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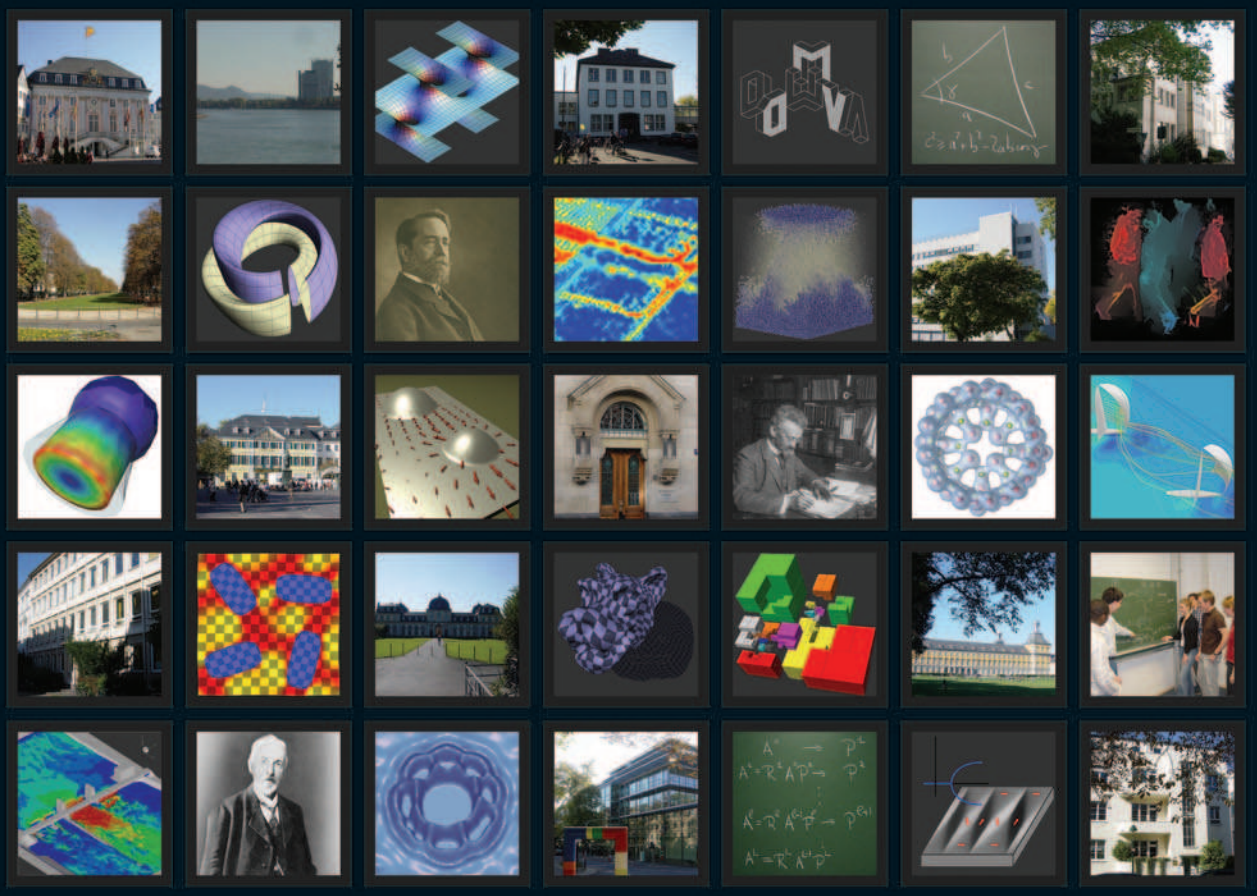
Deutsche Mathematiker-Vereinigung
Jahrestagung 2006

Bonn, 18.–22.9.2006



Hauptvortragende:

John Ball (Oxford)
Gerd Faltings (Bonn)
Andreas Griewank (Berlin)
Alexander Kechris (Pasadena)
François Labourie (Paris)
Gérard Laumon (Paris)
Elon Lindenstrauss (Princeton)
Peter Littelmann (Köln)
Sonia Mazzucchi (Trento)
Alfio Quarteroni (Lausanne)
Michael Röckner (Bielefeld)
René Schilling (Marburg)
Klaus Schmidt (Wien)
Eberhard Zeidler (Leipzig)

Veranstalter: Die mathematischen Institute der Universität Bonn

Weitere Informationen: www.dmv2006.uni-bonn.de

Herausgeber: Prof. Dr. Werner Ballmann
Mathematisches Institut
Rheinische Friedrich-Wilhelms-Universität Bonn
Beringstraße 1, 53115 Bonn, Germany

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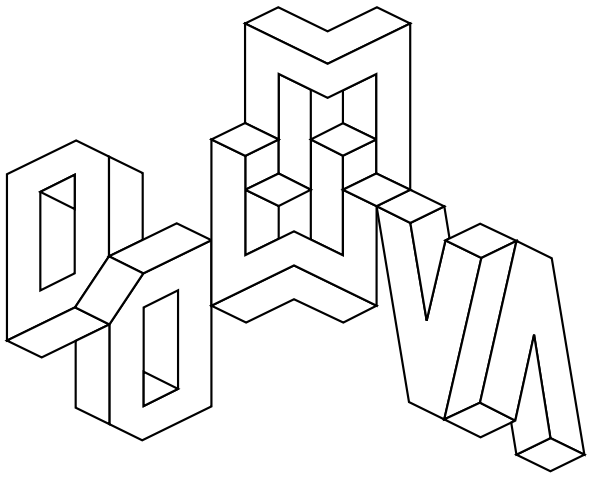
Deutsche Mathematiker-Vereinigung



Jahrestagung 2006
18. – 22. September

Die mathematischen Institute
der Rheinischen Friedrich-Wilhelms-Universität Bonn

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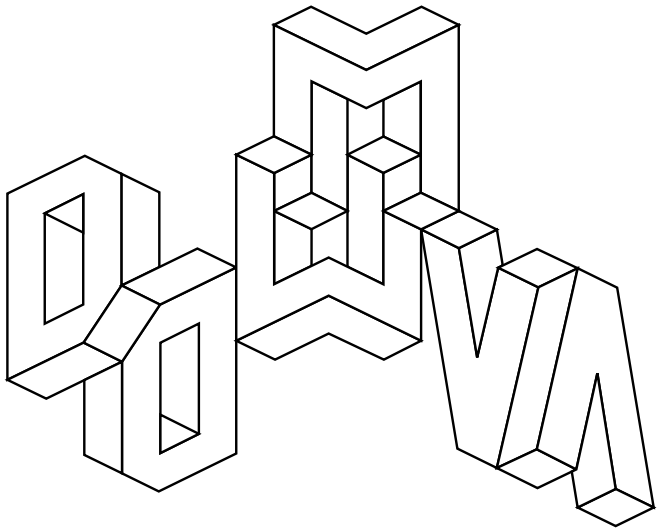
INHALTSVERZEICHNIS



Allgemeine Informationen

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BEGRÜSSUNG

Das Präsidium der Deutschen Mathematiker-Vereinigung und die örtliche Tagungsleitung begrüßen alle Kolleginnen und Kollegen sowie alle an der Mathematik Interessierten, die an der Jahrestagung der DMV

vom 18. bis 22. September 2006

in der Bundesstadt Bonn teilnehmen. Es ist die zweite Jahrestagung der DMV in Bonn, die erste fand im Jahre 1962 statt.

Die Tagung steht unter Schutz und Schirm des *Ministerpräsidenten des Landes Nordrhein–Westfalen, Dr. Jürgen Rüttgers*, Gastgeberin ist die Rheinische Friedrich–Wilhelms–Universität Bonn unter dem Rektorat von *Magnifizenz Professor Dr. Matthias Winiger*, Ausrichter der Tagung sind die mathematischen Institute der Universität Bonn. Die örtliche Tagungsleitung liegt in den Händen von *Professor Dr. Werner Ballmann*.

Das mathematische Programm ist vielfältig, neben den Hauptvorträgen, für die international renommierte Mathematiker gewonnen werden konnten, sind knapp dreißig Minisymposien mit interessanten Themenstellungen vorgesehen. Das Rahmenprogramm ist umfangreich, unter anderem werden drei Ausstellungen gezeigt: die traditionelle *“Mathematik zum Anfassen”* in der Aula des Ernst-Moritz-Arndt-Gymnasiums, die Ausstellung *“Jüdische Mathematiker in der deutschsprachigen akademischen Kultur”* im Stucksaal des Poppelsdorfer Schlosses und im Arithmeum die Ausstellung “Kurt Gödel” aus Anlass seines hundertsten Geburtstages.

DANKSAGUNGEN

Unser besonderer Dank gilt der Telekom Stiftung für die großzügige finanzielle Unterstützung und die hervorragende Zusammenarbeit bei der Vorbereitung der Aktivitäten zur Lehrerausbildung. Unser Dank gilt ebenfalls den Verlagen: *Springer Verlag, Birkhäuser Verlag, Verlag Walter de Gruyter, Cambridge University Press, WILEY-VCH Verlag, European Mathematical Society Publishing House, GWV-Fachverlage und Oldenbourg Verlag,* die die Tagung als Sponsoren unterstützen.

Besonders danken möchten wir auch dem Rektorat der Universität Bonn, das uns von Anfang an seine volle Unterstützung zugesagt hat. Unser Dank gilt auch allen Kollegen, die uns bei der Vorbereitung der Tagung mit Rat und Tat zur Seite gestanden haben.

WISSENSCHAFTLICHES PROGRAMM

Die Eröffnung der Tagung, der Eröffnungsvortrag sowie der Öffentliche Vortrag am Montag finden in der Aula im Universitätshauptgebäude (siehe Karte, S. 20) statt. Von Dienstag bis Freitag werden alle Hauptvorträge im Wolfgang-Paul-Hörsaal (S. 20, Nr. 5) veranstaltet.

Festliche Eröffnung der Tagung

Montag, 18. September

ab 10 Uhr
Begrüßung und Grußworte
Preisverleihungen
Musikalische Umrahmung durch das Benjamin Himpel Trio

12:00–13:00 Uhr
Eröffnungsvortrag
Gerd Faltings *(Max-Planck-Institut Bonn)*
Theta divisors on moduli spaces of vector bundles

17:15–18:15 Uhr
Öffentlicher Vortrag
Eberhard Zeidler *(Max-Planck-Institut Leipzig)*
Mathematik – ein geistiges Auge des Menschen: abstrakt und praktisch

Hauptvorträge

Dienstag, 19. September

09:00–10:00 Uhr
Klaus Schmidt *(Universität Wien / Erwin Schrödinger Institut)*
Algebraic Dynamical Systems

10:30–11:30 Uhr
Alfio Quarteroni *(École Polytechnique Fédérale de Lausanne)*
Domain decomposition methods for heterogeneous partial differential equations

12:00–13:00 Uhr
Michael Röckner *(Universität Bielefeld / Purdue University)*
Stochastic Partial Differential Equations and Infinite Dimensional Analysis

Mittwoch, 20. September

09:00–10:00 Uhr **Andreas Griewank** *(Humboldt-Universität Berlin)*
Automated optimal design with bounded retardation

10:30–11:30 Uhr **Peter Littelmann** *(Universität Köln)*
On geometry and combinatorics in representation theory

12:00–13:00 Uhr **Alexander Kechris** *(California Institute of Technology)*
Logic and dynamical systems

Donnerstag, 21. September

09:00–10:00 Uhr **Gérard Laumon** *(CNRS/Université Paris-Sud Orsay)*
Geometry of the Fundamental Lemma

10:30–11:30 Uhr **Sonia Mazzucchi** *(Università Trento)*
Feynman path integrals as infinite dimensional oscillatory integrals

12:00–13:00 Uhr **René Schilling** *(Universität Marburg)*
Sample path properties of stochastic processes

Freitag, 22. September

09:00–10:00 Uhr **Elon Lindenstrauss** *(Princeton University)*
Invariant measures for multidimensional diagonalizable group actions and arithmetic applications

10:30–11:30 Uhr **Francois Labourie** *(Université Paris-Sud Orsay)*
Higher Thurston Theory

12:00–13:00 Uhr **John Ball** *(University Oxford)*
Singularities in nonlinear continuum mechanics

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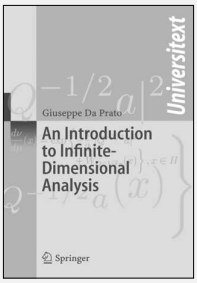


An Introduction to Infinite-Dimensional Analysis

G. Da Prato, Scuola Normale Superiore, Pisa, Italy

In this revised and extended version of his course notes from a 1-year course at Scuola Normale Superiore, Pisa, the author provides an introduction – for an audience knowing basic functional analysis and measure theory but not necessarily probability theory – to analysis in a separable Hilbert space of infinite dimension. Moreover, some details have been added as well as some new material on dynamical systems with dissipative nonlinearities and asymptotic behavior for gradient systems.

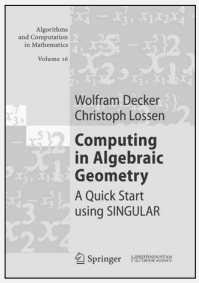
2006. Approx. 200 p. (Universitext)
Softcover
ISBN 3-540-29020-6 ► **€ 44,95 | £ 34,50**

Qualitative Theory of Planar Differential Systems

F. Dumortier, Limburgs Universitair Centrum, Diepenbeek, Belgium; **J. Llibre**, **J. C. Artés**, Universitat Autònoma de Barcelona, Bellaterra, Spain

The book deals essentially with systems of polynomial autonomous ordinary differential equations in two real variables. The emphasis is mainly qualitative, although attention is also given to more algebraic aspects as a thorough study of the center/focus problem and recent results on integrability. Introduces the performant software tool P4 for numerical experiments on differential equations.

2006. Approx. 380 p. (Universitext)
Softcover
ISBN 3-540-32893-9 ► **€ 39,95 | £ 30,50**



Computing in Algebraic Geometry

A Quick Start using SINGULAR

W. Decker, Universität des Saarlandes, Saarbrücken, Germany; **C. Lossen**, Technische Universität Kaiserslautern, Germany

Originating from a number of intense one week schools taught by the authors, the text is designed so as to provide a step by step introduction which enables the reader to get started with his own computational experiments right away. The authors present the basic concepts and ideas in a compact way, omitting proofs and detours, and they give references for further reading on some of the more advanced topics.

2006. XV, 327 p. (Algorithms and Computation in Mathematics, Vol. 16)
Hardcover
ISBN 3-540-28992-5 ► **€ 39,95 | £ 30,50**

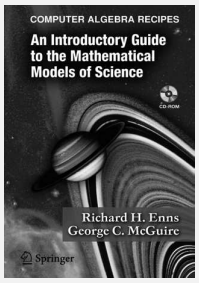
Compact Riemann Surfaces

An Introduction to Contemporary Mathematics

J. Jost, Max Planck Institute for Mathematics in the Sciences, Leipzig, Germany

Although Riemann surfaces are a time-honoured field, this book is novel in its broad perspective that systematically explores the connection with other fields of mathematics. It can serve as an introduction to contemporary mathematics as a whole as it develops background material from algebraic topology, differential geometry, the calculus of variations, elliptic PDE, and algebraic geometry.

3rd ed. 2006. XIV, 277 p. (Universitext)
Softcover
ISBN 3-540-33065-8 ► **€ 44,95 | £ 34,50**



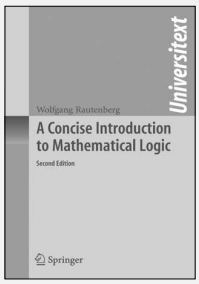
A Concise Computer Algebra Recipes

An Introductory Guide to the Mathematical Models of Science

R. H. Enns, Simon Fraser University, Burnaby, BC, Canada; **G. C. McGuire**, University College of the Fraser Valley, Abbotsford, BC, Canada

The heart of this text is a large number of computer algebra worksheets or "recipes" that have been designed using MAPLE (Version 10) not only to provide tools for problem solving, but also to stimulate the readerís imagination.

2006. X, 430 p. With CD-ROM. Softcover
ISBN 0-387-25767-5 ► **€ 49,95 | £ 38,50**



Introduction to Mathematical Logic

W. Rautenberg, Freie Universität Berlin, Germany

Traditional logic as a part of philosophy is one of the oldest scientific disciplines. Mathematical logic, however, is a relatively young discipline. This book is much more concise than most others, treating the material in a streamlined fashion which allows the instructor to cover many important topics in a one semester course.

2nd ed. 2006. XVIII, 260 p. 8 illus.
(Universitext) Softcover
ISBN 0-387-30294-8 ► **€ 42,95 | £ 29,95**

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MINISYMPOSIEN

Die Minisymposien sind Workshops zu ausgewählten Themen, die im Rahmen der Jahrestagung organisiert werden. Für die Durchführung solcher Symposien im Rahmen der diesjährigen Tagung konnte man sich im Vorfeld bewerben. Die Minisymposien erstrecken sich in der Regel über zwei bis drei Nachmittage, jeweils in der Zeit von 15-18 Uhr. Genauere Informationen zu den einzelnen Symposien finden Sie ab Seite 35.

