiges Bild von Mathematik zu vermitteln? Kann eine wissenschaftlich orientierte Arbeitsweise so faszinierend sein, dass sie nachhaltig für Mathematik motiviert? Der Vortrag basiert auf einer Fallstudienuntersuchung und soll Möglichkeiten aufzeigen und erste Ergebnisse vorstellen.

S10.3
MON
16:30
I
17:00
E

Assessment standards and their stability

Katherine Roegner (Technical University Berlin)

The issue of how to establish and ascertain difficulty levels of tests was considered at the Technical University Berlin in the setting of "Linear Algebra for Engineers", a large-scale course with multiple sections for several lectures and many tutorials serving over 3000 students per year. Auxiliary goals were to improve the stability of the tests from one semester to the next to ensure that standards are being met as well as to ensure that students are not being unnecessarily penalized or rewarded due to a fluctuation in the difficulty.

This contribution explores ...

A scheme was developed that weights the points assigned to an expected student solution for each examination problem or subproblem. Hereby, all competencies or possible steps that students could reasonably be expected to apply were listed in order of their difficulty from a student's point of view. Initially, the ordering in the list was selected based on experience. Adjustments have been made by considering student performance in previous examinations. These competencies or steps were then given a weighting according to this ordering to be multiplied with by the points. From these weighted points, it is possible to compare the levels of difficulty of the examinations over time. The weightings depend naturally on the curriculum, although some degree of transferability to other courses in "Linear Algebra for Engineers" is anticipated to some extent. The reliability of the entire scheme depends on the standardization of several factors in the course.

S10.4
MON
17:00
I
17:30
E

CATO - Eine deutschsprachige CA-Oberfläche

Hans-Dieter Janetzko (HTWG Konstanz)

CATO ist eine ComputerAlgebra-Taschenrechner-Oberfläche, die an ein Computeralgebrasystem wie Maple, Mathematica, Maxima, MuPAD oder Yacas über eine Java-Schnittstelle angeschlossen wird. Sie realisiert auch Konzepte von N. Kajler, die er unter anderem in [1] vorgestellt hat.
Die Eingabe einfacher Berechnungen erfolgt über die Tastatur des Computers, bzw. die Tasten von CATO, während die Befehle in Menüs ausgewählt werden. CATO wandelt die deutschsprachigen Befehle ("Lösen einer Gleichung", "Integrieren", "Zeichnen einer Funktion", ...) in den entsprechenden CA-Befehl um, setzt dabei die richtigen Klammern und Parametertrennzeichen, sendet den übersetzten Befehl an das angeschlossene CAS, erhält das Ergebnis und zeigt es an. Der Vorteil für den Benutzer ist somit: Er muss sich nicht mit den speziellen Befehlen und deren Syntax und Grammatik befassen, sondern kann sich wegen der Verwendung bekannter deutscher Begriffe der Mathematik auf sein Problem konzentrieren.
Der Autor wird in seinem Vortrag die Verwendung von CATO an verschiedenen Beispielen demonstrieren und auch von den Erfahrungen in der Lehre berichten.

[1] N. Kajler and N. Soiffer, *A survey of user interfaces for computer algebra systems*, J. of Symbolic Computing, 25 (1998) 127–159.

S10.5
MON
17:30
I
18:00
E

Prüfzeichencodierung: Theorie und einige populäre Anwendungen

Günther Karigl (Technische Universität Wien)

Prüfzeichenverfahren dienen der Erkennung von Fehlern bei der Datenerfassung, Verarbeitung und Übertragung von Zeichenfolgen wie z.B. von Kontonummern. Im Vordergrund steht dabei die Fehlererkennung und nicht die Fehlerkorrektur, welche in der Regel durch Wiederholung der Eingabe bzw. Übertragung erfolgt.

Der Vortrag behandelt einige algebraische Konzepte zur Prüfzeichenkodierung sowie bekannte Beispiele solcher Verfahren und deren Eigenschaften, u.a. IBAN (International Bank Account Number), EAN (European Article Number), ISBN (International Standard Book Number) und das System der österreichischen Sozialversicherungsnummern.

A simple recursion for polynomials of sums of powers

S10.6
MON
18:00
I
18:30
E

Helmut Länger (Vienna University of Technology)

For every positive integer k and every non-negative integer n put

$$p_k(n) := \sum_{i=1}^{n} i^{k-1}$$

A simple recursion for the polynomials $p_k(n)$ is presented.

What does a biography tell about mathematics? Reflecting on our documentary work with Yuri Manin

S10.7
TUE
17:00
I
18:30
E

Agnes Handwerk⋆
Harrie Willems

As journalists, we worked from 2009 until 2011 with the mathematician Yuri Manin on a documentary about his life.

Yuri Manin, born 1937 in Simferopol / Ukraine, is an outstanding mathematician. His first fifty years he lived in the Soviet Union and was a full professor at the Moscow State University. After the fall of the Iron Curtain he took the advantage to follow inivitations of universities round the world. From 1995 on he became one of the co-directors of the Max Planck Institute for Mathematics in Bonn and held from 2002 till 2011 a position as Chair of the Board of Trustees and professor at Northwestern University (USA).

Yuri Manin always emphasizes that he was not a victim of the Soviet system and argues that, different from the bad conditions in humanities, the conditions to work on mathematics were extraordinary. Above all he gives some impressive examples what it means for him doing mathematics. He describes his very early experience of thinking, his passion of thinking and to be absorbed by thinking.

By showing our documentary and starting from the biography of Yuri Manin, we ask how mathematicians and the mathematical community reflect on their relationship to society and the influence of the subjective factor.

Minisymposium M1

Actuarial and Financial Mathematics

Nicole Bäuerle (Karlsruhe)
Uwe Schmock (Wien)

M1.1
MON
15:30
I
16:00
C

Local volatility models: approximation and regularization

Stefan Gerhold⋆ (TU Wien)
P. Friz (TU Berlin)
M. Yor (Paris VI)

There are several reasons why Dupire's local volatility formula fails in the non-diffusion setting. And yet, in practice, ad-hoc preconditioning of the option data works reasonably well; we attempt to explain why. In particular, we propose a regularization procedure of the option data so that Dupire's local vol diffusion process recreates the correct option prices, even in manifest presence of jumps. The approach is related to a recent proof, by Yor et al., of Kellerer's theorem from the theory of peacocks. Finally, we quantify the blowup of the local volatility surface that precludes the existence of a local vol model in jump settings.

Semi-static hedging of barrier options via a general self-duality

Thorsten Rheinländer (Technische Universität Wien)

M1.2
MON
16:00
I
16:30
C

We study semi-static hedging of barrier options, and propose an extension of the known methods to cover the case of continuous stochastic volatility models when there is correlation between the price and the volatility process.

Semi-static refers to trading at most at inception and a finite number of stopping times like hitting times of barriers. The possibility of this hedge, however, requires classically a certain symmetry property of the asset price which has to remain invariant under the duality transformation. This leads naturally to the concept of self-duality which generalises the put-call symmetry. To overcome the symmetry restriction, a certain power transformation has been proposed which leads to the notion of quasi self-duality. While this works well in the context of exponential Lévy processes, it does not essentially change the picture for continuous stochastic volatility models. A quasi self-dual price process in this setting is up to the costs of carry the stochastic exponential of a symmetric martingale. In particular, this would exclude any non-zero correlation between the volatility and the price process which is unrealistic.

We propose a different approach to deal with the correlated case: by a multiplicative decomposition, the price process is factorised into a self-dual and a remaining part. This latter part is used as a numeraire for a change of measure. Under this new measure called $\mathbb{Q}$, replacing the risk-neutral measure $\mathbb{P}$, the price process S is no longer a martingale but gets replaced by a modified price process D. We then show that a generalization of self-duality holds if one replaces in one side of the defining equation the measure $\mathbb{P}$ by $\mathbb{Q}$, and the process S by its modified form D, respectively. In contrast to self-duality which holds only in special circumstances, its general form needs only weak assumptions in the context of continuous stochastic volatility models.

An application of this general self-duality allows one to trade the barrier option at the hitting time τ for a time-dependent put option Γ_τ written on the modified price process, at zero cost. We then show how to perfectly replicate Γ_τ by dynamically trading in stock, realized volatility and cumulative volatility.

We then derive the price of Γ_τ by Malliavin calculus, in particular the Clark-Ocone formula. In a stochastic volatility context, this necessarily involves higher greeks. Such an approach has been pioneered for European options in the Heston model, where second-order approximation option prices have been obtained. Here we adapt this approach to our specific situation, i.e. hedging of a time-dependent put option written on the modified price process under the measure $\mathbb{Q}$, and generalise it to our general stochastic volatility framework.

This is joint work with Elisa Alos and Zhanyu Chen.

M1.3
MON
16:30
I
17:00
C

Incorporating parameter risk into derivatives prices

Matthias Scherer⋆ (Technische Universität München)
Karl Bannör (Technische Universität München)

Adequately specifying the parameters of a financial or actuarial model is challenging. In case of historical estimation, uncertainty arises through the estimator's volatility and possible bias. In case of market implied parameters, the solution of a calibration to market data might not be unique or the numerical routine returns a local instead of a global minimum. We provide a new method based on convex risk measures to quantify parameter risk and to translate it into prices, extending results in [6] and [7]. We introduce the notion of risk-capturing functionals and prices, provided a distribution on the parameter (or model) set is available, and present explicit examples where the Average-Value-at-Risk and the entropic risk measure are used. For some classes of risk-capturing functionals, the risk-captured price preserves weak convergence of the distributions. In particular, the risk-captured price generated by the distributions of a consistent sequence of estimators converges to the true price. For asymptotically normally distributed estimators we provide large sample approximations for risk-captured prices. Following [3], [4], [5], and [8], we interpret the risk-captured price as an ask price, reflecting aversion towards parameter risk. To acknowledge parameter risk in case of calibration to market prices, we create a parameter distribution from the pricing error function, allowing us to compare the intrinsic parameter risk of the stochastic volatility models of Heston and Barndorff-Nielsen and Shephard as well as the Variance Gamma option pricing model by pricing different exotics.

[1] K.F. BANNÖR, M. SCHERER, *Capturing parameter uncertainty with convex risk measures*, forthcoming in European Actuarial Journal, (2013).
[2] K.F. BANNÖR, M. SCHERER, *On the calibration of distortion risk measures to bid-ask prices*, working paper, (2012).
[3] J. BION-NADAL, *Bid-ask dynamic pricing in financial markets with transaction costs and liquidity risk*, Journal of Mathematical Economics, 45(11) (2009) 738–750.
[4] P. CARR, H. GEMAN, D. MADAN, *Pricing and hedging in incomplete markets*, Journal of Financial Economics, 62 (2001) 131–167.
[5] A. CHERNY, D. MADAN, *Markets as a counterparty: An introduction to conic finance*, International Journal of Theoretical and Applied Finance, (13)8 (2010) 1149–1177.
[6] R. CONT, *Model uncertainty and its impact on the pricing of derivative instruments*, Mathematical Finance, 16(3) (2006) 519–547.
[7] E. LINDSTRÖM, *Implication of parameter uncertainty on option prices*, Advances in Decision Sciences, (2010) 15 pages.
[8] M. XU, *Risk measure pricing and hedging in incomplete markets*, Annals of Finance, 2 (2006) 51–71.

M1.4
MON
17:00
I
17:30
C

Multivariate geometric distributions with latent factor structure

Jan-Frederik Mai⋆ (Technische Universität München)
Matthias Scherer (Technische Universität München)
Natalia Shenkman (Technische Universität München)

The univariate geometric law is the only discrete distribution satisfying the lack-of-memory (LM) property, which is both important and convenient for many applications. We determine the class of multivariate geometric distributions that allow for a latent one-factor representation and propose convenient parameterizations. This prepares this class of multivariate distributions for applications in high-dimensional modelling such as required, e.g., in risk management, where it is often convenient and intuitive to describe the dependence between risk factors by a latent factor model. A more detailed outline of the talk is given in the following abstract of the related research article [1]:

Two stochastic representations of multivariate geometric distributions are analyzed, both are obtained by lifting the LM property of the univariate geometric law to the multivariate case. On the one hand, the narrow-sense multivariate geometric law can be considered a discrete equivalent of the well-studied Marshall-Olkin exponential law. On the other hand, the more general wide-sense geometric law is shown to be characterized by the LM property and can differ significantly from its continuous counterpart, e.g. by allowing for negative pairwise correlations. For both families of distributions, their d-dimensional exchangeable subclass is characterized analytically via d-log-monotone, resp. d-monotone, sequences of parameters. Using this reparameterization, the subfamilies of distributions with conditionally i.i.d. components in the sense of de Finetti's theorem are determined. For these, a third stochastic construction based on a non-decreasing random walk is presented. The narrow-sense family is embedded in this construction when the increments of the involved random walk are infinitely divisible. The exchangeable narrow-sense law is furthermore shown to exhibit the MRTI property.

[1] J.-F. Mai, M. Scherer, N. Shenkman, *Multivariate geometric distributions, (logarithmically) monotone sequences, and infinitely divisible laws*, Journal of Multivariate Analysis, 115, (2013) 457–480.

M1.5
MON
17:30
I
18:00
C

Deterministic optimal consumption and investment in a stochastic model with applications in insurance

Marcus C. Christiansen (University of Ulm)

We motivate and solve the classical financial optimization problem of optimizing mean-variance terminal wealth and intermediary consumption in a Black-Scholes market with the special feature that the consumption rate and the investment proportion are constrained to be deterministic processes.

Mean-variance investment is a true classic since Markowitz. However, the classical stochastic control approach leads to immediately and diffusively investment decisions and consumption and, therefore, does not reflect a sponsor's probable preferences for smooth cash flows. Indeed, in practice, unit-linked life insurance policies often follow control strategies that are rather close to deterministic processes. In control theory, it is non-standard to control a stochastic system by an optimal deterministic control. We show how to adapt the standard theory to this situation, demonstrate the use of the moments of wealth as state variables rather than wealth itself, and derive and present the optimal consumption-investment profile.

M1.6
MON
18:00
I
18:30
C

On the Existence of an Equivalent Martingale Measure in the Dalang–Morton–Willinger Theorem, which Preserves the Dependence Structure

Uwe Schmock* (Technische Universität Wien)
Ismail Cetin Gülüm (Technische Universität Wien)

We consider a stochastic process in a finite-period setting, which models the discounted prices of d financial assets. We assume that this financial market model is arbitrage-free. Dalang, Morton and Willinger proved the existence of an equivalent martingale measure, which has a bounded density. Using this result, we show the existence of an equivalent martingale measure with bounded density which preserves a given dependency structure of the discounted asset price process. We consider in particular the independence of additive or componentwise multiplicative increments, the Markov property and, slightly more general, the k-multiple Markov property. Up to our knowledge, the boundedness of the density in the general Markovian case was open for several years. We build upon results obtained by S.R. Pliska and F. Delbaen.

M1.7
TUE
11:15
I
11:45
C

An HJM approach to multiple-curve modeling

Christa Cuchiero⋆ (Technische Universität Wien)
Claudio Fontana (Université d'Evry Val d'Essonne)
Alessandro Gnoatto (LMU München)

We propose a general framework for interest rate modeling in the multiple-curve setup which has occurred in the course of the recent financial crisis. More precisely, we provide an HJM approach for simultaneous modeling of the riskfree forward rates (deduced from OIS rates) and the multiplicative spreads between the simply compounded riskfree forward rates and the forward rates implied by forward rate agreements for some future time interval $[T, T+\delta]$. We specify in particular the HJM drift condition in this setting and establish conditions which ensure that the multiplicative spreads are greater than 1. This general framework allows to unify and extend several approaches which have been proposed in literature in the context of multiple-curve modeling. For instance, we can obtain a log-normal LIBOR market model (similarly as in the seminal paper by Brace, Gatarek and Musiela) or recover the Lévy driven HJM model studied by Crepey et al. [1, 2] but also short rate models as for example considered by Kenyon [3]. When the driving process of both the riskfree forward rate and the spread is specified to be affine, we obtain a Markovian structure which allows for simple pricing formulas of LIBOR interest rate derivatives by exploiting the affine property of the driving process.

[1] S. Crépey, Z. Grbac and H. N. Nguyen. *A multiple-curve HJM model of interbank risk*, Mathematics and Financial Economics, 6(3): 155–190, 2012.
[2] S. Crépey, Z. Grbac, H. N. Nguyen and D. Skovmand *A multiple-curve CVA interest rate model*, Working paper, 2013.
[3] C. Kenyon *Short-Rate Pricing after the Liquidity and Credit Shocks: Including the Basis*, SSRN-eLibrary, 2010.

M1.8
TUE
11:45
I
12:15
C

Regime switching, filtering and portfolio optimization

Jörn Sass (University of Kaiserslautern)

A continuous time regime switching model, where the observation process is a diffusion whose drift and volatility coefficients jump governed by a continuous time Markov chain, can explain some of the stylized facts of asset returns, even in this simple linear and non-autoregressive form.

But due to the switching volatility, in continuous time the underlying Markov chain could be observed and no filtering is needed (in theory). Therefore, even if explicit theoretical results can be derived, they often won't provide a good approximation for the discretely observed model in which we have to filter. On the other hand, a continuous time hidden Markov model (HMM), where only the drift jumps and the volatility is constant, allows for explicit calculations but has not such good econometric properties.

With an emphasis on observability and available information we discuss estimation, model choice and portfolio optimization in both models. To combine useful aspects of both models, we then look at a HMM where the volatility depends on the filter for the underlying Markov chain. We analyze its relation to Markov switching models and, using examples from portfolio optimization, we illustrate that we can still get quite explicit results and that these provide a good approximation to the discretely observed model.

M1.9
TUE
12:15
I
12:45
C

A Bayesian Dividend Problem in Risk Theory

Stefan Thonhauser* (Université de Lausanne)
Gunther Leobacher (Universität Linz)
Michaela Szölgyenyi (Universität Linz)

The origin of the dividend maximization problem in risk theory is the observation that focusing solely on the safety aspect of an insurance business leads to a quite unrealistic behaviour. We assume that the surplus process of an insurance portfolio, or equivalently the cash flow process of a company, is given by a Brownian motion with an unobservable drift parameter. For transforming the problem into a problem with complete observation, we apply classical filter theory. The modified problem can then be treated by the dynamic programming approach and the value function, the maximal dividend payments, is then characterized as the unique viscosity solution of the associated HJB equation. We state a numerical procedure for determining value function and approximating an optimal dividend strategy. Finally we will illustrate the results by some examples and discuss a class of reasonable dividend strategies.

Minisymposium M2

Frames, High-dimensional Data Analysis, and Dimension Reduction

Martin Ehler (München)

M2.1
THU
15:30
I
16:00
G

Optimal Compressive Imaging of Fourier Data

Gitta Kutyniok⋆ (Technische Universität Berlin)
Wang-Q Lim (Technische Universität Berlin)

One fundamental problem in applied mathematics is the issue of recovery of data from specific samples. Of particular importance is the case of pointwise samples of the associated Fourier transform, which are, for instance, collected in Magnetic Resonance Imaging (MRI). Strategies to reduce the number of samples required for reconstruction with a prescribed accuracy have thus a direct impact on such applications – which in the case of MRI will shorten the time a patient is forced to lie in the scanner without moving.

In this talk, we will present a sparse subsampling strategy of Fourier samples which can be shown to perform optimally for functions governed by anisotropic features. For this, we will introduce a dualizable shearlet frame for reconstruction, which provides provably optimally sparse approximations of this class of functions – such cartoon-like images are typically regarded as a suitable model for images, in particular images from MRI. The sampling scheme will be based on compressed sensing ideas combined with a coherence-adaptive sampling density considering the coherence between the Fourier basis and the shearlet frame. We finally prove that this general sampling strategy can sparsely approximate a function of the considered model class from a collection of its Fourier samples with optimal sampling rate.

M2.2
THU
16:00
I
16:30
G

An operator theory approach to irregular frames of translates

Peter Balazs⋆ (Acoustics Research Institute, Austrian Academy of Sciences)
Sigrid Heineken (Departamento de Matemática, Universidad de Buenos Aires.)

We consider translates of functions in $L^2(\mathbb{R}^d)$ along an irregular set of points. We find a representation of the canonical dual of a frame sequence $\{T_{\lambda_k}\phi\}_{k\in\mathbb{Z}} = \{\phi(.-\lambda_k)\}_{k\in\mathbb{Z}}$ - where ϕ is a function in the Paley Wiener Space PW_E - in terms of its Fourier transform:

$$\hat{\theta}_k = \begin{cases} \frac{\hat{\phi}}{|\hat{\phi}|^2}\widetilde{e_{\lambda_k}} & \text{on } supp(\hat{\phi}) \\ 0 & \text{otherwise} \end{cases},$$

where $\widetilde{e_{\lambda_k}}$ is the canonical dual of the frame sequence of the exponentials.

Introducing a suitable notion of a (pseudo-)Gramian function for the irregular case, we obtain conditions for a family of irregular translates to be a Bessel sequence or Riesz sequence.

Frames, dual sequences, and frame multipliers

Diana Stoeva (Acoustics Research Institute, Austrian Academy of Sciences, Vienna)

M2.3
THU
16:30
I
17:00
G

In the talk we will focus on the following topics:

- dual sequences of frames (dual frames or not necessarily frames);
- invertible frame multipliers and representation of the inverse as a multiplier.

For given frames $\Phi = (\phi_n)_{n=1}^{\infty}$ and $\Psi = (\psi_n)_{n=1}^{\infty}$ for a Hilbert space $\mathscr{H}$, and given complex scalar sequence $m = (m_n)_{n=1}^{\infty} \in \ell^{\infty}$, the operator $M_{m,\Phi,\Psi} : \mathscr{H} \to \mathscr{H}$ given by

$$M_{m,\Phi,\Psi} f = \sum_{n=1}^{\infty} m_n \langle f, \psi_n \rangle \phi_n$$

is called a *frame multiplier*. It is known that when Φ and Ψ are Riesz bases for $\mathscr{H}$, and $0 < \inf|m_n| \leq \sup|m_n| < \infty$, then $M_{m,\Phi,\Psi}$ is invertible (bounded bijection of $\mathscr{H}$ onto $\mathscr{H}$) and $M_{m,\Phi,\Psi}^{-1} = M_{(1/m_n),\widetilde{\Psi},\widetilde{\Phi}}$, where $\widetilde{\Phi}$ and $\widetilde{\Psi}$ denote the canonical duals of Φ and Ψ, respectively. This result has opened the following questions: *Are there other invertible frame multipliers, whose inverses can be written as multipliers using appropriate dual frames of* Φ *and* Ψ*? Are there other invertible frame multipliers* $M_{m,\Phi,\Psi}$*, whose inverses can be written exactly as* $M_{(1/m_n),\widetilde{\Psi},\widetilde{\Phi}}$ *using the canonical duals?* We will present results related to these questions. In particular, the case of Gabor multipliers is of interest for applications. We will consider invertible Gabor multipliers whose inverses can be written as multipliers. Further, we will give necessary and sufficient conditions for an invertible operator on L^2 (and its inverse) to be represented as a Gabor frame multiplier with a constant symbol $m = (1)$.

The multiplier's results are related to dual frames and gave rice to new properties of the set of the dual frames of a given frame. In addition, we discuss dual sequences of a given frame, which are not necessarily frames.

Most of the results to be presented are joint work with Peter Balazs.