Für die Gestaltung der Inhalte sowie die Durchführung der einzelnen Symposien sind die jeweiligen LeiterInnen verantwortlich. Änderungen vorbehalten.

Liste der Minisymposien:

STUDENTENKONFERENZ

Am Donnerstag und Freitag, den 21. und 22. September, findet die Studentenkonferenz Mathematik 2006 statt. Während der Konferenz tragen Absolventen Ergebnisse ihrer Abschlussarbeit vor. Die besten Arbeiten des zurückliegenden Jahres werden mit attraktiven Preisen, wie z.B. Forschungsaufenthalten an renommierten Instituten, sowie Bücherpreisen ausgezeichnet.

Das detaillierte Programm wird auf der Tagungshomepage

`http://www.dmv2006.uni-bonn.de/studentenkonferenz.html`

bekanntgegeben.

MATHEMATIK UND ÖFFENTLICHKEIT

Podiumsdiskussion: Am **Dienstag, den 19. September**, findet im Alfred-Philippson-Hörsaal des Geographischen Instituts der Universität Bonn in der Meckenheimer Allee 166 eine Veranstaltung zum Thema:

Neue Perspektiven der Lehrerausbildung
in der Mathematik und den Naturwissenschaften

statt. Eine Anmeldung ist unbedingt erforderlich.

Das Symposium wird von der Deutsche Telekom Stiftung organisiert und unterstützt. Änderungen im Programmablauf vorbehalten. Weitere Informationen auf Seite 243.

Öffentlicher Vortrag: Für den traditionellen öffentlichen Vortrag am Montag, den 18. September, konnte Herr Prof. Dr. Eberhard Zeidler vom Max-Planck-Institut Leipzig gewonnen werden. Er wird über das Thema sprechen:

Mathematik – ein geistiges Auge des Menschen: abstrakt und praktisch

Ort: Aula im Hauptgebäude der Universität Bonn
Zeit: Montag, 18. September, 17:15–18:15 Uhr

PRÄSENTATIONEN

Die folgenden Verlage:

Springer Verlag — *Birkhäuser Verlag*
Cambridge University Press — *GWV-Fachverlage*
Oldenbourg Verlag — *Verlag Walter de Gruyter*
WILEY-VCH Verlag
European Mathematical Society Publishing House

haben ihre Teilnahme an einer Präsentation von Büchern anlässlich der DMV-Tagung zugesagt. Diese Ausstellung findet im Foyer des Wolfgang-Paul-Hörsaals, Wegelerstraße/Kreuzbergweg (S. 20, Nr. 5), statt.

VERSAMMLUNGEN

Donnerstag, 21. September

16:00 Uhr Ordentliche Mitgliederversammlung des Vereins zur Förderung des Mathematischen Forschungsinstituts Oberwolfach
im Großen Hörsaal des Mathematischen Instituts, Wegelerstraße 10

17:00 Uhr Ordentliche Mitgliederversammlung der DMV
(am gleichen Ort)

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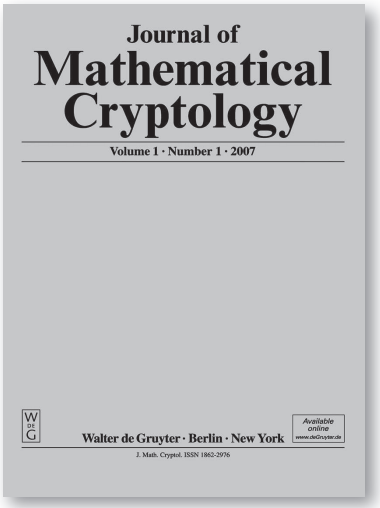

Starting in 2007

■ Journal of Mathematical Cryptology

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Aims and Scopes

The Journal of Mathematical Cryptology (JMC) is a forum for original research articles in the area of mathematical cryptology. Works in the theory of cryptology and articles linking mathematics with cryptology are welcome. Submissions from all areas of mathematics significant for cryptology are invited, including but not limited to, algebra, algebraic geometry, coding theory, combinatorics, number theory, probability and stochastic processes. The scope includes mathematical results of algorithmic or computational nature that are of interest to cryptology. While JMC does not cover information security as a whole, the submission of manuscripts on information security with a strong mathematical emphasis is explicitly encouraged.

Subscription Information

JMC has four issues per year, with approximately 100 pages per issue.
Approximate subscription rates for 2007:
Print only: approx. € 288.00 / *US$ 348.00
Online only: approx. € 288.00 / *US$ 348.00
Print + Online: approx. € 312.00 / *US$ 378.00

Call for papers

A manuscript can be submitted to any one of the Managing Editors

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or Tran van Trung (Email: trung@iem.uni-due.de)

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RAHMENPROGRAMM

Sonntag, 17. September, ab 11 Uhr

Sonntagstreff Mathematik im Deutschen Museum Bonn

Ort: Deutsches Museum Bonn, Ahrstraße 45
Kosten: Erwachsene 4 €, ermäßigt 2.50 €, Familien-Ticket 7 €, Schüler 1.50 €
Anmeldung ist nicht erforderlich.

Die Veranstaltung richtet sich an eine breite Öffentlichkeit. Es werden mehrere Vorträge von renommierten Mathematikern gehalten, die auch für Laien verständlich sind. Nähere Informationen siehe Seite 247.

Montag, 18. September, 18:30 Uhr

Rektorempfang

Ort: Uni-Hauptgebäude, Fest- und Senatssaal, Großes Dozentenzimmer
Kosten: 10,- EUR pro Person

Dienstag, 19. September, ab 15:30 Uhr

Neue Perspektiven der Lehrerausbildung in der Mathematik und den Naturwissenschaften

Symposium mit Podiumsdiskussion und anschließendem Empfang

Ort: Alfred-Philippson-Hörsaal des Geographischen Instituts, Meckenheimer Allee 166
Kosten: keine, Anmeldung erforderlich

Donnerstag, 21. September, 19:30 Uhr

Conference Dinner inklusive Rhein-Schifffahrt

Ort: auf dem Schiff “Wappen von Bonn”
Ablegestelle am Rheinufer / Alter Zoll (S. 20, Nr. 1)
Kosten: 30,- EUR pro Person, Anmeldung erforderlich
(für die Fahrt inkl. Abendessen. Getränke im Preis nicht inbegriffen)

Freitag, 15. September – Freitag, 22. September

Ausstellung “Mathematik zum Anfassen”

Ort: Vorhalle der Aula im Ernst-Moritz-Arndt Gymnasium, Endenicher Allee
Kosten: Keine

Montag, 18. September – Freitag, 22. September

Ausstellung "Jüdische Mathematiker in der deutschsprachigen akademischen Kultur"

Ort: Stucksaal im Poppelsdorfer Schloss
Öffnungszeiten: 9:00 – 19:45 Uhr
Kosten: keine

Dienstag, 19. September & Mittwoch, 20. September, jeweils 20 Uhr

Theaterstück: Felix Hausdorff – "Der Arzt seiner Ehre"

Ort: Saal der Evangelischen Studierendengemeinde, Königstraße 88
Anmeldung erforderlich

Dienstag/Mittwoch/Donnerstag (19./20./21.09.06), jeweils um 15:00 Uhr

Führung Bonn-Innenstadt "Auf und unter'm Pflaster"

(mindestens 20, höchstens 25 Teilnehmer, Anmeldung erforderlich)
Kosten: EUR 7,00 pro Person (Dauer 2 Stunden)

Dienstag/Mittwoch/Donnerstag (19./20./21.09.06), jeweils um 15:00 Uhr

Führung "Haus der Geschichte"

(mindestens 20, höchstens 25 Teilnehmer)
Kosten: Keine, Anmeldung erforderlich

Montag, 18. September – Samstag, 23. September

Beethoven-Haus Bonn

Öffnungszeiten: Montag bis Samstag: 10–18 Uhr, Sonntag: 11–18 Uhr
Eintritt: 4,00 EUR
Studenten: 3,00 EUR

Gruppenführung: Dienstag/Mittwoch/Donnerstag (19./20./21.09.06)
jeweils um 15:00 Uhr
(mindestens 20, höchstens 25 Teilnehmer; Anmeldung erforderlich)
Kosten: 4,80 EUR pro Person

Kleingruppen (max. 5 Personen) und **Einzelbesucher** täglich um 14:30 Uhr (außer Dienstag): "Auf den Spuren von Beethovens Leben und Werk"
Dauer: 30 Minuten.
Kosten: keine

Dienstag/Mittwoch/Donnerstag (19./20./21.09.06), jeweils um 15:00 Uhr
Führung "Arithmeum"

Dauer: ca. 60-90 Minuten
Kosten: Keine
Anmeldung erforderlich, Gruppen von max. 25 Personen

Hinweis: Falls für die Führungen keine ausreichende Anzahl von Anmeldungen eingeht, können einzelne der o.g. Termine gestrichen werden. In diesem Falle erhalten Sie die für den Programmpunkt gezahlte Gebühr selbstverständlich erstattet. Abschließende Informationen über Ihr gebuchtes Rahmenprogramm entnehmen Sie bitte Ihren Tagungsunterlagen. Anmeldungen zum Rahmenprogramm, wenn nicht schon während der Registration zur Tagung geschehen, können im Tagungsbüro erfragt werden.

ALLGEMEINE HINWEISE

Tagungsstätten: Die Eröffnungsveranstaltung, einschließlich des Eröffnungsvortrags, findet am Montag, den 18. September 2006, in der Aula des Hauptgebäudes der Universität Bonn, Regina-Pacis-Weg 3 statt. In der Karte auf Seite 20 ist das Hauptgebäude orange in der Nähe des Rheinufers (S. 20, Nr. 6) eingezeichnet.

Die Hauptvorträge finden im Wolfgang-Paul-Hörsaal (S. 20, Nr. 5) statt. Darüber hinaus werden die Räumlichkeiten des Instituts für Angewandte Mathematik und des Mathematischen Instituts (S. 20, Nr. 1, 2 bzw. 4), des Geographischen Instituts (Meckenheimer Allee 166), des Instituts für Physikalische und Theoretische Chemie (Wegelerstraße 12) sowie Räume des AVZs (S. 20, Nr. 3) genutzt.

Kaffeepausen: Während der Tagung, von Dienstag bis Freitag, wird es in der Wegelerstraße 10 (S. 20, Nr. 2) jeweils in der Zeit von 10–12 Uhr und von 14:30–16:30 Uhr Kaffee und Gebäck zur kleinen Stärkung geben.

Internetzugang während der Jahrestagung: In der Wegelerstraße 10 (S. 20, Nr. 2) in den beiden Hörsälen und in der Bibliothek, sowie im Wolfgang-Paul-Hörsaal werden Sie WLAN vorfinden. Darüber hinaus wird es einen Computer-Pool geben. Zugangsdaten bzw. weitere Informationen erhalten Sie auf Wunsch im Tagungsbüro.

Tagungsbüro: Dort steht Ihnen unser Team zur Verfügung; es dient als allgemeiner Anlaufpunkt. Sie können sich hier u.a. registrieren und aktuelle Ankündigungen erfragen. Orte und Öffnungszeiten wie folgt:

Sonntag (17.09.) im *Rondell, Hauptgebäude der Universität*, 16:00-20:00 Uhr;

Montag (18.09.) in der *Garderobe, Hauptgebäude der Universität*, 8:30-16:30 Uhr;

Dienstag–Donnerstag (19.-21.09.) im *Hausdorff-Raum, Beringsstr. 3*, 13:30-16:30 Uhr;

Freitag (22.09.) im *Hausdorff-Raum, Beringsstraße 3*, 12:00-14:00 Uhr.

Beachten Sie hierfür die Übersichtskarte auf Seite 20.

Telefon des Tagungsbüros: **+49–(228)–73–4822**

E-Mail-Adresse der Tagung: **dmv2006@uni-bonn.de**

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Telefon: +49-(228)-73-3340
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Dort finden Sie die aktuellsten Hinweise und Ankündigungen rund um die Tagung.

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DMV-Mitglieder	65 €	80 €
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Prof. Dr. Werner Ballmann *(Universität Bonn)*

Mitglieder des örtlichen Organisationskommitees:

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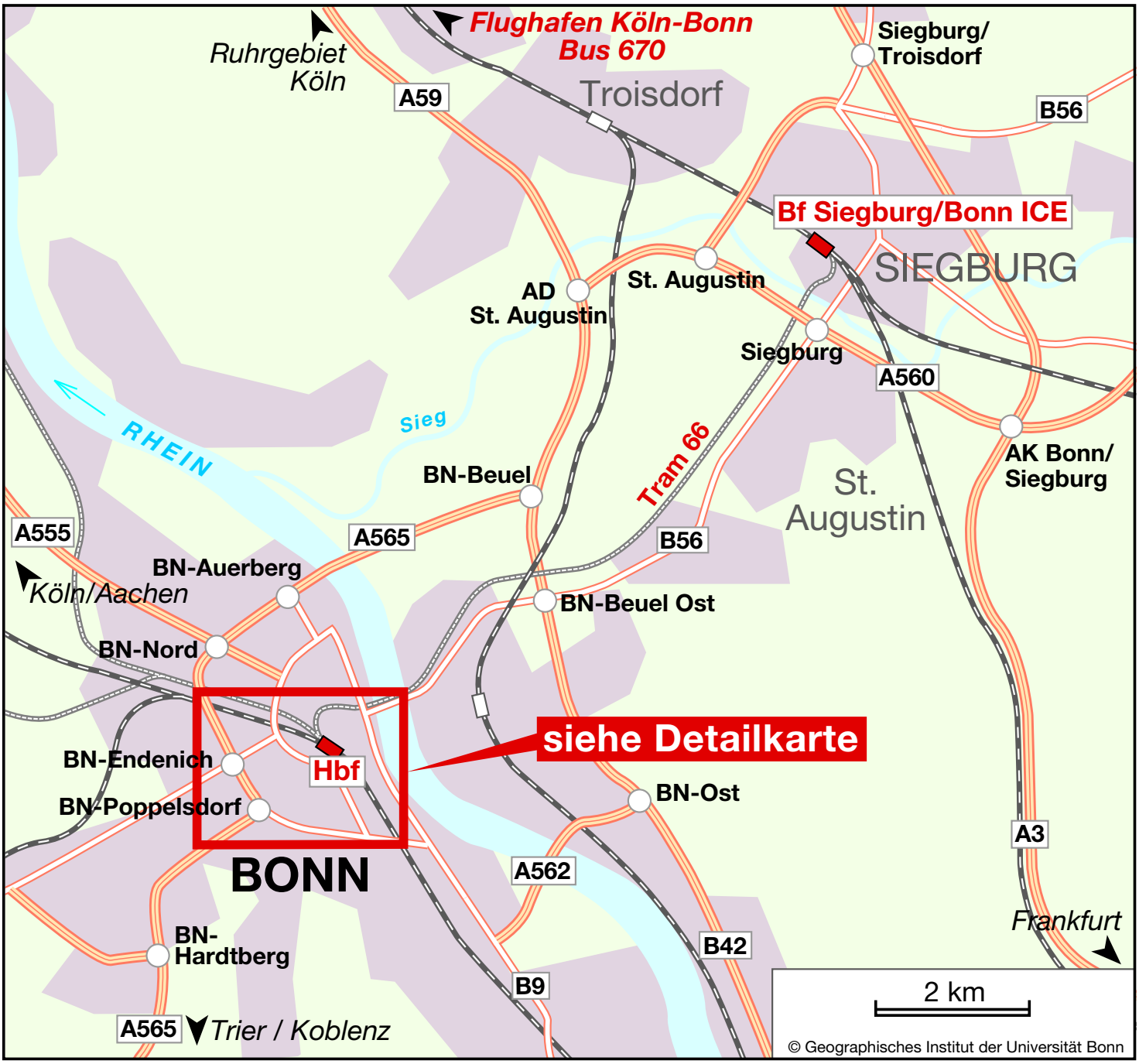
Konferenzphoto: Wir laden zu einem Konferenzphoto am Dienstag, den 19. September 2006, um 14:15 Uhr ein. Nähere Informationen sind im Tagungsbüro zu erfragen.

Postersession: Während der DMV-Tagung besteht die Möglichkeit, Forschungsergebnisse im Rahmen einer Posterpräsentation im Foyer des AVZ (S. 20, Nr. 3) vorzustellen. Zusätzlich bietet eine spezielle Postersession im Plenum jedem Tagungsteilnehmer ein Forum zur kurzen Präsentation seines Posters anhand einer Folie. Nähere Informationen erhalten Sie im Tagungsbüro.

KARTENMATERIAL

Die folgenden Seiten beinhalten eine Anfahrtskarte (S. 19) zur Universiät Bonn, die allgemeine Übersichtskarte der Tagungsorte (S. 20) und eine Zusammenstellung der Gastronomie in Tagungsnähe (S. 21). Die Karten wurden vom Geographischen Institut der Universität Bonn erstellt.



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3. **AVZ**, *Endenicher Allee*
4. **Mathematisches Institut**, *Beringstr. 1*
5. **Wolfgang-Paul-Hörsaal**, *Wegelerstr./Kreuzbergweg*
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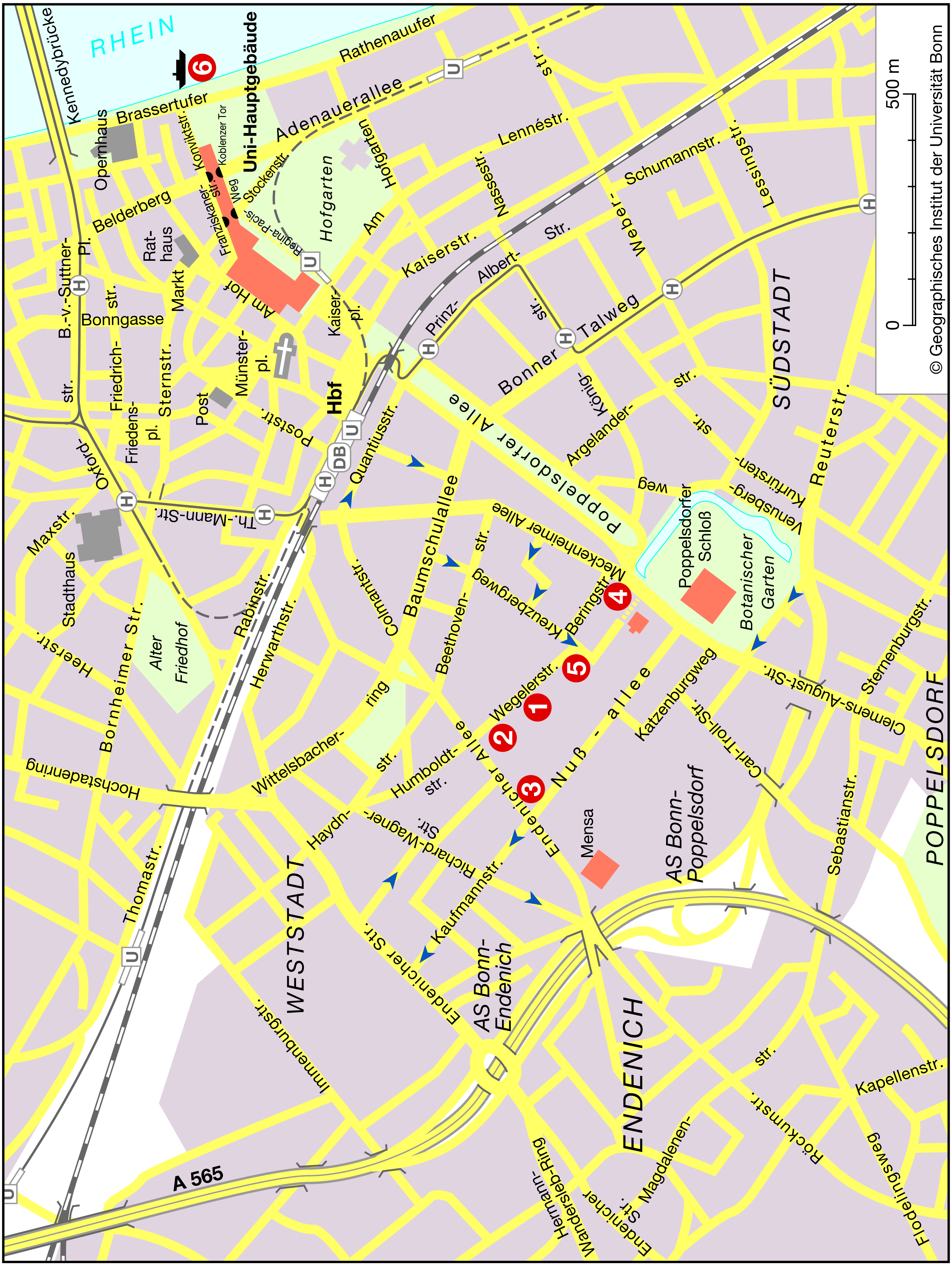

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18 Mensa Poppelsdorf	Endenicher Allee

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Grundstudium Mathematik

Amann, H. / Escher, J.

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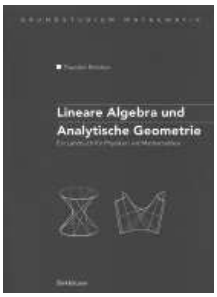
3., korr. Aufl.
2006. Ca. 460 S. Brosch.
ISBN 3-7643-7755-0

Analysis II

2., korr. Aufl.
2006. XII, 415 S. Brosch.
ISBN 3-7643-7105-6

Analysis III

2001. 496 S. Brosch.
ISBN 3-7643-6613-3



Bröcker, T.

Lineare Algebra und Analytische Geometrie

Ein Lehrbuch für Physiker und Mathematiker
2., korr. Aufl.
2004. X, 366 S. Brosch.
ISBN 3-7643-7144-7

Artin, M.

Algebra

2003 (1. unveränderter Nachdruck).
722 S. Broschur
ISBN 3-7643-5938-2

Remmert, R. / Ullrich, P.

Elementare Zahlentheorie

3. Aufl.
2006. Etwa 280 S. Brosch.
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Funktionentheorie in der Ebene und im Raum

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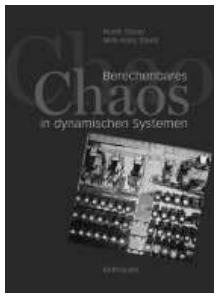

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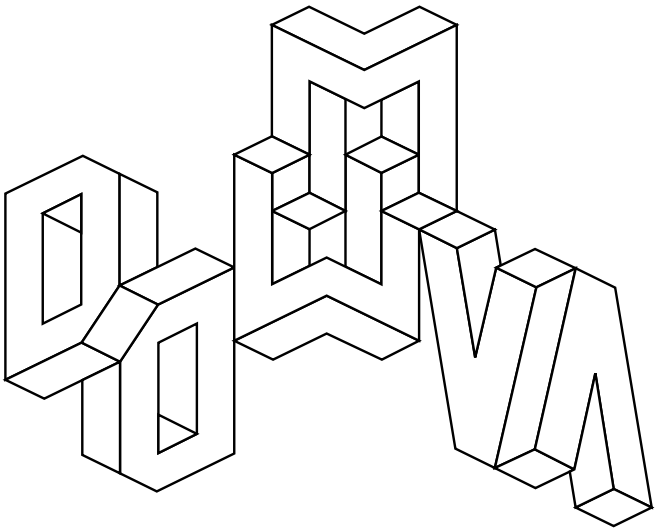

Hauptvorträge

mit Vortragsauszügen

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Hauptvorträge

Montag, 18. September

Aula, Hauptgebäude der Universität, Regina-Pacis-Weg

12:00 – 13:00 **Gerd Faltings** *(MPI Bonn)*

Theta divisors on moduli spaces of vector bundles

17:15 – 18:15 **Eberhard Zeidler** *(MPI Leipzig)*

Mathematik – ein geistiges Auge des Menschen: abstrakt und praktisch

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Dienstag, 19. September

Wolfgang-Paul-Hörsaal, Institut für Physik, Wegelerstraße/Kreuzbergweg

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09:00 – 10:00 **Klaus Schmidt** *(Universität Wien / Erwin Schrödinger Institut)*

Algebraic Dynamical Systems

10:30 – 11:30 **Alfio Quarteroni** *(École Polytechnique Fédérale de Lausanne)*

Domain decomposition methods for heterogeneous partial differential equations

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12:00 – 13:00 **Michael Röckner** *(Universität Bielefeld / Purdue University)*

Stochastic Partial Differential Equations and Infinite Dimensional Analysis

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Mittwoch, 20. September

Wolfgang-Paul-Hörsaal, Institut für Physik, Wegelerstraße/Kreuzbergweg

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09:00 – 10:00 **Andreas Griewank** *(Humboldt-Universität Berlin)*
Jacobian-free Optimization

10:30 – 11:30 **Peter Littelmann** *(Universität Köln)*
On geometry and combinatorics in representation theory

12:00 – 13:00 **Alexander Kechris** *(California Institute of Technology)*
Logic and dynamical systems

Donnerstag, 21. September

Wolfgang-Paul-Hörsaal, Institut für Physik, Wegelerstraße/Kreuzbergweg

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09:00 – 10:00 **Gérard Laumon** *(CNRS / Université Paris-Sud Orsay)*
Fundamental Lemma and Hitchin Fibration

10:30 – 11:30 **Sonia Mazzucchi** *(Università Trento)*
Feynman path integrals as infinite dimensional oscillatory integrals

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12:00 – 13:00 **René Schilling** *(Universität Marburg)*
Sample path properties of stochastic processes

Freitag, 22. September

Wolfgang-Paul-Hörsaal, Institut für Physik, Wegelerstraße/Kreuzbergweg

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09:00 – 10:00 **Elon Lindenstrauss** *(Princeton University)*
Invariant measures for multidimensional diagonalizable group actions and arithmetic applications

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10:30 – 11:30 **Francois Labourie** *(Université Paris-Sud Orsay)*
Higher Thurston Theory

12:00 – 13:00 **John Ball** *(University Oxford)*
Singularities in nonlinear continuum mechanics

Vortragsauszüge

Gerd Faltings *(MPI Bonn)*
Theta divisors on moduli spaces of vector bundles

The classical Riemann theta function can be interpreted as the determinant of the cohomology of line bundles on a Riemann surface. The generalization to vector bundles provides a projective embedding of the moduli space of vector bundles. Generalizing this to G-bundles for a reductive group G amounts to a) constructing the associated line bundle and b) finding enough global sections. Problem a) has been solved. Concerning b), the Verlinde formula shows that the dimension of the space of global sections is essentially one. A divisor has yet to be constructed.

Eberhard Zeidler *(MPI Leipzig)*
Mathematik – ein geistiges Auge des Menschen: abstrakt und praktisch

Der Vortrag richtet sich an eine breite Öffentlichkeit. Anhand von ausgewählten Beispielen aus den Naturwissenschaften und der Hochtechnologie soll erläutert werden, dass die Mathematik den Menschen in die Lage versetzt, in Erkenntnisbereiche vorzustoßen,

in denen unsere üblichen Erfahrungen völlig versagen. Das betrifft die Weiten des Kosmos im Großen, die Welt der Elementarteilchen im Kleinen und zum Beispiel die Welt der Materialien. Durch Anwendungen in der Medizin erhält die Mathematik eine bisher nicht gekannte humane Dimension, indem sie Menschen hilft, zum Beispiel durch die schmerzfreie Computertomographie. Die ungarische Mathematikerin Rósza Péter hat einmal gesagt: “Ich liebe die Mathematik nicht nur, weil man sie in der Technologie anwenden kann, sondern auch weil sie schön ist”.

Klaus Schmidt *(Universität Wien / Erwin Schrödinger Institut)*
Algebraic Dynamical Systems

An *algebraic action* of a countable discrete group Γ is an action of Γ by automorphisms of a compact abelian group X. The study of algebraic $\mathbf{Z}$-actions amounts to the investigation of single automorphisms of compact groups, one of the many classical sources of ergodic theory. During the 1990's some remarkable properties of algebraic $\mathbf{Z}^d$-actions with $d > 1$ were discovered which had no analogue in 'traditional' ergodic theory (i.e. in the study of single ergodic transformations or flows). These new phenomena ranged from unexpected rigidity properties (isomorphism rigidity and measure rigidity) and intricate higher order mixing behaviour (connected with solutions of linear equations in multiplicative groups of fields) to the arithmetically intriguing values of the entropies of such actions (which turn out to be Mahler measures of multivariate polynomials).
This lecture presents an overview of algebraic $\mathbf{Z}^d$-actions, some connections between these actions and certain lattice models of statistical mechanics, and a few facts about algebraic Γ-actions of more general discrete amenable groups.

Alfio Quarteroni *(École Polytechnique Fédérale de Lausanne)*
Domain decomposition methods for heterogeneous partial differential equations

In this talk I will review some classical PDE models based on domain decomposition to describe complex phenomena in continuum mechanics. Applications will concern environmental problems, cardiovascular flow problems, and problems arising from sport competition.
In environmental applications, heterogeneous PDE models are used to reduce the complexity of the numerical simulation on large scale problems.

The interest in the use of mathematical modelling and numerical simulation in the study of the cardiovascular system (and its inherent pathologies) has greatly increased in the past few years. We will describe the mechanical interaction of blood flow with arterial walls and simulate numerically the complex fluid-structure interaction problem in large arteries.
In sport, mathematical models are often used to try to enhance performances of athlets as well as to improve the design of vehicles that are used in the various disciplines.
More in general, we will highlight the role of interface conditions and Steklov-Poincar operators in scientific computing.

Michael Röckner *(Universität Bielefeld / Purdue University)*
Stochastic Partial Differential Equations and Infinite Dimensional Analysis

A major part of the talk will consist of a review about new analytic methods in the study of stochastic partial differential equations (SPDE) that have been developped in the past few years. Furthermore, we shall also describe some very recent progress within this subject. Main emphasis will be given to the approach of solving nonlinear SPDE through solving the corresponding linear Kolmogorov equations. Since these Kolmogorov equations are partial differential equations in infinitely many variables and known finite dimensional methods can only be applied in a very restricted way, new infinite dimensional analytic tools are required. We shall describe some of them in the talk. They lead to existence and uniqueness results for solutions of the SPDE, but also allow for analyzing their special properties, such as regularity or asymptotic behaviour. An interesting fact is that these techniques also lead to new results about deterministic PDE, since the case, where the stochastic noise term in the SPDE is identically equal to zero, is always included. Finally, applications to various classes of SPDE will be presented.

Andreas Griewank *(Humboldt-Universität Berlin)*
Jacobian-free Optimization

Most classical and modern algorithms for nonlinear numerical optimization are based on the assumption that the gradients of the active constraint equations can be evaluated exactly or approximated by divided differences. Moreover, the rectangular matrix formed

by these active constraint gradients needs to be directly factorized at each new iterate if one employs sequential quadratic programming or interior point methods.
In view of large problem dimensions we develop strategies to avoid evaluating and factorizing Jacobians by either low-rank updating or by employing essentially matrix-free fixed point solvers. In the talk we motivate these approaches, analyze their computational cost per cost, state their convergence properties and present numerical results from geophysical parameter estimation and aerodynamic shape optimization.

Peter Littelmann *(Universität Köln)*
On geometry and combinatorics in representation theory

In representation theory, the exchange with combinatorics and geometry has a long tradition and many different roots. We consider an example to present some of the latest developments and methods. The problem addressed in the example goes back to A. Horn, who posed a conjecture in 1962 on the characterization of the possible eigenvalues of a sum of Hermitian matrices. The problem turned out to have many interesting ramifications and the proof of the conjecture uses representation theory, combinatorics and geometric invariant theory. The problem and its generalizations has seen tremendous development in the last years, but many aspects of its analogue for other groups than the general and the special linear group is not very well understood still.

Alexander Kechris *(California Institute of Technology)*
Logic and dynamical systems

In this talk, I will give an introduction to a theory of complexity of classification problems in mathematics and discuss its connections with set theoretic versions of rigidity phenomena for ergodic, measure preserving actions of countable discrete groups.

Gérard Laumon *(CNRS / Universit Paris-Sud Orsay)*

Fundamental Lemma and Hitchin Fibration

The Langlands-Shelstad Fundamental Lemma is a combinatorial conjecture which plays a crucial role in the stabilization of the Arthur-Selberg trace formula and the computation of the Hasse-Weil zeta functions of the Shimura varieties.
Waldspurger has shown that it is sufficient to prove it in equal characteristics. In this case the Fundamental Lemma may be interpreted as a cohomological statement, due to the functions-sheaves dictionary of Grothendieck.
In joint work with Ngô Bao Châu, we have proved the Fundamental Lemma for unitary groups. We use earlier results of Rapoport and myself, Goresky, Kottwitz and MacPherson, and a computation by Ngô of the numbers of points of the Hitchin fibrations over a finite field in terms of stable global orbital integrals.
In my talk I would like to present these developments.

Sonia Mazzucchi *(Università Trento)*

Feynman path integrals as infinite dimensional oscillatory integrals

In 1942 R. Feynman proposed an heuristic path integral representation for the solution of the Schrödinger equation, describing the time evolution of the state of a $d-$dimensional quantum mechanical particle moving in a potential.
In 1976 S. Albeverio and R. Høegh-Krohn gave a well defined mathematical meaning to Feynman's heuristic formula in term of a well defined functional integral: the infinite dimensional Fresnel integral.
Oscillatory integrals on finite dimensional spaces are a classical topic, largely developed in connection with several applications in mathematics (for instance in the theory of Fourier integral operators) and physics (for instance in optics). Infinite dimensional oscillatory integrals arose as a generalization of finite dimensional oscillatory integrals to the case the integration is performed on an infinite dimensional real separable Hilbert space.
Among the many existing approaches to the rigorous mathematical realization of the heuristic Feynman path integrals, infinite dimensional oscillatory integrals are particularly powerful, as they allow to deal with a large class of potentials and to implement an infinite dimensional version of the stationary phase method for the study of the asymptotic semiclassical behavior of the solution of the Schrödinger equation.

The general theory will be described, as well as some recent developments and applications to the quantum theory.