M2.4
THU
17:00
I
17:30
G

Multi-Window Gabor Frames in Amalgam Spaces

Radu Balan (University of Maryland)
Kasso Okoudjou* (University of Maryland)
Jens C. Christensen (University of Maryland)
Ilya A. Krishtal (Northern Illinois University)
Jose L. Romero (University of Vienna)

We show that multi-window Gabor frames with windows in the Wiener algebra $W(L^\infty, l^1)$ are Banach frames for all Wiener amalgam spaces. As a byproduct of our results we positively answer an open question that was posed by [Krishtal and Okoudjou, Invertibility of the Gabor frame operator on the Wiener amalgam space, J. Approx. Theory, 153(2), 2008] and concerns the continuity of the canonical dual of a Gabor frame with a continuous generator in the Wiener algebra. The proofs are based on a recent version of Wiener's $1/f$ lemma.

M2.5
THU
17:30
I
18:00
G

Estimation of stochastic operators with compactly supported scattering functions

Götz E. Pfander* (Jacobs University Bremen)
Pavel Zheltov (Jacobs University Bremen)

In many radar scenarios, the radar target or the medium is assumed to possess randomly varying parts. The properties of a target are described by a random process known as the spreading function. Its second order statistics under the WSSUS assumption are given by the scattering function.

Recent results on finite dimensional Gabor frames and on stochastic modulation spaces, as well as an extension of operator sampling to stochastic operators allow for the development of novel target estimators. These estimators allow for the determination of the scattering function given complete statistical knowledge of the operator echo from a single sounding by a weighted pulse train.

The presented results apply whenever the scattering function is supported on a compact subset of the time-frequency plane. No restrictions on the geometry or the area of its support set are present.

Minisymposium M3

Mathematics of Planet Earth 2013

Gert-Martin Greuel (Kaiserslautern)
Andreas Matt (Oberwolfach)

M3.1
MON
15:30
I
16:15
D

Can mathematics help to control and avoid environmental stress?
Dietmar Kröner (University of Freiburg)

How much time will be used by a tsunami to reach the shoreline? Which airport have to be closed if a volcano on Iceland blows out? Which region will be flooded if the water level will increase by 1 meter? How to control the speed and density of cars on a highway to avoid traffic jams?

All these questions and many others are related to the safeness of people on the planet earth and mathematics can help to answer these questions. In this contribution we will show the underlying mathematical models of these problems, we shortly discuss the theoretical and numerical background and present some results obtained by numerical simulations. The related mathematical challenges for these computations are accuracy, efficiency, local dynamical grid adaption, parallel computation, load balancing, artificial boundary conditions, validation and visualization. Furthermore we will demonstrate by an interactive installations of the vulcano problem, how we can interest non-experts for mathematics.

M3.2
MON
16:15
I
17:00
D

Atmospheric Modelling on Arbitrary Grids
Hilary Weller (University of Reading)

Weather forecasting models which use latitude-longitude grids, semi-implicit time-stepping and semi-Lagrangian advection are usually the most accurate and efficient models in the world. However this efficiency is achieved using algorithms which require heavy communication over long distances. This communication limits scalability on massively parallel computers which are becoming common-place. I will discuss numerical methods for arbitrary grids which involve less communication and less memory access such as low-order mimetic schemes and Runge-Kutta vertically implicit, horizontally explicit time-stepping schemes. I will also discuss multi-resolution meshes as an alternative to one-way nesting in order to achieve high resolution for local area forecasts.

M3.3
MON
17:15
I
18:00
D

Essential Principles of Geomathematical Modeling and Their Applications

Willi Freeden (Geomathematics Group, University of Kaiserslautern)

A geomathematical tour is described starting from classical Fourier expansions up to modern Tykhonov regularization techniques. The essential ingredients of geomathematical modeling are contained in the following scheme:

approximation. method	Fourier expansion	splines/wavelets	wavelets
	orthogonal approximation		(non-)orthogonal approximation
approximate structure		bandlimited/non-bandlimited	non-bandlimited
	polynomials	kernels	kernels
	zooming-out		zooming-in
localization	increasing frequency localization,		decreasing frequency localization
	decreasing space localization,		increasing space localization
	increasing correlation		decreasing correlation
data structure	equidistributed	weakly irregular	strongly irregular distributed
	large nodal widths		small nodal widths
scale regularization	global	parameter	locally adapted
noise	colored	nature	white
	soft-thresholding		hard-thresholding

The ideas and concepts are applied to satellite gradiometer data to explain phenomena of climate change and to develop new resources.

M3.4
MON
18:00
I
18:30
D

What mathematicians can do to save Alpine glaciers?

Guillaume Jouvet (Freie Universität Berlin)

Alpine glaciers have been shrinking since more than one century and this trend is expected to continue if the global warming progresses. If the mathematicians can not change the climate, at least, they can contribute to better understand the evolution of glaciers and finally to predict their future. This talk aims to explore the role of applied mathematics in the implementation of glacier models. Those models combine some fluid mechanics equations to describe the motion of ice with hydrological models to account for the effects of snow precipitations and melting. Solving such equations poses several challenges due to their complexity, to the huge size of the resulting system and to the complexity of the glacier geometries. To deal with such difficulties, I will present a numerical method, which couples finite volumes and finite elements strategies. As an application, I will show some simulations of the largest glacier of the European Alps, Aletschgletscher, based on different climatic scenarios. Finally, we will see how this model allowed us to make a major advance in a police investigation started in 1926!

[1] G. Jouvet, M. Huss, H. Blatter, M. Funk, *Modelling the retreat of Grosser Aletschgletscher in a changing climate*, Journal of Glaciology, 57(206), 2011.
[2] G. Jouvet, M. Huss, M. Picasso, J. Rappaz, H. Blatter, *Numerical simulation of Rhone's glacier from 1874 to 2100*, Journal of Computational Physics, 228(17), 2009.
[3] G. Jouvet, M. Picasso, J. Rappaz, H. Blatter, *A new algorithm to simulate the dynamics of a glacier: theory and applications*, Journal of Glaciology, 54(188), 2008.

M3.5
TUE
15:30
I
16:15
C

The Mathematics of Biological Evolution

Peter Schuster (Institute for Theoretical Chemistry, University of Vienna)

An attempt is made to visualize evolution with "mathematical glasses". Darwin's natural selection and evolution based on mutation and error-prone reproduction are modeled either by ODEs or by stochastic processes depending on population size and environmental fluctuations. The concept of an abstract genotype space and its mapping into phenotypes turned out to be a valuable tool for the analysis of cell-free evolution, virus evolution, and bacterial evolution at the molecular level. For constant or precisely controlled environmental conditions mathematical models are available, which allow for detailed analysis of the evolutionary process and provide a basis for applications in technology and medicine.

M3.6
TUE
16:15
I
17:00
C

Modeling, valuation and management of economic risks

Ralf Korn (University of Kaiserslautern)

The recent financial crisis has impressively demonstrated that economic risks which are not related to production and consumption are a major threat for our society. Mathematics plays a central role in modeling, valuing and managing those risks. We will highlight major contributions of and challenges for mathematics in the areas of finance, insurance and economic valuation. They range from modeling issues for prices and indices, the use of pricing by arbitrage arguments (such as the famous Black-Scholes formula) to aspects of intergenerational justice. We will also hint at the gap between theoretical results and their applications and finally point out important mathematical problems that have to be solved to ensure the reliability of parts of our social system.

M3.7
TUE
17:15
I
17:45
C

How Mathematics can Help to Observe Climate Change — An Example

Volker Michel (University of Siegen, Geomathematics Group)

The "Mathematics of Planet Earth 2013" initiative focuses on mathematical methods that enable us to solve the manifold scientific problems that are somehow linked to the Earth. One out of many problems of this kind is an accurate observation of climatic effects such as droughts, floods, El Niño effects, etc. As an example of benefits from mathematical innovations, we show that a novel mathematical method, the Regularized Functional Matching Pursuit (RFMP), yields a highly accurate reconstruction of water mass transports e.g. in the Amazon area from gravity data of the satellite mission GRACE. For instance, seasonal differences in the precipitation can be visualized and droughts respectively floods of the last decade can be resolved better.

The mathematical background is as follows: We have to solve an ill-posed inverse problem given by a Fredholm integral equation of the first kind, where large data sets are possible. A regularized version of a greedy algorithm is used to iteratively construct a solution of the inverse problem. This solution is combined from global trial functions (orthogonal polynomials) and localized trial functions (reproducing kernel based spline basis functions). Without the use of a priori information, the algorithm primarily uses localized basis functions in areas with a high detail structure. Hence, the obtained solution is sparse in the sense that essentially less trial functions than available are chosen by the algorithm for the computation of the solution.

The RFMP together with its mathematical properties and some applications was first published in [1, 2], where additional mathematical results are shown in [6]. Further applications of the RFMP can be found in [3, 4]. For the relevant systems of trial functions on the sphere and the ball, see, for example, the textbook [5].

[1] D. Fischer, *Sparse Regularization of a Joint Inversion of Gravitational Data and Normal Mode Anomalies*, PhD Thesis, Verlag Dr. Hut, Munich, 2011.

[2] D. Fischer and V. Michel: *Sparse Regularization of Inverse Gravimetry — Case Study: Spatial and Temporal Mass Variations in South America*, Inverse Problems, 28 (2012), 065012 (34pp).

[3] D. Fischer and V. Michel: *Automatic Best-Basis Selection for Geophysical Tomographic Inverse Problems*, Geophysical Journal International, 193 (2013), 1291-1299.

[4] D. Fischer and V. Michel: *Inverting GRACE Gravity Data for Local Climate Effects*, Siegen Preprints on Geomathematics, 9, 2012, accepted for publication in: Journal of Geodetic Science, 2013.

[5] V. Michel: *Lectures on Constructive Approximation — Fourier, Spline, and Wavelet Methods on the Real Line, the Sphere, and the Ball*, textbook, 326 pages, Birkhäuser Verlag, Boston, 2013.

[6] V. Michel: *RFMP, an Iterative Best Basis Algorithm for Inverse Problems in the Geosciences*, in: Handbook of Geomathematics (W. Freeden, M.Z. Nashed, and T. Sonar, eds.), 2nd edition, article in preparation.

M3.8
TUE
17:45
I
18:15
C

Generalized mass action systems and Birch's theorem

Georg Regensburger* (Johann Radon Institute for Computational and Applied Mathematics (RICAM), Austrian Academy of Sciences, Linz, Austria)
Stefan Müller (Johann Radon Institute for Computational and Applied Mathematics (RICAM), Austrian Academy of Sciences, Linz, Austria)

The study of dynamical systems arising from chemical reaction networks with mass action kinetics was initiated by the work of Horn, Jackson, and Feinberg in the 1970s; see for example the survey [2]. This theory provides results about existence, uniqueness, and stability of positive steady states for all rate constants and initial conditions depending on the underlying network structure alone. So it can be used in applications where the reaction network is given, but the values of the rate constants are unknown. In terms of the corresponding polynomial equations with parametrized coefficients, existence and uniqueness of positive real solutions is guaranteed by Birch's theorem [1].

However, the validity of the underlying mass action law is limited to elementary reactions in homogeneous and dilute solutions. In intracellular environments, the rate law has to be modified. We discuss generalized mass action systems where reaction rates are allowed to be power-laws in the concentrations. In particular, the exponents (kinetic orders) can differ from the corresponding stoichiometric coefficients. Our main result essentially states that, if the sign vectors of the stoichiometric and kinetic-order subspaces coincide, there exists a unique positive steady state for all rate constants [3]. We discuss the corresponding extension of Birch's theorem for generalized polynomial equations with arbitrary real exponents, which is also robust with respect to perturbations in the exponents, as determined by sign vector conditions.

[1] M. W. Birch, *Maximum likelihood in three-way contingency tables*, J. Roy. Statist. Soc. Ser. B **25** (1963), 220–233.

[2] J. Gunawardena, *Chemical reaction network theory for in-silico biologists*, 2003, available at `http://vcp.med.harvard.edu/papers/crnt.pdf`.

[3] S. Müller and G. Regensburger, *Generalized mass action systems: Complex balancing equilibria and sign vectors of the stoichiometric and kinetic-order subspaces*, SIAM J. Appl. Math. **72** (2012), 1926–1947.