Renè Schilling *(Universität Marburg)*
Sample path properties of stochastic processes

In recent years the study of stochastic processes has experienced a renaissance both in mathematical modelling and more theoretical research. While many applications use Lévy processes (i.e. processes with stationary and independent increments, which are one of the simplest classes of stochastic processes with jumps) we focus on Lévy-type processes which can be viewed as non-translation-invariant generalizations of Lévy processes. These processes can be characterized via their infinitesimal generators – non-classical pseudo-differential operators with rough symbols– and we give a brief introduction and survey on the construction and description of such processes. The main emphasis will be on the properties of the sample paths, e.g. *smoothness* and various fractal dimensions, and how to describe them in terms of the symbol of the pseudo differential operators.

Elon Lindenstrauss *(Princeton University)*
Invariant measures for multidimensional diagonalizable group actions and arithmetic applications

We consider a certain class of concrete actions of $\mathbb{R}^d$ for $d \geq 2$, namely actions of diagonalizable groups on locally homogeneous spaces. A basic example is the action of the group of diagonal matrices on the space of homothety classes of lattices in $\mathbb{R}^{d+1}$. We will present progress in our understanding of these actions, and discuss some arithmetic applications. Entropy plays a key role in the study of theses actions and in the applications.

Francois Labourie *(Université Paris-Sud Orsay)*

Higher Thurston Theory

We shall explain how the study of (some) representations of the fundamental group of a compact surface in $SL(n, \mathbb{R})$ leads to a generalisation of Teichmüller theory thought of as a dictionnary between geometry and dynamical systems. We shall concentrate on the approach describing these representations as 'crossratios'. We shall also explain a uniformisation conjecture which would link the subject to vector bundles over Riemann moduli space and partial results toward this conjecture.

John Ball *(University Oxford)*

Singularities in nonlinear continuum mechanics

The lecture will discuss various singularities that arise in energy minimizers for elastic materials and liquid crystals, and how their existence depends on the properties of the relevant energy densities.

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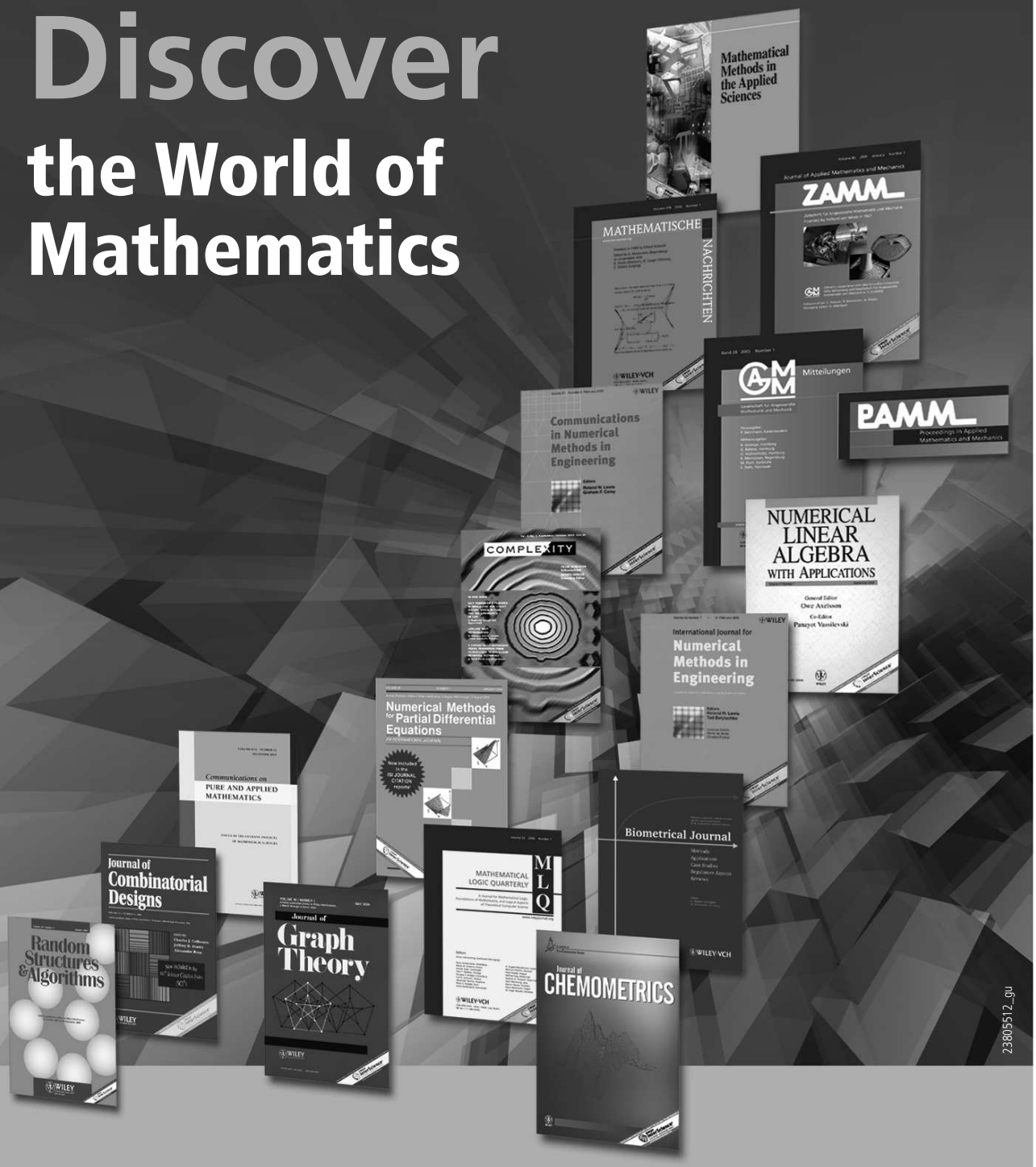

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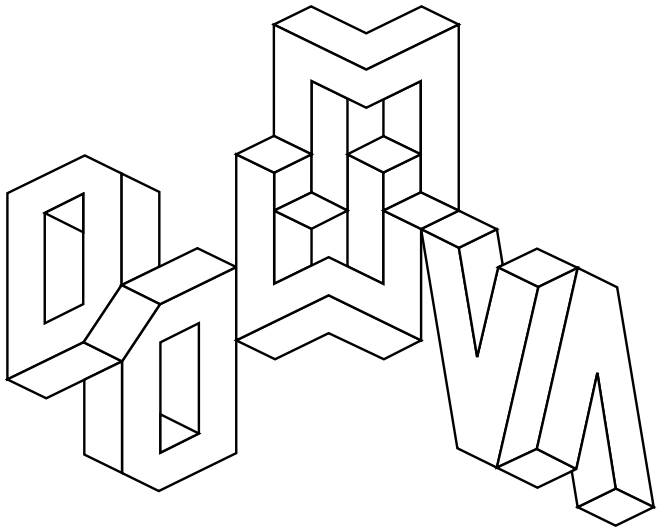

Minisymposien

mit Vortragsauszügen

universitätbonn

Minisymposium 1

Discrete Optimization

Leiter des Symposiums:

Prof. Dr. Jens Vygen
Forschungsinstitut für
Diskrete Mathematik
Universität Bonn
Lennestraße 2
53113 Bonn, Germany

Prof. Dr. Robert Weismantel
Fakultät für Mathematik / IMO

Otto-von-Guericke-Universität Magdeburg
Universitätsplatz 2
39106 Magdeburg, Germany

Dienstag, 19. September

Übungsraum 3, Geographisches Institut, Meckenheimer Allee 166

15:00 – 15:50 **Martin Skutelle** *(Dortmund)*
Network flows with path restrictions

16:00 – 16:20 **Christoph Buchheim** *(Köln)*
Compact IP formulations of Boolean optimization problems

16:30 – 16:50 **Dennis Michaels** *(Magdeburg)*
Discrete methods for tackling nonlinear mixed integer optimization problems in chemical engineering

17:00 – 17:50 **Alexander Martin** *(Darmstadt)*
Minimizing switching networks

Mittwoch, 20. September

Übungsraum 3, Geographisches Institut, Meckenheimer Allee 166

15:00 – 15:50 **Andreas Brieden** *(München)*
Optimization for agriculture

16:00 – 16:20 **Marc Pfetsch** *(Berlin)*
Symmetry reduction in graph coloring via orbitopes

16:30 – 16:50 **Ulrich Brenner** *(Bonn)*
A faster polynomial-time algorithm for the unbalanced Hitchcock transportation problem

17:00 – 17:50 **Fritz Eisenbrand** *(Dortmund)*
The stable set polytope of quasi-line graphs

Vortragsauszüge

Martin Skutelle *(Dortmund)*
Network Flows with Path Restrictions

Network flows are usually specified by assigning flow values to the arcs of a given network. Flow conservation constraints ensure that, except for certain source and sink nodes, the amount of flow entering a node equals the amount of flow leaving that node. Moreover, arc capacities often bound the flow values on the arcs. It is a classical and well known result that any flow can be decomposed into flows along paths and cycles. This insight yields the so-called path-based formulation of a flow problem where the task is to assign flow values to paths and cycles (instead of arcs). By imposing certain restrictions on the paths that are used to send flow, interesting variants of classical flow problems can be derived. Motivated by practical applications, one can, for example, bound

- the number of flow-carrying paths (*unsplittable* or k*-splittable* flow problems),
- the length of flow-carrying paths (*length-bounded* flow problems),
- the amount of flow sent through each path (flows with *path capacities*).

Also all sorts of combinations of the above mentioned constraints can be taken into consideration. We present recent results on network flows with path restrictions and discuss interesting directions for future research.

Christoph Buchheim *(Köln)*
Compact IP formulations of Boolean optimization problems

We present a new polyhedral approach to general logic optimization problems. Compared to other methods, our approach produces much smaller IP models, making it more efficient from the practical point of view. We mainly obtain this by two different ideas: first, we do not require the objective function to be in any normal form. The transformation into a normal form usually leads to the introduction of many additional variables or constraints. Second, we reduce the problem to the degree-two case in a very efficient way, using a slightly extended formulation. The resulting model turns out to be closely related to the max-cut problem; we can show that the corresponding polytope is a face of a suitable cut polytope. In particular, our separation problem can be completely reduced to the separation problem for max-cut. Experimental results show that

our branch-and-cut implementation of this approach is significantly faster than other methods.

Dennis Michaels *(Magdeburg)*
Discrete methods for tackling nonlinear mixed integer optimization problems in chemical engineering

Joint work with Utz-Uwe Haus and Robert Weismantel

Many optimization problems in chemical engineering give rise to non-convex nonlinear mixed-integer optimization problems. While many tools for generating locally optimal solutions are nowadays available, determining a globally optimal solution still remains a challenging task. In this talk an approach to tackle such instances is introduced that mostly resorts to techniques from discrete optimization. A hierarchy of mixed-integer linear problems is defined that contain all solutions of the original instance. For this, the nonlinear terms occuring in the original formulation are polyhedrally relaxed respecting local and global properties in the domain. A key step of this approach is to identify combinatorial substructures like stable sets or nonlinear flow conservation conditions that are given by the constraints of the original nonlinear model. A linear description of those substructures leads to valid inequalities that strengthen the linear relaxations. The capability of this approach is demonstrated by considering two different applications coming from chemical engineering.

Alexander Martin *(Darmstadt)*
Minimizing switching networks

Switching networks are directed acyclic graphs with specified disjoint sets of input and output nodes. A connection request is a partial function from the set of output nodes to the set of input nodes specifying which input node needs to be routed to which output nodes. A switching network is called rearrangeably nonblocking with respect to multicast traffic if all connection requests are routable, that is, if for each request there exists a set of mutually vertex-disjoint directed trees connecting each input node to its designated output nodes. Clos networks are switching networks, where nodes are set up in stages to reduce size and cost.
The problem of characterizing routability of multicast-rearrangeable Clos networks is still open. In this talk we bring some new insights into this problem. We formulate the

problem as a vertex-coloring problem. We identify critical requests whose routability implies the routability of all others by applying some known theorems, by using reduction techniques and by exploiting symmetry. By efficiently enumerating all critical requests, we are able to characterize the routability of Clos networks with up to 32 input and output nodes.

Andreas Brieden *(München)*

Optimization for agriculture

In many regions farmers cultivate a number of small lots that are distributed over a wider area. This leads to high overhead costs and economically prohibits use of high tech machinery hence results in a non-favorable cost-structure of production. The classical form of land consolidation is typically too expensive and too rigid, whence consolidation based on lend-lease agreements has been suggested. In order to exploit the potential of this method specific mathematical optimization algorithms have to be developed that use many ideas from different mathematical areas. E.g., one approach leads to a quadratic optimization model that can be approximately solved by means of the theory of convex bodies. In subroutines Hadamard matrices are required to create mixed integer linear programs whose “good nature” can be proved by a careful analysis of the simplex algorithm.

Marc Pfetsch *(Berlin)*

Symmetry reduction in graph coloring via orbitopes

It is a well-known phenomenon that symmetries in integer programming (IP) formulations makes them extremely hard to solve. The reason is that, on the one hand, the corresponding LP relaxations become poor and, on the other hand, the branch-and-bound tree is unnecessarily large, because equivalent solutions are found again and again. This situation also occurs for a natural IP formulation for *graph coloring*, which has a variable for each pair of a node in the graph and a potential color.
We have recently introduced so-called partitioning *orbitopes*, which are the convex hulls of 0/1 matrices with exactly one 1 in each row, whose columns are lexicographically sorted. The goal is to remove symmetry by isolating a lexicographically maximal representative in each orbit of the full symmetric group acting on the columns of the matrices. We derived a complete linear description of these polytopes. In this talk, we investigate

the integer hulls of the intersections of orbitopes with the polytopes associated with the mentioned graph coloring formulation. The goal is to remove symmetry as much as possible. It turns out that even describing the dimensions of the resulting polytopes seems to be quite complicated (and so is the investigation of the facial structures). Nevertheless, we will discuss several classes of valid inequalities and present computational results based on them.

Joint work with Yuri Faenza and Volker Kaibel.

Ulrich Brenner *(Bonn)*

A faster polynomial-time algorithm for the unbalanced Hitchcock transportation problem

We present a new algorithm for the Hitchcock transportation problem. On instances with n sources and k sinks, our algorithm has a worst-case running time of $O(nk^2(\log n + k \log k))$. This algorithm closes a gap between algorithms which have a running time linear in n but exponential in k and a polynomial-time algorithm with running time $O(nk^2 \log^2 n)$.

Fritz Eisenbrand *(Dortmund)*

The stable set polytope of quasi-line graphs

It is a long standing open problem to find an explicit description of the stable set polytope of *claw-free graphs*. Yet more than 20 years after the discovery of a polynomial algorithm for the maximum stable set problem for claw-free graphs, there is even no conjecture at hand today.
Such a conjecture exists for the class of *quasi-line graphs*. This class of graphs is a proper superclass of line graphs and a proper subclass of claw-free graphs for which it is known that not all facets have $0/1$ normal vectors. The *Ben Rebea conjecture* states that the stable set polytope of a quasi-line graph is completely described by *clique-family* inequalities. Chudnovsky and Seymour recently provided a decomposition result for claw-free graphs and proved that Ben Rebea's conjecture holds, if the quasi-line graph is not a *fuzzy circular interval graph*.
In this talk I present a proof of the Ben Rebea conjecture by showing that it also holds for fuzzy circular interval graphs.

Joint work with G. Oriolo, G.Stauffer and P. Ventura.

Minisymposium 2

Numerics for PDE-Constrained Control Problems

Leiterin des Symposiums:

Prof. Dr. Angela Kunoth
Institut für Angewandte Mathematik
Universität Bonn
Wegelerstraße 6
53115 Bonn, Germany

Donnerstag, 21. September

Raum 610, Institut für Angewandte Mathematik, Wegelerstr. 6

15:00 – 15:50 **Helmut Harbrecht** *(Kiel, z.Zt. Bonn)*
Shape Optimization for Elliptic PDEs

16:00 – 16:50 **Max D. Gunzburger** *(Florida State University)*
Improved construction and application of reduced-order models

17:00 – 17:50 **Karl Kunisch** *(Universität Graz)*
Reduced Order Control Based on Approximate Inertial Manifolds

Freitag, 22. September

Raum 610, Institut für Angewandte Mathematik, Wegelerstr. 6

15:00 – 15:50 **Ekkehard Sachs** *(Trier & Virginia Tech)*
t.b.a.

16:00 – 16:20 **Roland Pabel** *(Bonn)*
Wavelet Methods for PDE Constrained Elliptic Control Problems with Dirichlet Boundary Control

16:30 – 16:50 **Thomas Slawig** *(TU Berlin)*
PDE-Constrained Control Using Commercial Simulation Software – Control of the Navier-Stokes Equations with FEMLAB

17:00 – 17:50 **Steve Hou** *(Iowa State University)*
t.b.a

Vortragsauszüge

Helmut Harbrecht *(Kiel, z.Zt. Bonn)*
Shape Optimization for Elliptic PDEs

Joint work with K. Eppler (TU Dresden).

Shape optimization is quite indispensable for designing and constructing industrial components. Many problems that arise in application, particularly in structural mechanics and in the optimal control of distributed parameter systems, can be formulated as the minimization of functionals defined over a class of admissible domains.
The present talk aims at surveying on shape optimization for elliptic boundary value problems. Especially, the following items will be addressed:

- analysis of shape optimization problems,
- the discretization of shapes,
- first and second order shape optimization methods,
- existence and convergence of approximate shapes,
- efficient numerical techniques to compute the state equation.