Minisymposium M4

Numbers, Graphs, Algebraic Structures & Probability – the Graz Doctoral School in Discrete Mathematics

Wolfgang Woess (Graz)

M4.1
MON
15:30
|
16:00
SR2

Random walks on Baumslag-Solitar groups

Johannes Cuno⋆ (Technische Universität Graz)
Ecaterina Sava-Huss (Technische Universität Graz)

The Poisson boundary associated to a random walk on a group is a measure space that, roughly speaking, describes the long-time behaviour of the random walk. First, we give a short introduction to Poisson boundary theory and see that it provides a link between random walks, potential theory, and geometric group theory. Then, we discuss our recent work on the Poisson boundary of random walks on non-amenable Baumslag-Solitar groups, such as $\mathrm{BS}(2,3) \cong \langle a,t \mid a^2t = ta^3 \rangle$.

M4.2
MON
16:00
|
16:30
SR2

Extremal theory of dependent processes

Alina Bazarova⋆ (Technische Universität Graz)
István Berkes (Technische Universität Graz)
Lajos Horváth (University of Utah)

Trimming is a standard method of statistics to decrease the effect of large sample elements in various procedures of statistical inference. However, removing extreme elements from function series is also a powerful tool in analysis and probability theory. In this talk, we use this method to prove new results in the metric theory of continued fractions, the theory of games and the theory of stochastic processes.

M4.3
MON
16:30
|
17:00
SR2

The minimum number of subtrees of trees

Nina S. Haug⋆ (Alpen-Adria-Universität Klagenfurt)
Clemens Heuberger (Alpen-Adria-Universität Klagenfurt and TU Graz)
Hua Wang (Georgia Southern University)

We consider the following question: Among all trees that have the same (given) degree sequence, find a tree with the minimal number of subtrees.

While it is already known that the unique solution of the analogous maximisation problem is the "greedy tree", the solution of the minimisation problem is more complex. In the talk, we develop a polynomial time algorithm for finding an optimal solution of the minimisation problem.

Random colourings and automorphism breaking in graphs

Florian Lehner (TU Graz)

M4.4
MON
17:00
I
17:30
SR2

Let G be a graph with vertex set V and let $c\colon V \to C$ be a colouring of the vertices of G. The colouring c is said to be *distinguishing* if its stabiliser in $\operatorname{Aut} G$ is trivial, that is, no non-trivial automorphism of G preserves c. While every graph admits a distinguishing colouring (simply give every $v \in V$ a different colour), the question whether there is a distinguishing colouring with a small number of colours can be difficult.

Tucker conjectured that if G is locally finite and every automorphism of G moves infinitely many vertices, then there is a distinguishing 2-colouring (i.e. $C = \{0,1\}$) of G.

We investigate properties of random 2-colourings of such graphs and show that there is an equivalence relation whose equivalence classes are almost surely setwise stabilised by every automorphism in the stabiliser of a random 2-colouring. We give several examples where this equivalence relation is easily seen to be trivial. In these cases we can use random colourings to verify the above conjecture.

Invariants of Polynomial Decomposition

Dijana Kreso* (Graz University of Technology)
Michael Zieve (University of Michigan)

M4.5
THU
15:30
I
16:00
F

In the 1920's J. F. Ritt studied possible ways of writing a polynomial with complex coefficients as a functional composition of polynomials of lower degree. Polynomials of degree greater than 1 which cannot be written as a composition of polynomials which have strictly lower degree are said to be *indecomposable*. By induction, one may write any polynomial of degree greater than 1 as a composition of indecomposables; such a decomposition is said to be *complete*. It was Ritt himself who exhibited two invariants of complete decomposition of a polynomial. Namely, the number of indecomposable polynomials in a complete decomposition of f is uniquely determined by f, as well as the sequence of degrees of indecomposables. Ritt's results have been extended by several authors and his methods and ideas have been further applied to determine new decompostion invariants, as well as other properties of complete decompositions. In this talk I will present a unified approach to the question, give an overview of known results and present new contributions.

M4.6
THU
16:00
I
16:30
F

Fractals arising from numeration and substitutions

Milton Minervino (Montanuniversität Leoben)

Substitutions are simple combinatorial objects which create infinite words over a finite alphabet. They can be used to construct symbolic dynamical systems. We are mainly interested in *Pisot substitutions*, which allow a nice geometrical interpretation of the associated dynamical system. Indeed, we can study fractal domains and their tiling properties to understand better the behaviour of the dynamical system, in particular whether it has pure discrete spectrum. It is conjectured that each dynamical system generated by an irreducible unimodular Pisot substitution has pure discrete spectrum. The fractal domains, called *Rauzy fractals*, arise also in the context of Dumont-Thomas numeration, a generalization of β-numeration, and have particular importance in the theory of arithmetical codings of toral and solenoidal automorphisms. We generalize some of the main results and investigate the main differences when escaping the unimodularity and irreducibility assumptions.

Non-unique factorizations in maximal orders in central simple algebras

M4.7
THU
16:30
I
17:00
F

Daniel Smertnig (Karl-Franzens-Universität Graz)

In a noetherian domain every element can be expressed as a finite product of irreducibles, but in general such a factorization is far from being unique. In the setting of commutative rings and monoids, there is a long tradition of studying the extent and features of this non-uniqueness by means of arithmetical invariants. This has led to a fruitful theory of non-unique factorizations, whose techniques combine methods from abstract algebra, algebraic-, analytic- and combinatorial number theory: Problems about the factorization of elements in a Krull domain, this includes in particular rings of integers in algebraic number fields, are systematically reduced to discrete combinatorial problems about zero-sum sequences over class groups.

The non-commutative setting has received little attention so far: There are isolated results and various definitions of what unique factorization should mean, but there seems to have been no systematic attempt to extend the machinery for studying non-unique factorizations from the commutative setting.

Studying maximal orders in central simple algebras, a non-commutative analogon of rings of integers in algebraic number fields, we connect factorization problems to the (one-sided) ideal-theory of such orders. This leads to two cases: For a large majority of maximal orders (those where every stably free left ideal is free) we find a transfer homomorphism to a monoid of zero-sum sequences over a finite abelian group, showing that the sets of lengths in this case behave similar to the case of commutative Krull domains with finite class group. In the remaining cases the algebra is necessarily a totally definite quaternion algebra. Using recent results on the number theory of such algebras, and an ideal-theoretic construction, one shows that sets of lengths in this case behave distinctly different.

[1] D. Smertnig, *Sets of lengths in maximal orders in central simple algebras*, J. Algebra 390 (2013), 1–43, to appear, arXiv:1306.0834.

Shift Radix Systems - new characterization results and topological properties

M4.8
THU
17:00
I
17:30
F

Mario Weitzer (Doctoral Program Discrete Mathematics, TU & KFU Graz · MU Leoben)

Shift Radix Systems (SRS) turned out to be the missing link between two generalizations of positional notation systems - Beta-Expansions and Canonical Number Systems (CNS) - which have been studied extensively during the last decade, but still leave behind many open questions and unsolved problems. In distinction from positional notation systems, where all integers greater than 1 can serve as a basis, in the general cases only the elements of complicated sets satisfy certain natural finiteness conditions. An introduction to SRS is given and results in relation to the characterization of such sets are being presented. These results settle two previously open topological questions. For a specific set it is shown that it is disconnected and so is its complement.

M4.9
THU
17:30
I
18:00
F

Rotor-Router Walks

Ecaterina Sava-Huss⋆ (Technische Universität Graz)
Wilfried Huss (Technische Universität Graz)

Rotor-Router walks are deterministic analogues of random walks, in which the walker is routed to each of the neighbouring vertices in some fixed cyclic order. In this talk we introduce rotor-router walks, the notion of transience and recurrence for such walks, and if time allows other related concepts. We will also insist on the connection between random walks and rotor-router walks.

[1] W. Huss, E. Sava, *Transience and recurrence of rotor-router walks on directed covers of graphs*, Electron. Commun. Probab. 17 (2012), no. 41.
[2] W. Huss, E. Sava, *Internal aggregation models on comb lattices*, Electron. J. Probab. 17 (2012), no. 30.
[3] W. Huss, E. Sava,, *Rotor-router aggregation on the comb*, Electron. J. Combin. 18 (2011), no. 1, Paper 224, 23 pp..

Minisymposium M5

Operator Theory

Wolfram Bauer (Göttingen)
Birgit Jacob (Wuppertal)
Marko Lindner (Hamburg-Harburg)
Carsten Trunk (Ilmenau)

M5.1
TUE
11:15
I
11:45
SR2

Functional calculus estimates via admissibility

Felix L. Schwenninger* (University of Twente, NL)
Hans Zwart (University of Twente, NL)

Functional calculus, i.e. giving meaning to $f(A)$ for functions f and operators A, has been developed in the last century, starting with the work of von Neumann, [1]. We consider bounded analytic functions on the half plane as functions and generators A of strongly continuous semigroups e^{tA} as operators. This H^∞-calculus, see e.g. [2], has applications in stability analysis and maximal regularity for PDEs. Recently, a different approach to the calculus, defining $f(A)$ by means of notions from linear systems theory, was given in [5, 4]. Using this, we derive estimates for the norm of $f(A)e^{tA}$ near zero, in case that the semigroup is analytic. Since we allow for general reflexive Banach spaces, this generalizes results by Haase and Rozendaal, [3]. However, their approach also for works non-analytic semigroups.

[1] John von Neumann, *Mathematical foundations of quantum mechanics*, Princeton Landmarks in Mathematics. Princeton University Press, Princeton, NJ, 1996, reprint.
[2] Markus Haase, *The Functional Calculus for Sectorial Operators*, volume 169 of Operator Theory: Advances and Applications. Birkhäuser Verlag, Basel, 2006.
[3] Markus Haase and Jan Rozendaal, *Functional calculus for semigroup generators via transference*, submitted 2013.
[4] Felix L. Schwenninger and Hans Zwart, *Weakly admissible $\mathscr{H}_\infty^-$-calculus on reflexive Banach spaces*, Indag. Math. (N.S.), 23(4) (2012) 796–815.
[5] Hans Zwart, *Toeplitz operators and H_∞ calculus*, J. Funct. Anal., 263(1) (2012) 167–182.

Global pseudo-differential calculus on compact Lie groups

Jens Wirth* (LMU München und Universität Stuttgart)
Michael Ruzhansky (Imperial College London)
Ville Turunen (Aalto University, Helsinki)

M5.2
TUE
11:45
I
12:15
SR2

In this talk we will present some recent results on the global symbolic characterisation of algebras of pseudo-differential operators on compact Lie groups and the related global pseudo-differential calculus. The characterisations are formulated in terms of global symbols σ defined as matrix-valued functions on the non-commutative phase space $G\times\widehat{G}$, where G denotes the Lie group and $\widehat{G}$ the set of equivalence classes of irreducible representations of the group G. Defining suitable difference operators $\mathbb{D}_\xi$ acting on functions defined on the representation lattice allows to introduce symbol classes $S^m_{\rho,\delta}(G\times\widehat{G})$ by

$$\|\partial_x^\alpha \mathbb{D}_\xi^\beta \sigma(x,\xi)\|_{\mathrm{op}} \leq C_{\alpha,\beta}\langle\xi\rangle^{m+\delta|\alpha|-\rho|\beta|}, \qquad x\in G, \xi\in\widehat{G}$$

for all multi-indices α and β. Operators are then defined via group Fourier transform

$$Af(x) = \sum\nolimits_{\xi\in\widehat{G}} d_\xi \mathrm{Tr}(\xi(x)\sigma(x,\xi)\widehat{f}(\xi)).$$

Then operators with symbols from $S^m_{1,0}(G\times\widehat{G})$ are exactly the operators from Hörmander class $\Psi^m(G)$. Operators with symbols of the ρ-δ-type arise as parametrices to non-elliptic elements in the calculus and are worth to be studied in their own right. The approach allows to define and study such operators without further restrictions on ρ and δ.

For the particular case of a torus $\mathbb{T}=\mathbb{R}^n/\mathbb{Z}^n$, the aforementioned results yield a characterisation of certain classes of Fourier series operators and recover the corresponding difference-differential operator calculus.