Max D. Gunzburger *(Florida State University)*
Improved construction and application of reduced-order models

The approximate solution of optimization and control problems constrained by nonlinear partial differential equations is often a formidable task. At the least, it requires multiple state solutions or, in the feedback control setting, real-time state solutions. These tasks are difficult or even impossible to accomplish without using some sort of model reduction technique. We discuss some recent developments in the construction and application of reduced-order models for reducing the cost of state solutions. We focus on two issues: the generation of snapshots upon which reduced-order models are built and the incorporation of a parallelism-in-time methodology into reduced-order solution strategies. In the first case, we discuss some novel techniques developed by several authors (notably Antony Patera and co-workers and Omar Ghattas, Karen Willcox, and co- workers) for adaptively sampling parameter space during the snapshot generation process. We also show the results of some computational experiments that test the ability of reduced-order models to remain useful as the dynamical nature of the state solution changes during the optimization process. We close by describing some recent

work (by Janet Peterson and co-workers) on combining the parareal algorithm for time parallelism with reduced-order modeling, showing that the combination results in significant speedups compared to using only reduced-order modeling.

Karl Kunisch *(Universität Graz)*
Reduced Order Control Based on Approximate Inertial Manifolds

A reduced-order method for optimal control problems in infinite-dimensional based on approximate inertial manifolds is developed. Convergence of the cost, optimal controls and optimal states of the finite dimensional, reduced-order, optimal control problems to the original optimal control problem is analyzed. Special attention is given to the particular case when the dynamics are described by the Navier Stokes equations in dimension two. – This is joint work with Prof. Ito, North Carolina State University.

Ekkehard Sachs *(Trier & Virginia Tech)*
t.b.a.

(Abstrakt lag bei Redaktionsschluss noch nicht vor.)

Roland Pabel *(Bonn)*
Wavelet Methods for PDE Constrained Elliptic Control Problems with Dirichlet Boundary Control

We consider wavelet methods applied to control problems constrained by a linear elliptic PDE with Dirichlet boundary control. In order to handle the latter in a convenient way, we employ a saddle point formulation for the PDE constraints. Then the necessary conditions for optimization lead to a coupled system of saddle point problems. We investigate fast iterative solution methods for this system with optimal preconditioners based on the Fast Wavelet Transform for problems on up to three-dimensional spatial domains. In particular, the choice of different modelling parameters in the cost functional and their effect on the numerical simulation and solution will be discussed.

Thomas Slawig *(TU Berlin)*
PDE-Constrained Control Using Commercial Simulation Software – Control of the Navier-Stokes Equations with FEMLAB

We show how the commercial simulation software FEMLAB can be used to solve PDE-constrained optimal control problems. We give a general formulation for such kind of problems and derive the adjoint equation and optimality system. Then these preliminaries are specified for the stationary Navier-Stokes equations with distributed and boundary control. The main steps to define and solve a PDE with FEMLAB are described. We describe how the adjoint system can be implemented, and how the optimality system can be used by FEMLAB's built-in functions. Special crucial topics concerning efficiency are discussed. Examples with distributed and boundary control for different type of cost functionals in 2 and 3 space dimensions are presented.

Steve Hou *(Iowa State University)*
t.b.a.

(Abstrakt lag bei Redaktionsschluss noch nicht vor.)

Minisymposium 3

Stochastic Processes with Jumps: Theory and applications

Leiter des Symposiums:

Prof. Dr. René L. Schilling
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Prof. Dr. Rüdiger Kiesel
Universität Ulm
Fakultät für Mathematik
und Wirtschaftswissenschaften
Abteilung Finanzmathematik
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Dr. Moritz Kassmann
Institut für Angwandte Mathematik
Universität Bonn
Beringstraße 6
53115 Bonn, Germany

Montag, 18. September

HS XIV, Hauptgebäude, Regina-Pacis-Weg

15:00 – 15:50 **Jan Kallsen** *(München))*
Mean-variance hedging for jump processes

16:00 – 16:50 **Bernt Oksendal** *(Oslo)*
Malliavin calculus for Lévy processes and applicationto optimal portfolio with partial information

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16:30 – 16:50 **Thorsten Schmidt** *(Leipzig)*
Portfolio credit risk with default clustering

17:00 – 17:50 **Matthias Scherer** *(Ulm)*
Pricing corporate bonds in an arbitrary jump-diffusion model based on an improved Brownian-bridge algorithm

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Dienstag, 19. September

Kleiner Hörsaal, Mathematisches Institut, Wegelerstr. 10

15:00 – 15:50 **Krszystof Bogdan** *(Wroclaw)*
3G, 3P, 3U

16:00 – 16:20 **Zhen-Qing Chen** *(Seattle)*
Heat Kernel Estimates for Jump Processes of Mixed Types on Metric Measure Spaces

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16:30 – 16:50 **Hans-Peter Scheffler** *(Siegen)*
On generalized coupled continuous time random walks

17:00 – 17:50 **Helmut Abels** *(Max Planck Institute for Mathematics in the Sciences)*
On the Martingale Problem for a class of Pseudo-Differential Operators with Hölder Continuous Coefficients

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Mittwoch, 20. September

Kleiner Hörsaal, Mathematisches Institut, Wegelerstr. 10

15:00 – 15:50 **Werner Linde** *(Jena)*
Optimal Series Representation of Certain Gaussian Processes

16:00 – 16:20 **Niels Jacob** *(Swansea)*
Some strange operators in the theory of multi-parameter processes

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16:30 – 16:50 **Alexander Lindner** *(München)*
On continuity properties of the law of integrals of Lévy processes

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17:00 – 17:50 **Ilya Pavlyukevich** *(Humboldt-Universität Berlin)*
Dynamical systems perturbed by heavy-tailed Lévy noise

Vortragsauszüge

Jan Kallsen *(München)*
Mean-variance hedging for jump processes

A key problem in financial mathematics is how to hedge a contingent claim by dynamic trading in the underlying. Since models based on jump processes are incomplete, perfect replication is typically impossible. As a natural alternative one may seek to minimize the expected squared hedging error. In this talk we discuss the general structure of optimal hedging strategies as well as concrete results in specific models with stochastic volatility and jumps.

Bernt Oksendal *(Oslo)*
Malliavin calculus for Lvy processes and application to optimal portfolio with partial information

We consider a financial market driven by Lévy processes. We assume that a given trader in this market has access to an information flow which is possibly less than the

information generated by the underlying Lévy processes. Mathematically this means that the portfolio chosen by the trader must be adapted to this smaller filtration which represents the trader's information. For example, the filtration could be a delayed filtration of the filtration of the underlying processes. With a given utility function, we show that the portfolio which maximizes the expected utility for this partially informed trader can be expressed in terms of the Malliavin derivatives with respect to the underlying Lévy processes.
We illustrate the results by finding the optimal portfolio in specific examples. The presentation is based on joint work in progress with G.Di Nunno and T. Zariphopoulou.

References:

G.Di Nunno, B. Øksendal and T. Zariphopoulou: Optimal portfolio under partial information in a market driven by Lévy processes (in preparation)

Thorsten Schmidt *(Leipzig)*
Portfolio credit risk with default clustering

This talk considers a reduced form model for default which incorporates realistic default clustering and allows to derive closed-form solutions to the key ingredients in credit risk modeling: risk-free bond prices, defaultable bond prices (with and without stochastic recovery) and probabilities of survival. We show that all these quantities can be represented in general exponential quadratic forms, despite the fact that the intensity is allowed to jump in a shot-noise style.
The main goal is to apply the model to a portfolio of credits, eg for pricing credit indices. The model generalizes the attempt from Duffie and Gârleanu (2001). We show how to price first-to-default swaps, CDOs, and draw the link to currently proposed credit indices.

This is joint work with Raquel Gaspar.

Matthias Scherer *(Ulm)*
Pricing corporate bonds in an arbitrary jump-diffusion model based on an improved Brownian-bridge algorithm

In our paper "Pricing corporate bonds in an arbitrary jump-diffusion model based on an improved Brownian-bridge algorithm", we provide an efficient algorithm for the computation of default probabilities and bond prices in a structural default model with jumps. Our algorithm allows jump-diffusion processes with arbitrary jump-size distribution as a model for the logarithm of the value process of a firm. Moreover, the algorithm is unbiased and is capable to capture stochastic recovery rates, which are endogenously generated by structural default models with jumps. The algorithm requires to evaluate integrals with the density of the first-passage time of a Brownian bridge as integrand. In terms of precision, we significantly improve an approximation of these integrals which was suggested by Metwally and Atiya (2002) in order to accelerate their barrier-option pricing algorithm. It is well known that allowing a sudden default by jumps results in a positive limit of credit spreads at the short end of the term structure. We provide an explicit formula of this limit, which only depends on the Lévy measure of the logarithm of the firm-value process, the recovery rate, and the distance to default.

Krszystof Bogdan *(Wroclaw)*
3G, 3P, 3U

Based on joint work with T. Jakubowski, W. Hansen, and T. Byczkowski I will discuss applications of certain far reaching analogues of the triangle inequality in potential theory. The so-called 3G inequality, and the newer 3P and 3U inequalities, yield results on comparability of the Green function, transition probability, and the resolvent within the setup of the theory of additive perturbations of generators. Our focus will be on gradient-type perturbations.

References:

- K. Bogdan and T. Byczkowski, Potential theory for the α-stable Schrödinger operator on bounded Lipschitz domains *Studia Math.*, 133(1):53–92, 1999.
- K. Bogdan and T. Jakubowski, Estimates of heat kernel of fractional Laplacian perturbed by gradient operators, preprint (2006)
- W. Hansen, Uniform boundary Harnack principle and generalized triangle property, *J. Funct. Anal.*, 226(2):452–484, 2005.

- P. Kim and R. Song, Two-sided estimates on the density of Brownian motion with singular drift, *to appear in Ill. J. Math.*
- Q. S. Zhang, Gaussian bounds for the fundamental solutions of $\nabla(A\nabla u)+B\nabla u-u_t=0$, *Manuscripta Math.*, 93(3):381–390, 1997.

Zhen-Qing Chen *(Seattle)*

Heat Kernel Estimates for Jump Processes of Mixed Types on Metric Measure Spaces

Alfors d-regular set is a class of fractal sets which contains geometrically self-similar sets. In this talk, we will discuss recent progress on the study of symmetric jump-type processes of mixed type on a class of metric measure spaces that include d-regular sets. A typical example is the symmetric jump process with jumping intensity

$$\int_{\alpha_1}^{\alpha_2} \frac{c(\alpha,x,y)}{|x-y|^{d+\alpha}}\,\nu(d\alpha),$$

where ν is a probability measure on $[\alpha_1,\alpha_2]\subset(0,2)$, and $c(\alpha,x,y)$ is a jointly measurable function that is symmetric in (x,y) and is bounded between two positive constants. Results on parabolic Harnack principle and sharp two-sided heat kernel estimate for such jump-type processes will be presented. Two sided heat kernel estimates for jump processes with exponential decaying jumping measure will also be given. A typical example is the symmetric jump process with jumping intensity

$$e^{-c\,|x-y|}\int_{\alpha_1}^{\alpha_2} \frac{c(\alpha,x,y)}{|x-y|^{d+\alpha}}\,\nu(d\alpha),$$

which in particular includes the relativistic stable processes of mixed type.

Hans-Peter Scheffler *(Siegen)*

On generalized coupled continuous time random walks

The continuous time random walk (CTRW) model incorporates waiting times J_i between jumps Y_i of a particle. Classical assumptions are that $J_1, J_2, \ldots$ are iid belonging to some domain of attraction of a stable subordinator $D(t)$; $Y_1, Y_2, \ldots$ are iid belonging to the domain of attraction of an (operator) stable Lévy motion $A(t)$ and that (J_i) and (Y_i) are independent.

We present a two-fold generalization of this model by considering general triangular arrays $\Delta = \{(J_i^{(c)}, Y_i^{(c)}) : i \geq 1, c \geq 1\}$ of waiting times and jumps with iid rows and allowing arbitrary dependence between the waiting time $J_i^{(c)}$ before the jump $Y_i^{(c)}$. We assume that the row sums of Δ converge in distribution to some space-time Lévy process $\{(A(t), D(t))\}$. In this general setting the limiting distribution of the generalized CTRW modelled by Δ is of the form $M(t) = A(E(t))$ where $E(t)$ is the hitting time process of the subordinator $D(t)$, as in the classical case. However, since $A(t)$ and $D(t)$ are dependent, $A(t)$ and $E(t)$ are dependent. It turns out the the distribution of $M(t)$ can be represented in terms of $(A(t), D(t))$ even in this general coupled case. Moreover the Fourier-Laplace transform of the distribution of $M(t)$ is the solution to the so-called master equation in statistical physics. Finally the distribution of $M(t)$ is also the mild-solution of a coupled in space and time pseudo-differential equation generalizing fractional PDEs.

Helmut Abels *(Max Planck Institute for Mathematics in the Sciences)*
On the Martingale Problem for a class of Pseudo-Differential Operators with Hölder Continuous Coefficients

We discuss the martingale problem for Lévy-type operators for which the kernel is merely Hölder continuous in the space variable. It is well-known that the well-posedness of the Martingale problem reduces to the unique solvability of the inhomogeneous heat equation associated with the generator. The solvability of the latter equations is obtained by showing that a certain class of parameter-elliptic pseudodifferential operators with Hölder-continuous coefficients generate analytic semi-groups in $C_0^\alpha(\mathbb{R}^n)$. The necessary resolvents estimates are proved by using a careful parametrix construction and results on composition of pseudodifferential operators with Hölder-continuous coefficients. The talk is based on a joint project with Moritz Kassmann, Bonn.

Werner Linde *(Jena)*
Optimal Series Representation of Certain Gaussian Processes

Let (T, ρ) be a compact metric space and let $X = (X(t), t \in T)$ be a centered Gaussian process over T possessing a.s. continuous paths. Then there are continuous functions

u_k from T into $\mathbb{R}$ such that a.s.

$$X(t) = \sum_{k=1}^{\infty} \xi_k u_k(t)\,, \qquad t \in T\,.$$

Here $(\xi_k)_{k\geq 1}$ denotes an i.i.d. sequence of $\mathcal{N}(0,1)$–distributed random variables. Since this series representation of X is not unique, it is naturally to ask for optimal ones, i.e., for those where

$$\left(\mathbb{E} \sup_{t\in T} \left| \sum_{k=n}^{\infty} \xi_k u_k(t) \right|^2 \right)^{1/2},$$

as $n \to \infty$, tends to zero as fast as possible.
We investigate this problem for the fractional Brownian sheet on $[0,1]^N$ and for Lévy's fractional Brownian motion over a self–similar set $T \subset \mathbb{R}^N$. Optimal representations are obtained via suitable wavelet decompositions. The presented results rest on joint works with Thomas Kühn from Leipzig and with Antoine Ayache from Lille.

Niels Jacob *(Swansea)*
Some strange operators in the theory of multi-parameter processes

In this talk we discuss (pseudo-)differential operators which might give rise to multi-parameter (not necessarily Markovian) stochastic processes. The class of operators includes those arising in the theory of multi-parameter Markov processes but goes far beyond. The operators under considerations (even in case of local, i.e. differential, operators) do not belong to any standard class but they emerge naturally within our context. The talk is based on work in progress with A. Potrykus.

Alexander Lindner *(München)*
On continuity properties of the law of integrals of Lévy processes

For a bivariate Lévy process (ξ, η) consider the integral $\int_0^\infty e^{-\xi_{t-}}\, d\eta_t$, which appears as a stationary solution of certain generalised Ornstein-Uhlenbeck processes. We characterise, in terms of the bivariate characteristic triplet, when the above integral has atoms (provided it converges). We then turn attention to sufficient conditions ensuring the absence of atoms of distributions of the form $\int_0^\infty g(\xi_t)\, dt$, where ξ is a one-dimensional Lévy process and g is some deterministic function. The talk is based on joint work with Jean Bertoin and Ross Maller.

Ilya Pavlyukevich *(Humboldt-Universität Berlin)*

Dynamical systems perturbed by heavy-tailed Lévy noise

We consider a dynamical system in $\mathbb{R}$ driven by a vector field $-U'$, where U is a multi-well potential satisfying some regularity conditions. We perturb this dynamical system by a Lévy noise of small intensity and such that the heaviest tail of its Lévy measure is regularly varying. We show that the perturbed dynamical system exhibits metastable behaviour i.e. on a proper time scale it reminds of a Markov jump process taking values in the local minima of the potential U. Due to the heavy-tail nature of the random perturbation, the results differ strongly from the well studied purely Gaussian case.

Joint work with Peter Imkeller, HU Berlin.