[1] M. Ruzhansky, V. Turunen, and J. Wirth. Hörmander class of pseudo-differential operators on compact Lie groups and global hypoellipticity. *arXiv:1004.4396*, 2010.
[2] M. Ruzhansky and J. Wirth. On multipliers on compact Lie groups. *Funct. Anal. Appl*, 47:72–75, 2013.
[3] M. Ruzhansky and J. Wirth. Global functional calculus for operators on compact Lie groups *arXiv:1307.1464*, 2013.
[4] M. Ruzhansky and J. Wirth. A rough guide to non-commutative phase space. In preparation.

M5.3
TUE
15:30
|
16:00
SR2

Singular Weyl–Titchmarsh–Kodaira theory for Schrödinger operators with applications to inverse spectral and scattering theory

Gerald Teschl⋆ (Universität Wien)
Aleksey Kostenko (Universität Wien)

In this talk I will review singular Weyl–Titchmarsh–Kodaira theory for one-dimensional Schrödinger operators which has been developed recently as an extension of the classical theory. Moreover, I will present some applications to inverse spectral theory including a local Borg–Marchenko type result as well as a Hochstadt–Lieberman type result which are applicable to (e.g.) perturbed spherical Schrödinger operators or to perturbed harmonic oscillators. Finally, I will discuss high-energy asymptotics and applications to scattering theory. This is based on joint work (partly) with Jonathan Eckhardt, Aleksey Kostenko, and Alexander Sakhnovich.

M5.4
TUE
16:00
|
16:30
SR2

On the absolutely continuous spectrum for the Kirchhoff Laplacian on radial trees

Christian Seifert⋆ (Technische Universität Hamburg-Harburg)
Pavel Exner (Czech Technical University Prague)
Peter Stollmann (Technische Universität Chemnitz)

We consider the Kirchhoff Laplacian on a rooted radially symmetric metric tree graph. We study connections between geometric properties of the tree and spectral properties of the operator. By radial symmetry, the geometry of the tree is determined by the sequences of branching numbers and edge lengths. Assuming that only finitely many branching numbers and edge lenghs occur we prove that the absolutely continuous spectrum is non-empty if and only if these two geometric sequences are eventually periodic. The talk is based on [1].

[1] P. Exner, C. Seifert, P. Stollmann, *Absence of absolutely continuous spectrum for the Kirchhoff Laplacian on radial trees*, erscheint in Ann. Henri Poincaré (2013), arXiv: http://arxiv.org/abs/1305.0656

M5.5
TUE
16:30
|
17:00
SR2

Kotani-Last problem and Hardy spaces on surfaces of Widom type

Peter Yuditskii⋆ (Universität Linz)
Alexander Volberg (Michigan State University)

We present a theory of non almost periodic ergodic families of Jacobi matrices with pure (however) absolutely continuous spectrum. And the reason why this effect may happen: under our “axioms" we found an analytic condition on the resolvent set that is responsible for (exactly equivalent to) this effect.

In the framework of Austrian Science Fund (FWF) project P25591-N25.

Essential spectrum of block operator matrices

Matthias Langer (University of Strathclyde)

M5.6
TUE
17:00
|
17:30
SR2

In this talk I will present results about the essential spectrum of block operator matrices whose entries are differential operators with singular coefficients. In many cases the essential spectrum consists of two components: a regular part, which is connected with the block structure, and a singular part, which is caused by the singular coefficients.

The talk is based on joint work with O. Ibrogimov, H. Langer and C. Tretter.

Variational principles for self-adjoint operator functions arising from second order systems

Carsten Trunk* (Technische Universität Ilmenau)
Birgit Jacob (Bergische Universität Wuppertal)
Matthias Langer (University of Strathclyde, Glasgow)

M5.7
TUE
17:30
|
18:00
SR2

Variational principles are a very useful tool for the qualitative and numerical investigation of eigenvalues of self-adjoint operators. Let A be a self-adjoint operator in a Hilbert space H with domain $\mathscr{D}(A)$, and denote by $\lambda_1 \le \lambda_2 \le \dots$ those eigenvalues that are below the essential spectrum. Using the functional

$$p(x) = \frac{(Ax,x)}{(x,x)}$$

for non-zero x in the domain of A, these eigenvalues can be characterised by a min-max principle,

$$\lambda_n = \min_{L\subset\mathscr{D}(A),\,\dim L=n} \max_{x\in L,\,x\neq 0} p(x).$$

This is a well-known tool in operator theory and goes back to Lord Rayleigh, G. Polya, W. Ritz, H. Weyl, and R. Courant (just to mention a few).

The operator

$$A = \begin{bmatrix} 0 & I \\ -A_0 & -D \end{bmatrix} \tag{1}$$

with self-adjoint (unbounded) entries A_0 and D is not a self-adjoint operator in $H \times H$. In order to derive a variational principle for this block operator matrix, we consider a quadratic form $\mathfrak{t}(\lambda)$ which is defined via the entries A_0 and D. Under some assumptions this $\mathfrak{t}(\lambda)$ is a sectorial form if λ is from a certain area in the complex plane and the corresponding representing operators $T(\lambda)$ form a holomorphic family of type (B). We show that the point spectra of A and of the operator function T coincide and show a variational principle which involves the quadratic form $\mathfrak{t}(\lambda)$.

M5.8
WED
10:15
I
10:45
SR2

Differential seminorms, approximation algebras, and spectral invariance

Karlheinz Gröchenig* (Universität Wien)
Andreas Klotz (Universität Wien)

A differential subalgebra $\mathscr{B}$ of a C^*-algebra $\mathscr{A}$ is a subalgebra with norm such that

$$\|ab\|_{\mathscr{A}} \leq C(\|a\|_{\mathscr{A}}\|b\|_{\mathscr{B}} + \|b\|_{\mathscr{A}}\|a\|_{\mathscr{B}}) \quad \text{for all } a,b \in \mathscr{A}\,.$$

It is well known that every differential subalgebra of a unital C^*-algebra is spectrally invariant. This means that if $a \in \mathscr{B}$ is invertible in $\mathscr{A}$, then a^{-1} is already in the subalgebra $\mathscr{B}$. We derive a quantitative version of this well-known fact and show that a minimal amount of smoothness, as given by a differential norm, already implies norm control. We obtain an explicit estimate for the differential norm of an invertible element a. This estimate depends only on the condition number of a and the ratio of two norms.

An important class of examples is given by the approximation algebras from approximation theory. We mention some applications of spectral invariance, e.g., for the finite section method, off-diagonal decay of matrices, or the symbolic calculus of pseudodifferential operators.

[1] K. Gröchenig. Wiener's lemma: Theme and variations. an introduction to spectral invariance. In B. Forster and P. Massopust, editors, *Four Short Courses on Harmonic Analysis*, Appl. Num. Harm. Anal. Birkhäuser, Boston, 2010.

[2] K. Gröchenig and A. Klotz. Noncommutative approximation: inverse-closed subalgebras and off-diagonal decay of matrices. *Constr. Approx.*, 32(3):429–466, 2010.

[3] K. Gröchenig and A. Klotz. Norm-controlled inversion in smooth banach algebras, i. *J. London Math. Soc.*, 2013.

Quasi-banded operators, convolutions and their finite sections

M5.9
WED
10:45
I
11:15
SR2

Markus Seidel* (Technische Universität Chemnitz)
Helena Mascarenhas (Instituto Superior Técnico Lisbon)
Pedro A. Santos (Instituto Superior Técnico Lisbon)

We propose a class of operators on $L^p(\mathbb{R})$-spaces with $1 \le p \le \infty$, referred to as quasi-banded operators, which can be regarded as a generalization an unification of several interesting families which have been studied during the last years. In particular, banded and band-dominated operators as well as convolution type operators with continuous, quasi-continuous, slowly oscillating and (semi)almost periodic generating functions (i.e. Fourier multipliers) are covered by this class.

We study the applicability of the finite section method, that is the question if, or under which conditions, the solution $u \in L^p(\mathbb{R})$ of an equation

$$Au = b \quad \text{where } b \in L^p(\mathbb{R}) \text{ and } A \text{ is quasi-banded}$$

can be approximated by restricting this equation to finite subintervals of $\mathbb{R}$.

The criteria are stated in the simple and effective language of $\mathscr{P}$-strong limit operators. Therefore, this talk will start with a short introduction to this beautiful concept of $\mathscr{P}$-strong convergence, which permits to translate many important properties of the classical strong operator convergence to non-strongly converging operator sequences especially for the more exotic cases $p \in \{1, \infty\}$.

Commutative algebras of Toeplitz operators on the Bergman space

M5.10
WED
11:15
I
11:45
SR2

Nikolai Vasilevski (CINVESTAV, Mexico City)

Let $\mathbb{B}^n$ be the unit ball in $\mathbb{C}^n$, with $n \ge 1$. Denote by $\mathscr{A}^2_\lambda(\mathbb{B}^n)$, $\lambda \in (-1, \infty)$, the standard weighted Bergman space, which is the closed subspace of $L^2_\lambda(\mathbb{B}^n)$ consisting of analytic functions. The Toeplitz operator T_a with symbol $a \in L_\infty(\mathbb{B}^n)$ acting on $\mathscr{A}^2_\lambda(\mathbb{B}^n)$ is defined as the compression of a multiplication operator on $L^2_\lambda(\mathbb{B}^n)$ onto the Bergman space, i.e., $T_a f = B_\lambda(af)$, where B_λ is the Bergman (orthogonal) projection of $L^2_\lambda(\mathbb{B}^n)$ onto $\mathscr{A}^2_\lambda(\mathbb{B}^n)$.

The commutative C^*-algebras generated by Toeplitz operators are classified as follows: *given any maximal commutative subgroups of bihomorphisms of the unit ball $\mathbb{B}^n$, the C^*-algebra generated by Toeplitz operators whose symbols are constant on the orbits of this subgroup is commutative on each weighted Bergman space $\mathscr{A}^2_\lambda(\mathbb{B}^n)$.*

As a leading example we analyze the C^*-algebra generated by Toeplitz operators with radial symbols $a(z) = a(|z|)$, and show that, independently of a dimension n of the unit ball and a wight parameter $\lambda \in (-1, \infty)$, this algebra is isomorphic and isometric to the C^*-algebra of sequences that *slow oscillate* in the sense of Schmidt (1924).

As a byproduct we give a solution of the weighted extension of the classical Hausdorff moment problem.

M5.11
WED
11:45
I
12:15
SR2

Commutative Banach algebras generated by Toeplitz operators: structural results and applications

Wolfram Bauer (Universität Göttingen)

We study new classes of commutative Banach algebras that are generated by Toeplitz operators acting on the standard weighted Bergman space $\mathscr{A}^2_\lambda(\mathbb{B}^n)$ over the complex n-dimensional unit ball $\mathbb{B}^n$ in $\mathbb{C}^n$. These algebras are induced by certain abelian subgroups of the automorphism group of $\mathbb{B}^n$ and only given in terms of their generators. Moreover, they are not invariant under the involution of $\mathscr{L}(\mathscr{A}^2_\lambda(\mathbb{B}^n))$ and cannot be extended to commutative C^*-algebras. The aim of this talk is to describe the Gelfand theory of the above type of algebras that are subordinate to the quasi-elliptic group of automorphisms of $\mathbb{B}^n$. More precisely, we characterize the maximal ideal spaces and provide the Gelfand transform on a dense sub-algebra. These algebras are not semi-simple and in some cases the radical can be calculated explicitely. Finally, we point out that these observations lead to various applications in the spectral theory of Toeplitz operators and can be applied to a further structural analysis of the algebras, e.g. we partly can prove their spectral invariance which typically is not easy to obtain. The results presented in this talk are joint work with Nikolai Vasilevski (CINVESTAV, Mexico).

[1] W. Bauer, N. Vasilevski, *On the structure of a commutative Banach algebra generated by Toeplitz operators with quasi-radial quasi-homogeneous symbols*, Integr. Equ. Oper. Theory 74 (2012), 199-231.

M5.12
WED
12:15
I
12:45
SR2

Product of Toeplitz operators on the Fock space

Dieudonne Agbor (Universität Göttingen)

Extending the result of [1] we show that any finite product of Berezin-Toeplitz operators with in general unbounded symbols in the range of certain integral transform is also a Berezin-Toeplitz operator. As an application, we apply our result to the so called method of successive approximation due to Berezin [2] to obtain explicit formulas and small time approximation of heat kernels.

[1] W. Bauer, *Berezin-Toeplitz quantization and composition formulas*, J. Funct. Anal. 256 (2009) 3107-3142. Mass., 1984.

[2] F. A. Berezin, *Covariant and contravariant symbols of operators*, Math. USSR Izvest. 6(5) (1972) 1117-1151.

Minisymposium M6

Problems in Information and Communication in Mathematics

Wolfgang Dalitz (Berlin)
Wolfram Sperber (Karlsruhe)

M6.1
TUE
15:30
I
16:00
HS 10

Anyone can edit Wikipedia - Ansprüche und Arbeitsweise eines (mathematischen) Content Providers

Philipp Birken (Universität Osnabrück)

Heutzutage ist das wesentliche mathematische Nachschlagewerk für Schüler und Studenten die Wikipedia. Diese hohen Leserzahlen ergeben sich insbesondere dadurch, dass Wikipedia zu sehr vielen Themen die beste im Internet verfügbare Quelle ist. Diese hohe Qualität steht auf den ersten Blick im Widerspruch zur freien Editierbarkeit. Und so ist ein unter Wikipedianern beliebter Spruch: "Wikipedia funktioniert nur in der Praxis, nicht in der Theorie".

Der Vortrag soll aufzeigen, dass dies nur oberflächlich richtig ist und beschreibt das umfangreiche Qualitätssicherungssystem der Wikipedia am Beispiel des Bereiches Mathematik. Wesentliche Punkte hierbei sind ein hoher qualitativer Anspruch, ein systematisiertes Vieraugenprinzip und eine hohe Redundanz, die durch die nichtkommerzielle Natur des Projekts möglich ist.

M6.2
TUE
16:00
I
16:30
HS 10

Neues vom Zentralblatt MATH - mehr als neue Kleider

*Olaf Teschke** (FIZ Karlsruhe/Humboldt-Universität zu Berlin)
Gert-Martin Greuel (FIZ Karlsruhe/Universität Kaiserslautern)
Klaus Kiermeier (FIZ Karlsruhe)
Helena Mihaljević-Brandt (FIZ Karlsruhe)

Wie werden Mathematiker im 21. Jahrhundert die relevanten Informationen für ihre Forschung finden? Wie sollten Suchergebnisse strukturiert sein, um den Überblick in der exponentiell wachsenden Menge an Wissen zu behalten? Welche Sichtweisen werden neben der klassischen Dokumentensuche wichtig, und wie sind die unterschiedlichen Facetten am besten miteinander zu verknüpfen? Welche Menge an Metainformationen sind dazu relevant, und wie können diese automatisch oder intellektuell möglichst effizient generiert werden?

Die neue Benutzeroberfläche der zbMATH-Datenbank bietet einen grundlegend überarbeiteten Ansatz, um diese Probleme zu lösen: so werden Suchergebnisse automatisch strukturiert und neue Informationsschichten sind hinzugekommen: Neben den klassischen bibliographischen und inhaltlichen Facetten sind nun etwa Profile, die Suche nach mathematischen Formeln oder Links zu mathematischer Software integriert. Wesentlich ist, dass das Konzept erweiterbar angelegt ist, gerade auch im Hinblick auf die semantische Suche, die durch die ausgeprägte mathematische Fachsprache in den nächsten Jahren den Mehrwert gegenüber unspezifischen Suchmaschinen definieren wird.

[1] H. Mihaljević-Brandt, O. Teschke, *An invitation the new zbMATH interface,* Newsletter of the European Mathematical Society 88, June 2013, 63-64 (2013)

Reproducibility, software in experimental mathematics and lmonade

M6.3
TUE
16:30
I
17:00
HS 10

Burcin Eröcal (IWR, Universität Heidelberg)

Most results in experimental mathematics are accompanied by software implementations which often push the boundaries of what can be computed in terms of mathematical theory and efficiency. Since new algorithms are built on existing ones, just as theorems are derived from existing results, it would be natural to expect that the code produced for one project will be useful later on, to both the same researcher and others.

While theorems blissfully stay intact over time, software deteriorates and ages. Implementations need to be updated with respect to changes in underlying libraries and hardware architectures. Even if up to date, software developed for a specific application area often needs to be adapted to new situations. Like proofs can be reused by taking some components intact and modifying certain parts, software needs similar adaptations to be reusable.

This talk will present *the lmonade project*, which aims to provide infrastructure and tools to foster code sharing and openness in scientific software development by simplifying the tasks of distributing software with its dependencies, ensuring that it can be built on different platforms, and making sure the software is compatible across new releases of its dependencies.

By simplifying code sharing and distribution, especially when complex dependencies are involved, *lmonade* enables researchers to build on existing tools without fear of losing users to baffling installation instructions.

swMATH - ein neuer Informationsdienst für mathematische Software (I): Konzept

M6.4
TUE
17:00
I
17:30
HS 10

Sebastian Bönisch (FIZ Karlsruhe / Zentralblatt MATH)

Ein neuer Informationsservice für mathematische Software (**swMATH**) wird präsentiert. Kernpunkt und Alleinstellungsmerkmal ist die Kombination von wissenschaftlichen Publikationen und Software. Dieses Konzept wird sowohl zur Identifikation der Softwarepakete, als auch zu deren Anreicherung mit Metadaten benutzt. So wurden z.B. Heuristiken entwickelt, um aus unstrukturierten Daten geeignete Informationen zu extrahieren.

Es werden auch die organisatorischen und technischen Möglichkeiten der Zusammenarbeit mit dem Zentralblatt MATH zur wartungsarmen Betreuung aufgezeigt. Die Nutzung der IT-Infrastruktur des FIZ Karlsruhe gewährleistet den nachhaltigen Betrieb dieses Dienstes.

M6.5
TUE
17:30
I
18:00
HS 10

swMATH - ein neuer Informationsdienst für mathematische Software (II): Demo

Hagen Chrapary (FIZ Karlsruhe / Zentralblatt MATH)

Die Weboberfläche **swMATH.org** des neuen Informationsdienstes für mathematische Software wird in einer Online-Präsentation vorgestellt. Insbesondere werden die Analysemöglichkeiten und Features hervorgehoben, die sich aus dem publikationsbasierten Ansatz ergeben: Die automatisch generierte Keyword-Cloud und die Liste ähnlicher Software sind beispielsweise Informationen, die sich nur schwer über andere Quellen beschaffen lassen. Sie werden mithilfe der Metadaten der wissenschaftlichen Publikationen erzeugt und stellen einen echten Mehrwert für die mathematische Community dar.
Ebenfalls werden die Integration in andere Dienste durch offene Schnittstellen (REST) und einige Implementierungsdetails (Django, jQuery, PostgreSQL) angesprochen. Diskussionen wird ein breiter Raum zur Verfügung gestellt. Das endgültige Release erfolgt im Dezember 2013.

M6.6
TUE
18:00
I
18:30
HS 10

Electronic Library of Mathematics (ELibM) in EMIS: Ein Update

Michael Jost (FIZ Karlsruhe/Zentralblatt MATH)

Die Electronic Library of Mathematics in EMIS ist seit 1996 das weltweit größte Repositorium für "gratis Open Access" Zeitschriften aus dem Bereich Mathematik. Der Vortrag stellt die Geschichte und den aktuellen Stand der ELibM dar und beschreibt Planungen für zukünftige Entwicklungen.

M6.7
THU
10:15
I
10:45
HS 10

Mathematische Formelsuche - Ansatz und Prototyp

*Michael Kohlhase** (Jacobs University Bremen)
Wolfram Sperber (FIZ Karlsruhe/Zentralblatt Math)

Bisher ist die Suche in mathematischen Publikationen auf die Textsuche beschränkt. Die digitalen Formate für die Mathematik, insbesondere MathML und TEX, ermöglichen auch eine inhaltliche Analyse und eine Suche in mathematischen Ausdrücken (Formeln). Mathematische Formelsuche ist in der letzten Zeit zunehmend in den Fokus der Computer Mathematik Community gerückt. Der Formelsuche stehen viele Hindernisse entgegen: die Mehrdeutigkeit mathematischer Ausdrücke und deren Disambiguierung, die unterschiedliche Aussagefähigkeit verschiedener digitalen Formate für die Mathematik, die beliebige Komplexität mathematischer Formeln, die Struktur (etwa freie Variablen) mathematischen Ausdrücke, etc. Im MathSearch Projekt, das das FIZ Karlsruhe zusammen mit der Jacobs University Bremen durchführt, werden neue Methoden für die Formelsuche entwickelt und implementiert. Im Vortrag werden ein Konzept für die Formelsuche und der Prototyp für die Formelsuche in der Datenbank zbMATH vorgestellt.

Named Entities in der Mathematik: Identifizierung von Personen

M6.8
THU
10:45
I
11:15
HS 10

Nicolas Roy⋆ (zbMATH / FIZ Karlsruhe)
Lucía Santamaría (zbMATH / FIZ Karlsruhe)

The complete and unambiguous attribution of scholarly material to their authors ranks among the most critical challenges for digital libraries, and is of direct relevance for researchers, scientific institutions and grant agencies alike. Author identification, also known als entity resolution, is a challenging problem within the realm of natural language processing and machine learning.

The review and abstract service zbMATH contains over 3.2 million bibliographic entries corresponding to more than a century of pure and applied mathematical publications. The disambiguation of the more than 850,000 authors requires a combination of intellectual and algorithmic work. In this talk I will present the latest efforts made in author identification at zbMATH, including co-author networks, common classification relations and title analysis of the publications.

Automatische Klassifizierung mathematischer Dokumente

M6.9
THU
11:15
I
11:45
HS 10

Simon Barthel⋆ (Universität Braunschweig / Institut für Informationssysteme)
Sascha Tönnies (Forschungszentrum L3S)

Die ständig zunehmende Menge an digital verfügbaren Informationen ist Fluch und Segen zugleich. Auf der einen Seite können Benutzer Web-Suchmaschinen nutzen und haben somit bequemen und oft sogar freien Zugriff auf immer mehr Informationen. Auf der anderen Seite wird die Bewertung und die Eingrenzung von Web-Suchergebnissen für domänenfremde Benutzer immer schwieriger. Dies wird vor allem durch die riesige Menge an Web-Spam verschärft. Deshalb versuchen etablierte Informationsanbieter, thematisch fokussierte Sammlungen mit einem möglichst hohen Maß an Qualität sowohl des Inhalts als auch der zugehörigen Metadaten anzubieten. Der dadurch gewonnene Mehrwert liegt besonders in der Indizierung der Dokumente, die noch in vielen Bereichen, wie z.B. der Chemie (CAS), der Medizin (MeSH) oder der Mathematik (Zentralblatt MATH und Mathematical Reviews) per Hand durchgeführt wird. Aber aufgrund der enormen Datenmengen ist diese manuelle Aufgabe immer zeitaufwändiger und ist daher eine schwerwiegende Kostenfrage. Eine mögliche Lösung für dieses Problem scheinen die Verfahren zur automatisierten Klassifizierung zu bieten. In dem Vortrag werden gängige Verfahren zur Klassifizierung und die Besonderheiten, die bei mathematischen Dokumenten berücksichtigt werden müssen, vorgestellt. Außerdem werden die Ergebnisse eines großen Experimentes über den Beständen des Zentralblatts MATH vorgestellt, das im Rahmen des von der Deutschen Forschungsgemeinschaft geförderten Projekts "DeLiVerMATH" als Kooperation des Forschungszentrums L3S Hannover, der TIB Hannover und des FIZ Karlsruhe durchgeführt wurde.