Minisymposium 4

Spectral Theory and Ergodic Operators

Leiter des Symposiums:

PD Dr. Daniel Lenz
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PD Dr. Peter Müller
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Montag, 18. September

HS XII, Hauptgebäude, Regina-Pacis-Weg

15:00 – 15:50 **Peter Stollmann** *(Chemnitz)*
Between order and disorder: Hamiltonians for quasicrystals

16:00 – 16:50 **Michael Baake** *(Bielefeld)*
Combinatorial and spectral properties of pinwheel patterns

17:00 – 17:50 **Nicolas Destainville** *(Toulouse)*
Arctic phenomena in random tilings with fixed boundaries, in dimensions 2 and 3

Dienstag, 19. September

Hörsaal 311 AVZ I, Endenicher Allee 11-13

14:30 – 14:50 **Johannes Brasche** *(Clausthal)*
Interactions along Brownian paths

15:00 – 15:50 **François Germinet** *(Cergy-Pontoise)*
Recent results on localization for random Schroedinger operators

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16:00 – 16:50 **Wolfgang König** *(Leipzig)*
The Universality Classes in the Parabolic Anderson Model

17:00 – 17:50 **Marcel Griesemer** *(Stuttgart)*
Spectral analysis of non-relativistic QED

Mittwoch, 20. September

Hörsaal 311 AVZ I, Endenicher Allee 11-13

15:00 – 15:50 **Thomas Kriecherbauer** *(Bochum)*
On the universality of random matrices

16:00 – 16:20 **Tobias Mühlenbruch** *(Clausthal)*
Hurwitz continued fractions and Ruelle's transfer operator

16:30 – 16:50 **Luka Grubisic** *(Aachen)*
Estimates for the spectral asymptotic in a Large Coupling Limit

17:00 – 17:50 **Stefan Teufel** *(Tübingen)*
Effective quantum dynamics in perturbed periodic media

Vortragsauszüge

Peter Stollmann *(Chemnitz)*
Between order and disorder: Hamiltonians for quasicrystals

The talk introduces discrete and continuum Hamiltonians for aperiodically ordered solids. As is typical in an ergodic setting, these operators come in a whole family, indexed by an apropriate dynamical system. We present some fundamental ergodic and some simple spectral properties.

Michael Baake *(Bielefeld)*
Combinatorial and spectral properties of pinwheel patterns

The classic pinwheel tiling of the plane, which is due to Conway and Radin, is defined via a primitive substitution rule based on one triangle. It contains congruent copies of this triangle in infinitely many orientations, wherefore the hull has continuous rotation symmetry. Beyond some general results on compactness, unique ergodicity and minimality, not much is known about this still somewhat enigmatic tiling.

In this talk, based on joint work with U. Grimm and D. Frettlöh, an alternative substitution rule is introduced that permits the derivation of several hitherto unknown properties and results on the combinatorics and diffraction of this tiling, together with some open conjectures.

Nicolas Destainville *(Toulouse)*

Arctic phenomena in random tilings with fixed boundaries, in dimensions 2 and 3

The effects of boundaries on macroscopic quantities such as entropy and tile statistics are discussed in random tilings of rhombi, dominoes or rhombohedra. The states that dominate the statistical ensemble of tilings are characterized. We show that under specific boundary conditions, they can display a strong structural inhomogeneity: The tilings are frozenön macroscopic regions near the boundary and only display a random character inside the ärcticfrontier. This effect is, in particular, responsible for a large difference of entropy between fixed boundary tilings and free or periodic boundary ones. We present the variational principle accounting for this arctic phenomenon. The results are demonstrated by a combination of exact and/or numerical approaches.

Johannes Brasche *(Clausthal)*

Interactions along Brownian paths

(Abstrakt lag bei Redaktionsschluss noch nicht vor.)

François Germinet *(Cergy-Pontoise)*

Recent results on localization for random Schroedinger operators

We shall review recent developments in the theory of localization for random Schroedinger operators. This includes Anderson potential as well as Poisson potentials. We shall comment on both Anderson localization and dynamical localization.

Wolfgang König *(Leipzig)*

The Universality Classes in the Parabolic Anderson Model

I shall discuss the long time behaviour of the parabolic Anderson model, the Cauchy problem for the heat equation with random potential on $\mathbb{Z}^d$. We consider general i.i.d. potentials and show that exactly *four* qualitatively different types of intermittent behaviour can occur. These four universality classes depend on the upper tail of the potential distribution: (1) tails at ∞ that are thicker than the double-exponential tails, (2) double-exponential tails at ∞ studied by Gärtner and Molchanov, (3) a new class called *almost bounded potentials*, and (4) potentials bounded from above studied by Biskup and König. The new class (3), which contains both unbounded and bounded potentials, is studied in both the annealed and the quenched setting. We show that intermittency occurs on unboundedly increasing islands whose diameter is slowly varying in time. The characteristic variational formulas describing the optimal profiles of the potential and of the solution are solved explicitly by parabolas, respectively, Gaussian densities. I shall also give a heuristic explanation in terms of the bottom of the spectrum of the Anderson Hamiltonian.

This is joint work with Remco van der Hofstad and Peter Mörters.

Marcel Griesemer *(Stuttgart)*

Spectral analysis of non-relativistic QED

The energy spectrum of non-relativistic matter coupled to quantized radiation is known to be absolutely continuous in a large interval between the ground state energy and the ionization threshold. The nature of the spectrum near the ground state energy is not known so far. In this talk I will outline two proofs for its absolute continuity. The first one is based on a new Mourre estimate and the conjuagte operator theory of Amrein et al. in the generalized version of Sahbani. The second one makes use of the BFS renormalization transformation in a novel way.

This is joint work with Juerg Froehlich and I.M. Sigal.

Thomas Kriecherbauer *(Bochum)*
On the universality of random matrices

Eigenvalues of random matrices display universal behavior in a twofold way. On the one hand local eigenvalue statistics such as the spacing distributions seem to depend for large matrix dimensions only on the symmetries of the matrices but not on the details of the chosen probability measure. On the other hand these distributions appear in many different areas of mathematics (statistics, combinatorics, number theory) and physics. In this talk both aspects of this universal behavior will be discussed.

Tobias Mühlenbruch *(Clausthal)*
Hurwitz continued fractions and Ruelle's transfer operator

Joint work with Dieter Mayer and Fredrik Strömberg (TU Clausthal)

We report a recent development concerning the transfer operator associated to a dynamical system.
We present the well known Hurwitz continued fractions and the associated dynamical system. We present also a Ruelle transfer operator L_β for this dynamical system. The transfer operator L_β is related to the Selberg ζ-function associated to the geodesic flow on the modular surface $\mathrm{SL}_2(\mathbf{Z})\backslash\mathbf{H}$. Moreover, certein eigenfunctions of the transfer operator L_β have a cocycle interpretation. These cocycles are associated to Maass cusp forms using a theorem due to Bruggeman, Lewis and Zagier. Interestingly, all these connections between the stated areas in dynamical systems, ergodic theory and number theory seem also to hold for Hecke triangle groups.
Finally, we present numerical calculations of the spectrum of the transfer operator for some selected Hecke triangle groups, pointing out the relation to Maass cusp forms.

Luka Grubisic *(Aachen)*
Estimates for the spectral asymptotic in a Large Coupling Limit

We present asymptotically sharp estimates for the convergence of eigenvalues and spectral families in the Large Coupling Limit. We reformulate the spectral convergence problem for a class of stiff problems (or non-inhibited problems in the terminology of

Sanchez-Palencia) as a task of estimating the accuracy of the Rayleigh–Ritz approximations to the spectrum of an elliptic (positive definite) operator. Our argumentation is based on recent approximation estimates, by the author, which are stable in such "ill-behaved situations". The theory is first presented in an abstract setting, since we consider applications to problems both in Quantum and Classical Mechanics. After giving the general results we present a study of the spectral asymptotics of Schroedinger operators with deep well potentials and a study of the spectral asymptotics for certain 1D approximations in the Theory of Elasticity as the diameter of the thin elastic body diminishes. Our theory is also applicable to standard singularly perturbed problems but such models will not be further considered in this talk.

Stefan Teufel *(Tübingen)*

Effective quantum dynamics in perturbed periodic media

I review results obtained with G. Panati, C. Sparber and H. Spohn concerning the effective dynamics of a single quantum particle in a slowly perturbed periodic potential. They lead to corrections to the effective Hamiltonian obtained from Peierls' substitution and to the so called "semiclassical model of solids". These corrections have a geometrical origin and add to a quantitative understanding of phenomena like Piezoelectricity or the integer quantum Hall effect.

Minisymposium 5

Finanznumerik (Computational Finance)

Leiter des Symposiums:

Prof. Dr. Rüdiger Seydel
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Dr. Thomas Gerstner
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Universität Bonn
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Dienstag, 19. September

Raum 610, Institut für Angewandte Mathematik, Wegelerstr. 6

15:00 – 15:50 **Kees Oosterlee** *(Delft)*
Fast and Accurate Pricing of Early Exercise Options with the Fast Fourier Transform

16:00 – 16:50 **Ansgar Jüngel** *(Mainz)*
Nonlinear Black-Scholes-type Equations for Financial Derivatives

17:00 – 17:20 **Ralf Forster** *(FU Berlin)*
Fast and Reliable Pricing of American Options With Local Volatility

17:30 – 17:50 **Sebastian Quecke** *(Köln)*
Pricing American Options using Quadrature

Mittwoch, 20. September

Raum 610, Institut für Angewandte Mathematik, Wegelerstr. 6

15:00 – 15:50 **Erich W. Farkas** *(ETH Zürich)*
Numerical Analysis for Lévy Copula Processes

16:00 – 16:20 **Stanley Mathew** *(Frankfurt)*
Amortizing Forward: An Alternative Contract For Hedging Currency Risk

16:30 – 16:50 **Christian Gründl** *(Heidelberg)*
Computation of Credit Risk Using Sparse Grids

17:00 – 17:20 **Marlkus Holtz** *(Bonn)*
Valuation of Performance-Dependent Options using Sparse Grids

Vortragsauszüge

Kees Oosterlee *(Delft)*
Fast and Accurate Pricing of Early Exercise Options with the Fast Fourier Transform

When valuing and risk managing exotic derivatives, practitioners demand fast and accurate prices and sensitivities. Since the models being used in practice are becoming increasingly more complex, efficient methods have to be developed that can cope with the high dimensionality of such models. Aside from non-standard exotic derivatives, plain vanilla options in many stock markets are actually of the American type. As any pricing and risk management system has to be able to calibrate to these plain vanilla options, it is of the utmost importance to be able to value these American options quickly and accurately. In this paper we present highly efficient methods for options with early exercise or callable features. The methods developed rely heavily on the fast Fourier Transform (FFT). Early FFT based solution methods were mainly developed for pricing European options. Andricopoulos introduced the quadrature method QUAD, which can be used to value a variety of options with exotic features, assuming that the underlying process follows geometric Brownian motion. OSullivan combined the early Fourier transform methods with the QUAD method, and enabled the use of a fast resolution of the probability density function of the logarithm of the underlying. His method can be applied to a general set of underlying Lévy processes as well as to exotic path dependent features. Inspired by the quadrature pricing techniques, we propose a solution method that utilises the power of the FFT as much as possible. At the same time, we wish to get a grip on the resulting errors. The computational complexity in our recently developed solution methods reduces to $O(MN \log N)$, with M the number of observation times, and N the number of points in price dimension. In combination with Richardson extrapolation, and by using the fractional FFT method, we aim for the highest efficiency for the pricing of callable options under models where the underlying asset is exponentially affine in the state variables. This is the case for exponentially affine jump-diffusion models, exponential Lévy models, and variants hereof. We focus on both one-dimensional and two-dimensional processes, the latter class allowing us to develop efficient pricing methods for popular stochastic volatility models, such as the Heston model. The methods proposed are compared, also with iterative solution methods that solve the partial (integro-) differential equation with finite differences for a variety of American and Bermudan option pricing models with early exercise features.

Ansgar Jüngel *(Mainz)*

Nonlinear Black-Scholes-type Equations for Financial Derivatives

Standard financial derivatives like European options are priced by the famous Black-Scholes model which has the form of a linear parabolic equation. The Black-Scholes equation is derived under quite restrictive assumptions, e.g., no transaction costs occur and the market is complete. Without these conditions the resulting models may become nonlinear due to feedback effects, for instance.

In this talk some nonlinear Black-Scholes-type equations are discussed. The first model including the effect of transaction costs is a Black-Scholes equation with a volatility depending on the second derivatives of the solution. It has been derived by Barles and Soner in 1998. The equation is discretized using a higher order compact finite difference scheme and some numerical convergence results are given. The solutions are compared to those from the standard Black-Scholes model.

The second model describes the optimal value function in incomplete markets and has been derived by Leitner in 2001. It gives information on the transaction of shares the investor should make in order to maximise her or his profit. The market is allowed to possess non-tradable state variables like the employee income, weather parameter etc. Mathematically, the model is a parabolic equation with quadratic gradients. Existence and uniqueness results and numerical simulations are presented in order to show the influence of the nontradable state variables.

Ralf Forster *(FU Berlin)*

Fast and Reliable Pricing of American Options With Local Volatility

We consider the parabolic obstacle problem with variable coefficients appearing in the Black-Scholes equations with local volatility when evaluating American put options in mathematical finance. By suitable transformations we symmetrize the discretized problem to solve it by multigrid methods. Real-life data were used for the parameters and adapted carefully to the transformed problem. Finally we present numerical results to underline the convenience of this method within this setting.

Sebastian Quecke *(Köln)*
Pricing American Options using Quadrature

An efficient numerical method for pricing American-style options is presented. Starting from a discounted expectation approach we develop a flexible algorithm for option pricing. The computational complexity of the method is analyzed and error bounds are given. Adaptive quadrature and adaptive interpolation techniques allow to control accuracy. The resulting algorithm can be applied to fairly arbitrary market models and option types without considerable modifications. We present numerical results for several types of options under Lévy processes as example.

Erich W. Farkas *(ETH Zürich)*
Numerical Analysis for Lévy Copula Processes

We consider the valuation of derivative contracts on baskets where prices of single assets are Lévy like Feller processes of tempered stable type. The dependence among the marginals' jump structure is parametrized by a Lévy copula. For marginals of regular, exponential Lévy type in the sense of Boyarchenko and Levendorskii we show that the infinitesimal generator $\mathcal{A}$ of the resulting Lévy copula process is a pseudo-differential operator whose principal symbol is a distribution of anisotropic homogeneity.

We analyze the jump measure of the corresponding Lévy copula processes. We prove the domains of their infinitesimal generators $\mathcal{A}$ are certain anisotropic Sobolev spaces. In these spaces and for a large class of Lévy copulas, we prove a Garding inequality for $\mathcal{A}$.

We design a wavelet-based dimension-independent tensor product discretization for the efficient numerical solution of the parabolic Kolmogoroff equation $u_t + \mathcal{A}u = 0$ arising in valuation of derivative contracts under possibly stopped Lévy copula processes. We show that diagonal preconditioning yields bounded condition number of the resulting matrices.

Stanley Mathew *(Frankfurt)*
Amortizing Forward: An Alternative Contract For Hedging Currency Risk

With a classical forward contract investors protect their position against unfavorable developments of the currency in foreign exchange markets. In doing so, they are hedging market risk, while at the same time are – often regretted – giving up all chances of an enhanced performance should the market move in their favor. A contract that offers an opportunity to participate in the latter case is the Amortizing Forward introduced here. It provides the investor with a currency rate that protects his position, but enables a reduced liability.

The contract comprises an upper level K above which the notional amount is lowered (amortized) stepwise, and an upper barrier B, which terminates the Amortizing Forward entirely if triggered. An analytic solution is found for a simple case and it is demonstrated why for others only numerical methods can be considered. An unexpected result is exhibited by the fact that the barrier does not diminish but increase the value of the contract. This stands in contrast to the classical barrier-options, where the barrier is intended to reduce cost.

Christian Gründl *(Heidelberg)*
Computation of Credit Risk Using Sparse Grids

In den vergangenen 15 Jahren wurden fundierte Modelle zur Berechnung der Ausfallwahrscheinlichkeit einzelner Kreditkunden entwickelt. Anhand dieser Modelle wurden im Zuge des Internationalen Abkommens Basel II Richtlinien für die Eigenkapitalausstattung von Banken getroffen, die von bankinternen Ausfallwahrscheinlichkeiten abhängt.

Dabei werden heutzutage die meisten Berechnungen von korrelierten Ausfallwahrscheinlichkeiten mit Hilfe der Monte-Carlo Methode durchgeführt. In der Vergangenheit wurde gezeigt, dass man mit Hilfe stochastischer Differentialgleichungen Aufgabenstellungen der Optionspreis-Theorie modellieren kann. Diese Verfahren werden in dem Vortrag auf das Modell der Kreditrisikoberechnung übertragen. Einsatz findet hierbei ein Mehrgitter-Verfahren kombiniert mit der Technik der dünnen Gitter.

Markus Holtz *(Bonn)*

Valuation of Performance-Dependent Options using Sparse Grids

The efficient and accurate valuation of financial derivatives is a central topic in computational finance. Performance-dependent options are an important class of derivatives whose payoff depends on the performance of one asset in comparison to other assets. The fair price of such options can be determined by the martingale approach as a multidimensional integral whose dimension is the number of assets under consideration. Usually, the integrand is discontinuous, though, which makes accurate solutions difficult to achieve by numerical approaches.