M6.10
THU
11:45
I
12:15
HS 10

Textanalyse mathematischer Publikationen

Ulf Schöneberg* (FIZ Karlsruhe / Zentralblatt Math)
Wolfram Sperber (FIZ Karlsruhe / Zentralblatt Math)

Das elektronische Publizieren und die wachsende Anzahl an mathematischen Publikationen erfordern auch die Entwicklung neuer Methoden und Werkzeuge für die Suche nach mathematischer Literatur. Eine besondere Herausforderung ist dabei die Entwicklung automatisierter Verfahren für die inhaltliche Erschließung der Publikationen. In dem Vortrag werden Verfahren für die Verschlagwortung und den Aufbau eines kontrollierten Vokabulars für die Mathematik vorgestellt. Die in der Computerlinguistik entwickelten Methoden und Werkzeuge für die automatisierte Analyse natürlicher Sprachen sind hierfür der Ausgangspunkt. Diese müssen an die spezifischen Besonderheiten und Anforderungen der Mathematik angepasst und erweitert werden. Im Rahmen eines von der DFG geförderten Projekts wurden Verfahren für die automatisierte Extraktion von Schlüsselwort-Phrasen mathematischer Publikationen und den Aufbau eines kontrollierten Vokabulars entwickelt, die hier präsentiert werden.

[1] U. Schöneberg, W. Sperber *The DeLiVerMATH Project Text Analysis in Mathematics*, Lecture Notes in Artificial Intelligence Bd. 7961, Springer (2013) 369–373.

M6.11
THU
12:15
I
12:45
HS 10

MathMap - ein interaktiver Spaziergang durch die Mathematik

Michael Kohlhase (Jacobs University Bremen)

Die Mathematics Subject Classification (MSC) ist das meist verwendete System, um mathematische Forschungspublikationen in den mathematischen Kanon einzuordnen. Die Klassen der MSC sind hierarchisch strukturiert, es gibt aber auch Querverweise auf Klassen ähnlichen Inhalts. Mit der MathMap wurde eine Visualisierung für die MSC entwickelt. Ausgehend von den Klassifikationen der mathematischen Publikationen der Datenbank zbMATH, erfolgt eine Visualisierung der MSC Klassen entsprechend der Häufigkeiten der vergebenen Klassifikationsmarken. Die Anzahl der Publikationen einer Klasse bestimmt die Größe der MSC Klassen in der graphischen Darstellung. MSC Klassen, deren Klassifikationsmarken häufig gemeinsam für die Klassifikation einer Publikation verwendet werden, sind benachbart. Im Vortrag werden das Konzept und die Implementierung der MathMap (http://www.mathweb.org) vorgestellt.

Minisymposium M7

Spezifika der mathematischen Anfangsausbildung für Lehramtsstudierende

Günter Törner (Duisburg-Essen)
Reinhard Winkler (Wien)

M7.1
TUE
11:15
I
12:15
E

Was sind konstitutive Merkmale einer Lehramtsausbildung Mathematik? - die internationale Perspektive

Günter Törner (Universität Duisburg-Essen)

Vergleicht man die Publikationen in der Schriftenreihe des IDM Bielefeld aus dem Jahr 1975, so scheinen die Diskussionen immer wieder um die gleichen Probleme zu kreisen – und ein Fortschritt in der Entwicklung neuer Strukturen scheint nur bescheiden. Nimmt man noch die Ansätze in unseren europäischen Nachbarstaaten hinzu, so wird deutlich, dass viele Positionen auch kulturell und national begründet sind. Der Vortragende versucht vor diesem Hintergrund eine Bestandsaufnahme und wird wenige Handlungsvorschläge unterbreiten.

M7.2
WED
10:15
I
11:00
E

PädagogInnenbildung NEU
Die Reform der LehrerInnenbildung in Österreich

Roland Fischer (Universität Klagenfurt)

Die österreichische Bundesregierung hat für die laufende Legislaturperiode (endet im Herbst 2013) eine Reform der LehrerInnenbildung vorgesehen. Demnach sollte zum Zeitpunkt des Vortrages ein beschlossenes Bundesgesetz vorliegen. Dies ist beim derzeitigen Planungsstand (Mai 2013) durchaus zu erwarten. Im Vortrag soll über einige Grundgedanken der Reform und deren Konkretisierung berichtet werden. Geplante Themen: Wissenschaftlichkeit und Professionsorientierung, wissenschaftliche Fachdisziplinen und Schulfach, Studium und Schulpraxis.

Erfahrungen aus einem Brückenkurs sowie einer Calculus-Einführung anstelle klassischer Einführungsvorlesungen aus Analysis/Lineare Algebra

M7.3
WED
11:00
I
11:15
E

Bernd Thaller (Universität Graz)

An der Universität Graz wurden in den letzten Jahren unterschiedliche Zugänge zur Lehrerinnen-Anfangsausbildung ausprobiert und im letzten Jahr durch einen Brückenkurs ergänzt, wobei die Auswirkungen auf die Studierenden im Rahmen einer Diplomarbeit analysiert wurden. Zu den üblichen Defiziten des Lehramtsstudiums gehört es, dass das Fach von den Studierenden (an der Universität ebenso wie an der Schule) vor allem als Qualifikationshürde empfunden wird und zu wenig als Chance gesehen wird, Kenntnisse und Fähigkeiten zu erwerben, die im Leben und im Beruf von Nutzen sind. Mathematik wird beinahe ausschließlich als eine willkürliche, autoritär (und ohne Blick auf die Schulpraxis) zusammengestellte Sammlung von Prüfungsinhalten wahrgenommen. Man lernt für diese Prüfungen, damit man danach an Schulen unterrichten darf. Allerdings ist dieser Mathematik-Unterricht sowohl im Stil als auch im Inhalt ganz anders als das, was man an der Universität unter derselben Bezeichnung erlebt hat.

Im Zuge der Neugestaltung der Curricula für die Pädagog/inn/enbildung-Neu sollte die Chance ergriffen werden, das Lehramtsstudium berufsorientierter und im Hinblick auf die erforderlichen Kompetenzen der Lehrenden zu gestalten. Es stellt sich die Frage, ob das mit dem traditionellen, rein an den Bedürfnissen der Fachwissenschaft orientierten Zugang sinnvoll zu bewerkstelligen ist.

Eine Vorlesung für fünf Studienrichtungen - Lineare Algebra 1 an der Universität Innsbruck

M7.4
WED
11:15
I
11:30
E

Franz Pauer (Universität Innsbruck)

Die Einführungsvorlesung aus Linearer Algebra wird an der Universität Innsbruck seit Jahren gemeinsam für die Studienrichtungen Mathematik-Lehramt, Technische Mathematik, Physik, Informatik und Atmosphärenwissenschaften angeboten. Im Vortrag werde ich über die Auswahl der Inhalte und ihrer Reihenfolge, sowie über Probleme und Chancen dieser Lehrveranstaltung berichten.

M7.5
WED
11:30
I
11:45
E

Lehramtsspezifische Aufgaben zu Studienbeginn

Christoph Ableitinger (Universität Wien)

Lehramtsstudierenden fällt es häufig schwer, Inhalte der Hochschulmathematik mit Themen in Verbindung zu bringen, die in ihrem eigenen Mathematikunterricht behandelt wurden und die sie später auch selbst wieder in der Schule unterrichten sollen. Das Projekt "Mathematik besser verstehen" der Universität Duisburg-Essen ist diesem Problem durch die Entwicklung lehramtsspezifischer Aufgaben entgegengetreten, die in zweierlei Weise Brücken zwischen der Schul- und der Hochschulmathematik schlagen: Einerseits sollen Bezüge zur Schulmathematik dazu dienen, anschauliche Grundlagen für Konzepte der Hochschulmathematik bereitzustellen. Andererseits soll aber auch die hochschulmathematische Perspektive genutzt werden, um Inhalte der Schulmathematik umfassender zu verstehen und so die spätere didaktische Handlungsfähigkeit im Unterricht zu erweitern. Im Vortrag wird dies exemplarisch an einer Aufgabe aus der Analysis konkretisiert.

Zur Analysis-Ausbildung im Lehramtsstudium an der Universität Wien

Roland Steinbauer* (Universität Wien)
Stefan Götz (Universität Wien)

M7.6
WED
11:45
I
12:00
E

Der jüngere Diskurs zur doppelten Diskontinuität ([4, S. 1f]) geht davon aus, dass sich die im Lehramtsstudium allseits gewünschte Verbindung zwischen Schulmathematik und der Mathematik als Wissenschaft nicht von selbst einstellt, sondern explizit in der Ausbildung thematisiert werden muss (siehe etwa [1, 2]). Dies gilt insbesondere für die zu Studienbeginn vermittelten grundlegenden Konzepte der Analysis, die folglich von den Studierenden ohne gezielte Intervention im Allgemeinen nicht als fundamentale Ideen der Mathematik wahrgenommen werden. Entsprechende Grundvorstellungen werden bei ihnen ebenfalls ohne wenigstens exemplarische Freilegung obiger Zusammenhänge in der Regel nicht aufgebaut. Als Konsequenz reihen Studierende des Unterrichtsfaches Mathematik die Fachwissenschaft an die vorletzte Stelle in einer Relevanzbewertung der Wissensbereiche ihrer Ausbildung ([3, S. 105]).

Wir berichten über ein aktuelles Pilotprojekt an der Universität Wien zur engen Anbindung der fachdidaktischen an die fachmathematische Grundausbildung im Fach Analysis. Im Wintersemester 2012/13 wurde das Wahlpflichtfach Schulmathematik 6 „Differential- und Integralrechnung" (S. Götz) mit dem ersten und dem zeitgleich stattfindenden zweiten, speziell auf die Bedürfnisse des Lehramtsstudiums zugeschnittenen Teil des Hauptvorlesungszyklus „Analysis" (R. Steinbauer) verzahnt mit dem Ziel, die vielfältigen Beziehungen zwischen Schul- und Hochschulmathematik explizit aufzuzeigen und so für die Studierenden nutzbar zu machen.

[1] Thomas Bauer, Ulrich Partheil, Schnittstellenmodule in der Lehramtsausbildung im Fach Mathematik. Math. Semesterber. 56, 85–103 (2009).

[2] Albrecht Beutelspacher, Rainer Danckwerts, Gregor Nickel, Susanne Spies, Gabriele Wickel, Mathematik neu denken. Impulse für die Gymnasiallehrerbildung an Universitäten. Vieweg+Teubner, Wiesbaden, 2011.

[3] Sandra Etzlstorfer, $a^2 + b^2 = c^2$ — ¿Qué significa eso? Vergleich der Fachdidaktiken in Mathematik und Romanistik an der Universität Wien. Diplomarbeit an der Universität Wien, 2010.

[4] Felix Klein, Elementarmathematik vom höheren Standpunkte aus, Teil I: Arithmetik, Algebra, Analysis. B. G. Teubner, Leipzig, 1908.

M7.7
WED
12:00
I
12:15
E

Erfahrungen aus einführenden Analysis-Lehrveranstaltungen an der TU Wien
Reinhard Winkler (TU Wien)

Meine Erfahrungen zur Anfangsphase des Lehramtsstudiums stammen aus vier einführenden Analysis-Zyklen, die ich seit 2003 an der TU Wien gehalten habe. Einerseits stellt sich dem Lehrenden die Aufgabe, rechtzeitig gegen diverse weit verbreitete Missverständnisse anzukämpfen, die sowohl die Mathematik generell betreffen als auch die speziellen Anforderungen im Lehrberuf. Dieser Umstand erfordert deutliche neue Akzente und auch Kontrapunkte zu Gewohntem. Andererseits braucht es bei der Mehrzahl der Studierenden relativ viel Zeit und entsprechende Geduld seitens der Lehrenden, bis Neuartiges angenommen wird. Insbesondere stellt die Mathematik besondere Anforderungen an die Sprachbeherrschung in einem sehr weiten Sinne, der die fachspezifische Terminologie (die gibt es nicht nur in der Mathematik) nur nebenbei betrifft. Darüber hinaus verlangt die für die Mathematik charakteristische logische Komplexität eine entsprechend bewusste und verfeinerte Behandlung auch der natürlichen Sprache. Die Analysis mit ihrer Epsilontik voller logischer Quantoren rund um den Grenzwertbegriff ist dafür geradezu paradigmatisch. Bei der Gestaltung der Lehrveranstaltung scheinen mir Anfang und Ende besondere Aufmerksamkeit zu verdienen: Einführungskapitel (das kaum zu breit angelegt werden kann) und Prüfung (wo auch der schriftliche Teil bemerkenswerte Möglichkeiten eröffnet).