For performance-dependent options, we derive a representation of the solution which only involves the evaluation of several multivariate normal distributions. This solution uses novel tools from computational geometry which faciliate the fast enumeration of all cells in a hyperplane arrangement and its orthant decomposition. We show that the arising normal distributions can be efficiently computed using sparse grid quadrature methods. This way, the complexity and the dimensionality of the integration problem can be significantly reduced which allows the efficient pricing of performance-dependent options even for large benchmarks, which is illustrated in several numerical examples.

Minisymposium 6

Positive Definite Functions and Applications

Leiter des Symposiums:

Prof. Dr. Zoltán Sasvári
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Positive definite functions play a central role in several areas of mathematical research. Among others, they appear as characteristic functions of probability distributions, as correlation functions, within the context of spectral theory and convolution algebras, or in connection with representation of groups, semigroups and hypergroups. Further on, a large variety of mathematical applications have been developed making use of positive definite functions and their properties.

The study of positive definite functions and their associated reproducing kernel Hilbert spaces lead to a better understanding of the relations between the theory of Hilbert spaces, representation theory, harmonic analysis, and special functions. On top of that, methods based on positive definite functions in applications rely on a better understanding of fundamental properties of these relations.

The aim of the symposium is to bring together scientists from different mathematical areas working on or using positive definite functions. Next to six survey lectures on central topics there will be research presentations from both, the theoretical perspective as well as the point of view of applications.

Montag, 18. September

HS II, Hauptgebäude, Regina-Pacis-Weg

15:00 – 15:50 **Heinz Langer** *(Wien)*
M.G.Krein's extension problem of positive definite functions

16:00 – 16:20 **Matthias Langer** *(Glasgow)*
Continuations of Hermitian indefinite functions and operator models for corresponding canonical systems

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16:30 – 16:50 **Klaus-Robert Müller** *(Berlin, Potsdam)*
Denoising and Dimension Reduction in Feature Space

17:00 – 17:50 **Bernhard Schölkopf** *(Tübingen)*
Applications of Kernel Methods

Dienstag, 19. September

Seminarraum 2, AVZ I, Endenicher Allee 11-13

15:00 – 15:50 **Herbert Heyer** *(Tübingen)*
Positiv- und negativ-definite Funktionen auf Hypergruppen und deren Dualräumen

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16:00 – 16:20 **Rupert Lasser** *(München)*
Positive definite sequences on polynomial hypergroups and the discrete part of their spectral measures

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16:30 – 16:50 **Martin Schlather** *(Hamburg)*
Fast and Exact Simulation of Large Gaussian Lattice Systems

17:00 – 17:50 **Tilmann Gneiting** *(Washington)*
Real-world applications of positive definite functions: A diptych

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Mittwoch, 20. September

Seminarraum 2, AVZ I, Endenicher Allee 11-13

15:00 – 15:50 **Christian Berg** *(Kopenhagen)*
Transformations of moment sequences, a fix-point-measure and its Mellin transform

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16:00 – 16:20 **Paul Ressel** *(Eichstätt-Ingolstadt)*
Positive definite functions and exchangeable random processes

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16:30 – 16:50 **Holger Wendland** *(Göttingen)*
Positive Definite Functions in Aeroelasticity: Towards Airbus's Preferred Solution

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17:00 – 17:50 **Robert Schaback** *(Göttingen)*
Kernel-based meshless methods for solving PDEs

Vortragsauszüge

Heinz Langer *(Wien)*
M.G.Krein's extension problem of positive definite functions

In the lecture a survey of the theory of extensions of positive definite functions (which M.G.Krein considered one of his most important contributions to analysis) and its applications to the inverse spectral problem and to the extrapolation problem of weakly stationary processes is given.

Matthias Langer *(Glasgow)*
Continuations of Hermitian indefinite functions and operator models for corresponding canonical systems

There is a close connection between the continuation problem of positive definite functions from a finite interval to the real axis and the inverse spectral problem for certain differential equations. In this talk this connection is discussed for a simple example of a function that has a negative square if the interval is large enough. In this case a singularity appears for the differential equation. Operator models in a Pontryagin space are presented for this situation.

Klaus-Robert Müller *(Berlin, Potsdam)*
Denoising and Dimension Reduction in Feature Space

joint work with

Mikio L. Braun, Fraunhofer FIRST.IDA, Berlin

Joachim Buhmann, Department of Computer Science, ETH Zürich

We prove that the relevant information about a classification problem in feature space is contained in a rather small number of leading kernel PCA components. This new theoretical insight means that kernels not only transform data sets such that they become ideally linearly separable in feature space. Rather kernelizing is done in a manner which makes economic use of feature space dimensions, i.e. well chosen kernels provide efficient representations of the data that are effective for classification. Thus our work provides another contribution for explaining why kernel-based learning methods work well. Practically we propose an algorithm which enables us to estimate the subspace and dimensionality relevant for good classification. Our algorithm can therefore be applied (1) to analyze the interplay of data set and kernel better, (2) to help in model selection, and to (3) de-noising in feature space in order to yield better classification results. Simulations underline these claims.

Bernhard Schölkopf *(Tübingen)*
Applications of Kernel Methods

The talk will first discuss positive definite kernels in machine learning and why they are currently rather popular. Time permitting, we will also present some applications, including problems of computer graphics (surface modeling and morphing).

Herbert Heyer *(Tübingen)*
Positiv- und negativ-definite Funktionen auf Hypergruppen und deren Dualräumen

Hypergruppen sind lokalkompakte Räume, für welche der Raum der beschränkten Masse bzgl. einer axiomatisch festgelegten Faltung zu einer Banachalgebra wird. Beispiele für Hypergruppen sind Doppelnebenklassenräume von Gelfand-Paaren. Obgleich

der Ausbau der harmonischen Analyse von Hypergruppen in Anlehnung an den Spezialfall lokalkompakter Gruppen vollzogen wird, ergeben sich bereits im Falle kommutativer Hypergruppen neue Fragestellungen, die nur mit zusätzlichem analytischen Aufwand bewältigt werden können. Beispielsweise verliert der mittels der Charaktere definierbare Dualraum im allgemeinen die Eigenschaft, wieder eine Hypergruppe zu sein, womit die Pontrjagin-Eigenschaft eine Rarität wird. Trotzdem möchte man auch auf diesem Dualraum positiv-und negativ-definite Funktionen erklären und mittels der Fouriertransformation Sätze vom Bochnerschen bzw. Schoenbergschen Typ beweisen sowie die aus der Wahrscheinlichkeitstheorie bekannten Themenkreise der unendlich teilbaren Verteilungen und ihrer Einbettung in stetige Faltungshalbgruppen auf Hypergruppen übertragen. Im Vortrag soll die Problematik des aus der Kategorie der Hypergruppen herausfallenden Dualraums im Mittelpunkt stehen und gezeigt werden, welchen Einschränkungen man ausgesetzt ist, wenn man Positiv-und Negativ-Definitheit und damit einen Teil der Darstellungstheorie für möglichst große Klassen von Hypergruppen zur Wirkung bringen möchte.

Rupert Lasser *(München)*

Positive definite sequences on polynomial hypergroups and the discrete part of their spectral measures

Given a positive definite bounded sequence $(d_n)_{n\geq 0}$ on a polynomial hypergroup, Bochner's theorem yields a bounded positive Borel measure on the dual space. We derive results describing when and how the discrete part of this measure can be determined completely from the sequence $(d_n)_{n\geq 0}$ by applying certain average processes. In that way we generalize results of Ky Fan and N. Wiener.

Martin Schlather *(Hamburg)*

Fast and Exact Simulation of Large Gaussian Lattice Systems

Joint work with Tilmann Gneiting, Yindeng Jiang, Donald B. Percival and Hana Ševčíková

The circulant embedding technique allows for the fast and exact simulation of stationary and intrinsically stationary Gaussian random fields. The method uses periodic embeddings and relies on the fast Fourier transform. However, exact simulations require that

the periodic embedding is nonnegative definite, which is frequently not the case for two-dimensional simulations.
Here we consider a suggestion by Michael Stein, who proposed nonnegative definite periodic embeddings based on suitably modified, compactly supported covariance functions. Theoretical support to this proposal and software for its implementation are presented.

Tilmann Gneiting *(Washington)*
Real-world applications of positive definite functions: A diptych

In this talk, I discuss two complementary applications of positive definite functions that address important real-world problems, yet are of mathematical interest by themselves. A major human desire is to make forecasts for an uncertain future. There are strong arguments, philosophically, scientifically and economically, that forecasts should be probabilistic in nature, taking the form of probability distributions over future events. Scoring rules assess the quality of probabilistic forecasts, by assigning a numerical score based on the forecast and on the event or value that materializes. An elegant construction originally proposed by Eaton uses positive definite functions to construct scoring rules that encourage the forecaster to make careful assessments and to be honest. We study a generalization that is based on conditionally negative definite functions and generates rich classes of proper scoring rules.
The second part of my talk considers geostatistical models for spatio-temporal data. We use classical results in harmonic analysis to construct novel classes of positive definite, nonseparable space-time covariance functions, and fit them to wind data from Ireland.

Christian Berg *(Kopenhagen)*
Transformations of moment sequences, a fix-point-measure and its Mellin transform

In recent papers A. Durán and the speaker studied some non-linear transformations from Hausdorff moment sequences (a_n) to Stieltjes moment sequences (s_n), namely

$$s_n = (a_0 a_1 \cdots a_n)^{-1}, \quad s_n = (a_0 + a_1 + \cdots + a_n)^{-1}.$$

This made it possible to unify different constructions from the theory of additive functionals of Lévy-processes. The 'sum' transformation has a fix-point (m_n) defined by the recursive equation

$$(m_0 + m_1 + \cdots + m_n)m_n = 1, \quad n \geq 0$$

i.e.

$$m_0 = 1, \quad m_1 = \frac{-1+\sqrt{5}}{2}, \quad m_2 = \frac{\sqrt{22+2\sqrt{5}}-\sqrt{5}-1}{4}, \ldots,$$

and (m_n) is the moment sequence of a probability measure μ on $[0,1]$. In a new manuscript we prove that μ has an increasing and convex density and that the Mellin transform F of μ

$$F(z) = \int_0^1 t^z \, d\mu(t),$$

can be characterized in analogy with the Bohr-Mollerup theorem about the Gamma function as the unique log-convex function $F :]-1, \infty[\to]0, \infty[$ satisfying $F(0) = 1$ and the functional equation

$$1/F(s) = 1/F(s+1) - F(s+1), \quad s > -1.$$

We also prove that F extends to a meromorphic function in the whole complex plane.

Paul Ressel *(Eichstätt-Ingolstadt)*
Positive definite functions and exchangeable random processes

There is an intimate connection betwen exchangeable random structures and harmonic analysis on semigroups, applying to classical theorems of de Finetti (and generalizations therof) as well as to much more recent results on exchangeable random orders and partitions. The short overview will be followed by some open problems in this area.

Holger Wendland *(Göttingen)*
Positive Definite Functions in Aeroelasticity: Towards Airbus's Preferred Solution

In fluid-structure interaction (FSI) the reciprocal action of a flexible structure with a flowing fluid, in which it is submersed or by which it is surrounded, is studied. Naturally, FSI has applications in many fields of engineering, such as the stability and response of aircrafts, the flow of blood through arteries, the vibration of turbine and compressor blades, and the response of bridges and tall buildings to winds.

In this talk, I will present an efficient scheme for loose coupling in fluid-structure-interaction problems as they typically appear in the context of aircraft design. This coupling scheme uses a multivariate scattered data interpolation approach, based on positive definite functions and partition of unity methods. It allows us to couple arbitrary meshes on fluid and structure side. It conserves virtual work and forces. It is designed for large scale problems and allows the coupling of entire aircraft meshes. Finally, it is currently implemented into MSC.Nastran to become Airbus's preferred solution in the field of Aeroelasticity.

Robert Schaback *(Göttingen)*

Kernel-based meshless methods for solving PDEs

This talk provides a framework to derive error bounds and convergence rates for certain unsymmetric meshless methods, including the technique started by E. Kansa in 1986 and the Meshless Local Petrov Galerkin method (MLPG) of S.N. Atluri and collaborators, dating back to 1998. It consists of four essential ingredients:

(1) continuous dependence of the solution of the analytic problem on the data,
(2) a space of *trial* functions allowing a reasonably good approximation to functions in the regularity class of the solution,
(3) a weak or strong *testing* strategy with a certain stability property with respect to the trial space,
(4) a numerical solution of an overdetermined unsymmetric linear system within a certain tolerance.

The theory is not constrained to elliptic problems. It will be shown how to apply the framework for special situations where meshless translates of *kernels* are used as trial functions. In case of weak problems, meshless translates of kernels occur also as test functions, while the test side of strong problems is handled by collocation. Thus our framework covers methods in strong and weak form. In the weak case it allows distributional data, providing error bounds in negative Sobolev norms.

Minisymposium 7

Stochastic algorithms and Markov processes

Leiter des Symposiums:

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Institut für Mathematische Statistik
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Markov chain Monte Carlo methods, sequential Monte Carlo methods, and other related stochastic algorithms have become widely used tools in many application fields of mathematics. Despite their massive use, the theoretical understanding of convergence properties of these algorithms is often rather rudimentary. This is in particular the case in high dimensional models that typically arise in many applications. Whereas formerly, research has often been carried out more or less independently in probability theory, stochastic analysis, and statistical mechanics on the one side, and theoretical computer science, discrete mathematics, and numerical analysis on the other side, recently there is a rapidly growing activity at the borderline of the different disciplines. Besides classical probabilistic techniques (*e.g.* martingale methods), concepts from statistical mechanics (phase transitions, critical slowing down), and techniques from stochastic analysis (decay to equilibrium of Markov processes, spectral gap estimates) as well as infinite dimensional analysis (*e.g.* logarithmic Sobolev inequalities) have become crucial.

Montag, 18. September

HS XV, Hauptgebäude, Regina-Pacis-Weg

14:30 – 15:30 **Olle Häggström** *(Göteborg)*

15:30 – 16:00 **Nikolaus Schweizer** *(Bonn)*
Local spectral gaps on the mean field Ising model and Multilevel MCMC methods

16:00 – 16:30 **Emilio de Santis** *(Roma)*
Exact sampling for discrete time spin systems and unilateral fields

16:30 – 17:00 *break*

17:00 – 18:00 **Pierre del Moral** *(Nice)*
Coalescent tree based functional representations for some Feynman-Kac particle models

18:00 – 18:30 **Andreas Eberle** *(Bonn)*
Convergence of sequential MCMC methods I

18:30 – 19:00 **Carlo Marinelli** *(Bonn)*
Convergence of sequential MCMC methods II

Dienstag, 19. September

Großer Hörsaal, Mathematisches Institut, Wegelerstr. 10

14:30 – 15:30 **Dan Crisan** *(Imperial College London)*
Solving the filtering problem in a continuous time framework. Advantages and pitfalls

15:30 – 16:00 **Wilhelm Stannat** *(Darmstadt)*
On stability of the optimal filter

16:00 – 16:30 **Samy Tindel** *(Nancy)*
A model of Brownian directed polymer in a Gaussian random environment

16:30 – 17:00 *break*

17:00 – 18:00 **Mark Jerrum** *(Edinburgh)*
Tight bounds on mixing time of Markov chains

18:00 – 19:00 **Marek Karpinski** *(Bonn)*
Metric construction for path coupling, rapid mixing, and approximate counting

Mittwoch, 20. September

Großer Hörsaal, Mathematisches Institut, Wegelerstr. 10

14:30 – 15:30 **Wilfrid S. Kendall** *(Warwick)*
Perfect simulation: a survey and recent developments

15:30 – 16:30 **Marie-Colette van Lieshout** *(Amsterdam)*
Perfect simulation for length-interacting polygonal Markov fields in the plane

16:30 – 17:00 *break*

17:00 – 18:00 **Rudolf Grübel** *(Hannover)*
Markov chains in the analysis of algorithms

18:00 – 18:30 **Ralph Neininger** *(Frankfurt))*
The size of random fragmentation trees

Vortragsauszüge

Olle Häggström *(Göteborg)*
Problem solving is often a matter of cooking up an appropriate Markov chain

By means of a series of examples, taken from classic contributions to probability theory as well as from my own practice, I will try to convince the audience of the claim made in the title of the talk. Along the way, I will have reason to discuss topics such as coupling, correlation inequalities, and percolation.

Nikolaus Schweizer *(Bonn)*
Local spectral gaps on the mean field Ising model and Multilevel MCMC methods

I consider the Metropolis Markov Chain based on the nearest neighbor random walk on the positive half of the Mean Field Ising Model, i.e., on those vectors from $\{-1,1\}^N$ which contain more 1 than -1. Using randomly-chosen paths I prove a lower bound for the Spectral Gap of this chain which is of order N^{-2} and which does not depend on the inverse temperature β.

In conjunction with decomposition results such as those in Jerrum, Son, Tetali and Vigoda (2004) this result may be useful for bounding the spectral gaps of more complex Markov chains on the Mean Field Ising Model which may be decomposed into Metropolis chains. As an example, I apply the result to two Multilevel Markov Chain Monte Carlo algorithms, Swapping and Simulated Tempering. Improving a result by Madras and Zheng (2002), I show that the spectral gaps of both algorithms on the (full) Mean Field Ising Model are bounded below by the reciprocal of a polynomial in the lattice size N and in the inverse temperature β.