List of Participants

Ableidinger Markus (Linz)
Ableitinger Christoph (Wien)
Achleitner Franz (Wien)
Agbor Dieudonne (Göttingen)
Alpers Andreas (München)
Ambrose Christopher (Göttingen)
Andrié Manfred
Arnold Anton (Wien)
Auzinger Winfried (Wien)

Bach Volker (Braunschweig)
Baigger Guenter
Balakci Deniz (Göttingen)
Balan Radu (College Park)
Balazs Peter (Wien)
Bargetz Christian (Innsbruck)
Barroero Fabrizio (Graz)
Barthel Simon (Braunschweig)
Bauer Wolfram (Göttingen)
Bauer Joachim (Duisburg)
Bäuerle Nicole (Karlsruhe)
Baumgartner Florian (Innsbruck)
Bazarova Alina (Graz)
Beiglböck Mathias (Bonn/Wien)
Berglez Peter (Graz)
Birken Philipp (Osnabrück)
Blumthaler Ingrid (Padova)
Blunck Andrea (Hamburg)
Böhm Johannes (Jena)
Bönisch Sebastian (FIZ-Karlsruhe)
Bormann Sabine (Aachen)
Branding Volker (Wien)
Brunnhuber Rainer (Klagenfurt)
Brunotte Horst
Buckwar Evelyn (Linz)

Candellero Elisabetta (Birmingham)
Carl Wolfgang (Graz)
Chrapary Hagen (FIZ-Karlsruhe)
Christiansen Marcus C. (Ulm)
Chudej Kurt (Bayreuth)
Cristea Ligia L. (Graz)
Cuchiero Christa (Wien)
Cuno Johannes (Graz)

D'Angeli Daniele (Graz)
Dahlke Stephan (Marburg)
Dalitz Wolfgang (Berlin-Dahlem)
de Wolff Timo (Saarbrücken)
Deguchi Hideo (Toyama)
Diening Lars (München)
Dorfer Gerhard (Wien)
Dorninger Dietmar (Wien)
dos Reis Gonçalo (Berlin)
Dražić Ivan (Rijeka)
Drmota Michael (Wien)

Eberle Robert (Innsbruck)
Eigenthaler Günther (Wien)
El-Hady El-Sayed (Innsbruck)
Emmrich Etienne (Berlin)
Engel Alexander (Augsburg)
Engler Tina (Halle)
Ernst Thomas (Uppsala)
Eröcal Burcin (Heidelberg)

Feichtinger Hans G. (Wien)
Fellner Klemens (Graz)
Fetz Thomas (Innsbruck)
Fischer Roland (Klagenfurt)
Fleischhack Christian (Paderborn)
Flor Peter (Graz)
Förg-Rob Wolfgang (Innsbruck)
Frank Rolfdieter (Landau)
Freeden Willi (Kaiserslautern)
Frei Christopher (Graz/München)
Friedenberg Stefan (Essen)
Fuchs Clemens (Salzburg)

Garunkštis Ramūnas (Vilniaus)
Gasser Ingenuin (Hamburg)
Geiss Christel (Innsbruck)

Geiss Stefan (Innsbruck)
Gerhold Stefan (Wien)
Giordano Paolo (Wien)
Gittenberger Bernhard (Wien)
Goertz René (Hildesheim)
Goldstern Martin (Wien)
Gramsch Bernhard (Mainz)
Greuel Gert-Martin (Kaiserslautern)
Gröchenig Karlheinz (Wien)
Grothaus Martin (Kaiserslautern)
Grübel Rudolf (Hannover)
Grunau Hans-Christoph (Magdeburg)
Gutenbrunner Georg (St. Pölten)

Handwerk Agnes (Hamburg)
Hanusch Maximilian (Paderborn)
Harrach Bastian (Stuttgart)
Hartmann Carsten (Berlin)
Haslinger Friedrich (Wien)
Haug Nina S. (Klagenfurt)
Heine Clemens (Heidelberg)
Heinrich Lothar (Augsburg)
Hellekalek Peter (Salzburg)
Helmberg Gilbert (Innsbruck)
Henkemeyer Patrick (Duisburg)
Henn Hans-Wolfgang (Dortmund)
Herfort Wolfgang (Wien)
Herold Christine (Wiener Neustadt)
Hertel Eike (Jena)
Hertrich-Jeromin Udo (Wien)
Hilschenz Michael (Cottbus)
Hinterleitner Harald (Linz)
Hornik Kurt (Wien)
Humenberger Hans (Wien)
Huss Wilfried (Graz)

Imkeller Peter (Berlin)

Jamneshan Asgar (Berlin)
Janetzko Hans-Dieter (Konstanz)
Jenschke Tristan (Duisburg)
Jost Michael (FIZ-Karlsruhe)
Joswig Michael (Darmstadt)
Jouvet Guillaume (Berlin)

Kalpokas Justas (Vilniaus)
Kaltenbacher Barbara (Klagenfurt)
Kandolf Peter (Innsbruck)
Kang Mihyun (Graz)
Karigl Günther (Wien)
Kiermeier Klaus (FIZ-Karlsruhe)
Kirchner Gerhard (Innsbruck)
Kirschenhofer Peter (Leoben)
Klotz Andreas (Wien)
Klouth Richard (Mönchengladbach)
Knospe Heiko (Köln)
Koch Othmar (Wien)
Kohlhase Michael (Bremen)
Kolev Nikolai (São Paolo)
Korn Ralf (Kaiserslautern)
Kowalewski Markus (Uppsala)
Kramer Jürg (Berlin)
Krattenthaler Christian (Wien)
Kratz Werner (Ulm)
Krause Nils M. (Halle)
Krause Bernd (Köthen (Anhalt))
Kräuter Arnold R. (Leoben)
Krejić Nataša (Novi Sad)
Krenn Daniel (Graz)
Kreso Dijana (Graz)
Krklec Jerinkić Nataša (Novi Sad)
Kröner Dietmar (Freiburg)
Kühne Lars (Pisa)
Kunzinger Michael (Wien)
Kurow Jenny (Halle)

Langer Matthias (Glasgow)
Länger Helmut (Wien)
Larcher Gerhard (Linz)
Lasser Caroline (München)
Lebiedz Dirk (Ulm)
Lederer Mathias (Bielefeld)

Lehner Florian (Graz)
Levajković Tijana (Belgrad)
Lewintan Peter (Duisburg)

Mai Jan-Frederik (München)
Matioc Bogdan-Vasile (Wien)
Matt Andreas (Oberwolfach)
Matthes Daniel (München)
Mayer Daniel C. (Graz)
Mena Hermann (Innsbruck)
Menz Stephan (Potsdam)
Merker Jochen (Rostock)
Mette Ina (Berlin)
Metzner Lars (Hamburg)
Michel Volker (Siegen)
Mikikits-Leitner Alice (München)
Minervino Milton (Leoben)
Morgenstern Thomas (Karlsruhe)

Nebe Gabriele (Aachen)
Nedeljkov Marko (Novi Sad)
Neumann Lukas (Innsbruck)
Neuner Christoph (Stockholm)

Oberguggenberger Michael (Innsbruck)
Olbricht Walter (Bayreuth)
Ostermann Alexander (Innsbruck)

Panholzer Alois (Wien)
Pap Margit (Pécs)
Pauer Franz (Innsbruck)
Pfander Götz (Bremen)
Pfeifer Christian (Innsbruck)
Pfoertner Hugo (München)
Pofahl Ulrich (Eberswalde)
Pulch Roland (Wuppertal)

Racher Gerhard (Salzburg)
Rajter-Ćirić Danijela (Novi Sad)
Regensburger Georg (Linz)
Rendall Alan D. (Mainz)
Ressel Paul (Eichstätt)
Rheinländer Thorsten (Wien)
Richard Thomas (Aachen)
Richter Christian (Jena)
Richter Karin (Halle)
Riedel Thorsten (Braunschweig)
Roegner Katherine (Berlin)
Rottmann-Matthes Jens (Bielefeld)
Roy Nicolas (FIZ-Karlsruhe)
Ruffino Paulo (São Paolo)

Sani Ahmed (Agadir)
Sass Jörn (Kaiserslautern)
Sauvigny Friedrich (Cottbus)
Sava-Huss Ecaterina (Graz)
Scheicher Martin (Padova)
Scheiderer Claus (Konstanz)
Scherer Matthias (München)
Schmitt Peter (Wien)
Schmock Uwe (Wien)
Schölzel Karsten (Walferdange)
Schöneberg Ulf (FIZ-Karlsruhe)
Schott Dieter (Wismar)
Schranz-Kirlinger Gabriela (Wien)
Schröcker Hans-Peter (Innsbruck)
Schüffler Karlheinz (Krefeld)
Schüller Georg (Balatonalmadi)
Schuster Peter (Leeds)
Schuster Peter (Wien)
Schuster Franz (Wien)
Schwenninger Felix L. (NB Enschede)
Seidel Markus (Chemnitz)
Seifert Christian (Hamburg)
Shpartko Polina (Wien)
Skill Thomas (Bochum)
Sloane Neil J.A. (Highland Park)
Smertnig Daniel (Graz)
Sperber Wolfram (FIZ-Karlsruhe)
Spielberger Georg (Innsbruck)
Spirova Margarita (Chemnitz)

Stadler Peter (Innsbruck)
Steinbach Olaf (Graz)
Steinbauer Roland (Wien)
Steinicke Alexander (Innsbruck)
Steuding Jörn (Würzburg)
Stoeva Diana (Wien)
Stoll Michael (Bayreuth)
Strecha Johannes (Wien)
Strodthoff Birgit (Linz)
Stroth Gernot (Halle)
Szabó Tibor (Berlin)
Szmolyan Peter (Wien)
Szölgyényi Michaela (Linz)

Temmel Christoph (Amsterdam)
Teschke Olaf (FIZ-Karlsruhe)
Teschl Gerald (Wien)
Teufl Elmar (Tübingen)
Thaller Bernd (Graz)
Theobald Thorsten (Frankfurt)
Thiel Carsten (Magdeburg)
Thiemann René (Innsbruck)
Thonhauser Stefan (Lausanne)
Thuswaldner Jörg M. (Leoben)
Tomaschek Jörg (Walferdange)
Törner Günter (Duisburg)
Trunk Carsten (Ilmenau)
Tichy Robert (Graz)

Unger Gerhard (Graz)
Unterkofler Karl (Dornbirn)

Vasilevski Nikolai (Mexico City)
Viertl Reinhard (Wien)
Vogt Hendrik (Hamburg)
von Pippich Anna-Maria (Berlin)
Vu Dominik (Memphis)

Walker Christoph (Hannover)
Wallner Johannes (Graz)
Weber Martin R. (Dresden)
Wießing Benjamin (Halle)
Weitzer Mario (Leoben)
Weller Hilary (Reading)
Wendland Katrin (Freiburg i.Br.)
Wendland Wolfgang (Stuttgart)
Wendler Martin (Bochum)
Wenzel Walter (Erlangen)
Wimmer Lienhard (Isny)
Winkler Reinhard (Wien)
Wirth Jens (München)
Wirz Martina (Braunschweig)
Wittbold Petra (Essen)
Woess Wolfgang (Graz)
Wolfram Marie-Therese (Wien)
Wolter Jonas

Ylinen Juha (Jyväskylä)
Yuditskii Peter (Linz)

Zastrow Andreas (Gdańsk)
Zeiner Martin (Wien)
Zumkeller Reinhard (München)

Index