Emilio de Santis *(Roma)*
Exact sampling for discrete time spin systems and unilateral fields

We present a generalization of the technique of Häggström and Steif (2000) for the exact simulation of finite sections of infinite-volume Gibbs random fields. The main role is played by an auxiliary binary field, which indicates the sampling region. Percolation bounds can be used to prove that the algorithm terminates almost surely. In the simplest

case this field is Bernoulli; however a new blocking technique can be used that destroy the independence property but extend the validity of the algorithm. A connection with stationary unilateral fields in the plane, considered by Pickard (1980) and Galbraith and Walley (1982), is discussed.

Pierre del Moral *(Nice)*
Coalescent tree based functional representations for some Feynman-Kac particle models

We present tree based functional representations of a class of Feynman-Kac particle distributions, including an extension of the Wick product formula for interacting particle systems on coalescent forests. These weak expansions rely on an original combinatorial, and permutation group analysis on a special class of coalescent, and colored forests. We also show that these polynomial type representations provide non asymptotic and sharp propagation of chaos type properties, as well as sharp L^p-mean error bounds, and laws of large numbers for U-statistics.

Andreas Eberle *(Bonn)*
Convergence of sequential MCMC methods I

We study convergence properties of a class of stochastic algorithms for Monte Carlo integral estimation w.r.t. probability distributions, which combine elements of Markov chain Monte Carlo methods and importance sampling/ resampling schemes. We develop an analysis by funtional inequalities for an associated nonlinear flow of probability measures. This allows us to prove that the combined methods are sometimes converging rapidly in multimodal setups where traditional MCMC methods mix extremely slowly. For example, we can prove rapid convergence in the mean field Ising model at all temperatures.

Carlo Marinelli *(Bonn)*
Convergence of sequential MCMC methods II

We study convergence properties of a class of stochastic algorithms for Monte Carlo integral estimation w.r.t. probability distributions, which combine elements of Markov chain Monte Carlo methods and importance sampling/ resampling schemes. We develop an analysis by funtional inequalities for an associated nonlinear flow of probability measures. This allows us to prove that the combined methods are sometimes converging rapidly in multimodal setups where traditional MCMC methods mix extremely slowly. For example, we can prove rapid convergence in the mean field Ising model at all temperatures.

Dan Crisan *(Imperial College London)*
Solving the filtering problem in a continuous time framework. Advantages and pitfalls

Particle filters have enjoyed a period of fast development in the last fifteen years both from the theoretical and from the applicative viewpoint. For many filtering problems, a natural mathematical model for the signal is a continuous time Markov process that satisfies a stochastic diferential equation of the form

$$dx_t = f(x_t)\,dt + \sigma(x_t)\,dv_t, \tag{1}$$

where v is a Wiener process whilst the observation is modelled by an evolution equation of the form

$$dy_t = h(x_t)\,dt + dw_t.$$

where w is a Wiener process independent of v.
Within the continuous time framework, $\pi = \{\pi_t, t \geq 0\}$ the conditional distribution of the signal x_t given the observation data $\{y_s, s \in [0,T]\}$ is the solution of a nonlinear stochastic PDE, called the Kushner-Stratonovitch with no explicit solution in the general case. For a suitable class of functions φ, $\pi_t(\varphi)$ can be viewed as the expected value of a certain functional *parametrized* by the observation path $\{y_s, s \in [0,T]\}$ of a process ξ which is a solution of (1). In other words, we seek to obtain something akin to what in the theory of approximation for stochastic differential equations is called a *weak solution* of (1).
This fundamental observation leads to approximating algorithms for the filtering problem obtained by adapting existing weak approximations of SDEs to the filtering framework. Firstly, one approximates π by replacing the (continuous) observation path

with a discrete version. The standard method is to choose an equidistant partition $\{i\delta,\, i = 0, 1, ...\}$ of the timeline and consider only the observation data $\{y_{i\delta},\, i = 0, 1, ...\}$ corresponding to the partition time instances. The resulting probability measure π^δ converges to π as δ tends to 0. We present a number of convergence results regarding for approximations of π^δ.

Wilhelm Stannat *(Darmstadt)*

On stability of the optimal filter

Estimating a Markovian signal process observed with independent noise has many important applications not only in engineering sciences. The optimal estimate of the signal depends, of course, on the one hand on the observations but on the other hand also on the initial state of the signal. Since the signal is not observed directly, its initial state, however, is unknown. It is therefore our interest to understand the dependence of the optimal filter w.r.t. the initial state. In our talk we show how a variational approach can be used to understand this dependence and how to obtain explicit a priori lower bounds of variational type on the rate of stability. Our results are helpful for the design of efficient measurements. We will also have a closer look at a particular class of signal processes with multiplicative noise arising in the theory of software reliability.

Samy Tindel *(Nancy)*

A model of Brownian directed polymer in a Gaussian random environment

In this talk, we will study a Gibbs measure based on a model of Brownian directed polymer in a Gaussian random medium. This model is a continuous analog of some models of discrete random walks in a iid Gaussian potential, and is mainly parametrized by the spatial covariance Q of the random environment. Our hope is that the high number of methods at hand in this case (Brownian scaling, Malliavin calculus, Gaussian tools, analogy with Lyapounov exponents for SPDEs) will allow us to give a rather complete description of the Gibbs measure under consideration, and we will present here some estimates on the partition function of the model, as well as a lower bound on the growth of the polymer.

Mark Jerrum *(Edinburgh)*
Tight bounds on mixing time of Markov chains

The mixing time of a Markov chain is the time taken, starting from a fixed initial state, for it to converge to near-stationarity. Convergence is usually measured in terms of total variation distance. Good upper bounds on mixing time are required in the analysis of many randomised algorithms. Tight bounds are hard to come by, though it is well known that coupling arguments can sometimes yield results. This talk will concentrate on lesser known techniques, such as harmonic analysis or logarithmic Sobolev inequalities.

Marek Karpinski *(Bonn)*
Metric construction for path coupling, rapid mixing, and approximate counting

Coupling techniques have a long history in the theory of Markov chains, and can be used to obtain quantitative estimates of their convergence times, and rapid mixing. Good coupling are usually difficult to design, but path coupling has recently proved a very useful technique for constructing and analysing them. The basic idea here is to restrict the design of the coupling to pairs of states which are close in some suitable metric on the state space. We prove a general theorem for path coupling using stopping times based on a particular construction of metric which enables us to work with the standard one-step path coupling. We apply this result to design efficient approximation algorithms for several hard counting problems, like counting hypergraph independent sets and colorings.

Joint work with M. Bordewich and M. Dyer.

Wilfrid S. Kendall *(Warwick)*
Perfect simulation: a survey and recent developments

The technique of *exact* or *perfect simulation* was introduced in the celebrated paper of Propp and Wilson (1996), which showed how in favourable cases one might improve Markov chain Monte Carlo algorithms so as to deliver exact draws from statistical equilibrium. Since then the technique has seen much theoretical and practical development.

This talk will review ideas of perfect simulation and present an update to the survey of Kendall (2005). In particular I will discuss general results which show how one might carry out perfect simulation *in principle* (if not in practice) for general geometrically ergodic Markov chains and some generalizations.

Joint work with Stephen Connor.

References:

W. S. Kendall (2005), "Notes on Perfect Simulation" in *Markov chain Monte Carlo: Innovations and Applications* (edited by W. S. Kendall, F. Liang, J.-S. Wang); (2005) pp 93-146.

J. G. Propp and D. B. Wilson (1996), "Exact sampling with coupled Markov chains and applications to statistical mechanics", *Random Structures and Algorithms*, 9, 223-252.

Marie-Colette van Lieshout *(Amsterdam)*

Perfect simulation for length-interacting polygonal Markov fields in the plane

We construct perfect samplers for length-interacting Arak-Clifford-Surgailis polygonal Markov fields in the plane. This is achieved by providing for the polygonal fields a hard-core-interacting marked point process representation with individual points carrying polygonal loops as their marks. This enables us to use the general framework and software of (Van Lieshout and Stoica, 2006), in particular their generalised coupling-from-the-past (Kendall, 1998) and clan of ancestors (Fernandez et al, 2002) routines for our particular purposes.

Rudolf Grübel *(Hannover)*

Markov chains in the analysis of algorithms

The classical approach to the analysis of randomized algorithms or deterministic algorithms with random input concentrated on the average case behaviour, i.e. on the expectation EX_n of some random variable X_n that represents the complexity or running time of the algorithm as a function of the input size n. In the last 15-20 years considerable progress has been made in the analysis of the full distribution of X_n, and many limit results as $n \to \infty$ have been obtained for a variety of standard algorithms. In this context, Markov chains play an important role. We give several examples and discuss the general methodology.

Ralph Neininger *(Frankfurt)*

The size of random fragmentation trees

Random trees generated by a class of random fragmentation procedures are discussed with respect to their size. These trees are motivated by corresponding search trees that are frequently used in Computer Science as data structures where size corresponds to the memory needed to store the tree.
We show that the size of these trees, after normalization, is asymptotically normal for a wide class of such fragmentation procedures whereas for other fragmentation procedures we characterize their periodic behavior.

This talk is based on joint work with Svante Janson.

Minisymposium 8

Homogenisierung und Anwendungen

Leiterin des Symposiums:

Dr. Maria Neuss-Radu
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Die Homogenisierung ist eine Methode aus dem Bereich der asymptotischen Analysis welche erfolgreich bei der Untersuchung von Mehrskalenproblemen und den dabei auftretenden Skalenübergängen eingesetzt werden kann. Dabei handelt es sich um Prozesse, welche durch partielle Differentialgleichungen beschrieben werden können.

Die in diesem Zusammenhang auftretenden Fragestellungen sind:

- Kann man ein komplexes mikroskopisches Problem durch ein numerisch behandelbares, makroskopisches approximieren? Wie groß ist der dabei entstehende Fehler?
- Können vorhandene phänomenologisch hergeleitete, makroskopische Gesetze validiert werden, indem sie aus mikroskopischen Gesetzen mittels einer asymptotischen Analyse hergeleitet werden? Dabei kann die unterliegende mikroskopische Struktur periodischer oder stochastischer Natur sein.

Im Rahmen des Minisymposiums befassen wir uns mit Modellen, welche physikalische und chemische Prozesse in porösen Medien, biologischen Geweben, Verbundwerkstoffen und Netzwerken beschreiben.

Donnerstag, 21. September

Hörsaal 311 AVZ I, Endenicher Allee 11-13

15:00 – 15:50 **Andro Mikelić** *(Lyon)*
Rigorous upscaling of the reactive flow through a pore, under dominant Peclet and Damkohler numbers

16:00 – 16:50 **Ben Schweizer** *(Basel)*
Averaging of flows with capillary hysteresis in stochastic porous media

17:00 – 17:25 **Michael Lenzinger** *(Basel)*
Viscous fluid flow in bifurcating pipes

17:30 – 17:55 **Kasten Matthies** *(Bath)*
Exponential homogenization of periodic linear problems

Freitag, 22. September

Hörsaal 311 AVZ I, Endenicher Allee 11-13

15:00 – 15:25 **Dirk Hartmann** *(Heidelberg)*
From Discrete to Continuum Models in Mechanobiology

15:30 – 15:55 **Nicolas Neuss** *(Kiel)*
Multi-scale simulation of diffusion and absorption in chloroplasts

16:00 – 16:25 **Mariya Ptashnyk** *(Heidelberg)*
Derivation of a macroscopic receptor-based model using homogenization techniques

16:30 – 16:55 **Christof Eck** *(Erlangen)*
Homogenization for Phase Transitions with Microstructures

17:00 – 17:25 **Julia Orlik** *(Kaiserslautern)*
Homogenization of Strength, Fatigue and Creep Durability of Composites with Near Periodic Structure

17:30 – 17:55 **Malte Peter** *(Bremen)*
Homogenisation of chemical degradation mechanisms inducing the evolution of the microstructure of the porous media

Vortragsauszüge

Andro Mikelić *(Lyon)*
Rigorous upscaling of the reactive flow through a pore, under dominant Peclet and Damkohler numbers

In this talk we present a rigorous derivation of the effective model for enhanced diffusion through a narrow and long 2D pore. The analysis uses a singular perturbation technique. Starting point is a local pore scale model describing the transport by convection and diffusion of a reactive solute. The solute particles undergo a first order reaction at the pore surface. The transport and reaction parameters are such that we have large, dominant Peclet and Damkohler numbers with respect to the ratio of characteristic transversal and longitudinal lengths (the small parameter epsilon). We give a rigorous mathematical justification of the effective behaviour for small epsilon. Error estimates are presented in the energy norm as well as in L-infinity and L-1 norms of the space variable. They guarantee the validity of the upscaled model. As a special case, we recover the well-known Taylor dispersion formula. It is important to note presence of both chemical reactions and dispersion effects in the upscaled coefficients. Under dominant Peclet and Damkohler numbers, hydrodynamics and chemistry effects are strongly coupled.

Ben Schweizer *(Basel)*
Averaging of flows with capillary hysteresis in stochastic porous media

The fluid in an unsaturated porous medium is described by Darcy's law. Conservation of mass provides an evolution equation that couples the pressure p and the saturation u. A second relation between p and u is determined by the effects of capillarity. In general, the capillary pressure is a set-valued map and the second relation is of the form $p \in p_c(u, \partial_t u)$. The multi-valued function p_c leads to hysteresis effects of play-type.

We construct weak and strong solutions to the hysteresis system and homogenize it for random distributions of the physical parameters. In the effective equations a new variable with the units of a pressure appears. This new variable encodes the history of the process. The averaged equations have irreversible scanning curves and reflect the properties of the physical system.

Michael Lenzinger *(Basel)*
Viscous fluid flow in bifurcating pipes

We consider the flow of a viscous Newtonian fluid in a bifurcation of thin three-dimensional pipes with a diameter-to-length ratio of order $O(\epsilon)$. The model is based on the steady-state Navier-Stokes equations with pressure conditions on the outflow boundaries. Our aim is to construct an asymptotic expansion in powers of the diameter ϵ and a Reynolds number Re_ϵ, representing the assumption of small data. This approximation is based on Poiseuille flow in the pipes which is matched to the solution of a local Stokes problem in the junction. In this way we are able to include the influence of the bifurcation geometry on the fluid flow. We show that the solution of the junction problem decays exponentially to Poiseuille flow in the pipes and derive error estimates in powers of ϵ and Re_ϵ. The obtained results generalize and improve the existing ones in literature. In particular, our results show that Kirchhoff's law of the balancing fluxes has to be corrected in $O(\epsilon)$ in order to obtain an adequate error estimate for the gradient of velocity.

Karsten Matthies *(Bath)*
Exponential homogenization of periodic linear problems

The homogenisation of a divergence type second order uniformly elliptic operator is considered with arbitrary L^∞ rapidly oscillating periodic coefficients, either with periodic boundary conditions or in the whole space. We show that if the right-hand side is analytic then by optimally truncating the full two-scale asymptotic expansion for the solution one obtains an approximation with an exponentially small error in the period of the rapid oscillation. The optimality of the exponential error bound is established for a one-dimensional example by giving the analogous lower bound.

Dirk Hartmann *(Heidelberg)*

From Discrete to Continuum Models in Mechanobiology

In the last years, mechanobiology has drawn a lot of attention in the physical sciences from an experimental and theoretical viewpoint. Systems are investigated on different scales ranging from single molecules up to whole organisms.

One central problem in mechanobiology is the derivation of appropriate constitutive relations for continuous models, which should account for such different effects as growth in cell cultures or active contraction of polymer-fibres in migrating cells. Many systems can be described relative easily with discrete models on a microscopic scale, e.g. single cells in cell cultures or polymer fibres in cells. Whereas continuous macroscopic descriptions are usually less straight forward.

As constitutive relations are usually given in terms of free energies, Γ-convergence is the ideal framework for rigorously bridging the gap between discrete microscopic and continuous macroscopic models. For simple cases also homogenisation formulas can be applied, which allow an explicit calculation of the involved stress tensors. As examples, the mechanics of growing cell cultures and actively moving cells (Keratocytes) will be discussed.

Nicolas Neuss *(Kiel)*

Multi-scale simulation of diffusion and absorption in chloroplasts

We construct a microscopic model for diffusion of proteins in the interior of chloroplasts which can be considered as a complex heterogeneous medium. Under the assumption of periodic heterogeneities, we derive a homogenised model for this process and prove estimates of the approximation error. We then verify the validity of the model numerically, and see that it is a good approximation even for non-periodic settings. Finally, we discuss the possibility of using the approximation for the construction of multiscale preconditioners.

Mariya Ptashnyk *(Heidelberg)*
Derivation of a macroscopic receptor-based model using homogenization techniques

The aim of this work is to derive a macroscopic model describing receptor-ligand binding from the microscopic description using the methods of asymptotic analysis. We study the problem of diffusive transport of biomolecules in the intercellular space, modeled as porous medium, and of their binding to the receptors located on the surface membranes of the cells. Cells are distributed periodically in a bounded domain. To describe this process we introduce a reaction-diffusion equation coupled with nonlinear ordinary differential equations on the boundary (on the cells surface). The existence and uniqueness of the solution of this problem is proved. We consider the limit, when the number of cells tends to infinity and at the same time their size tends to zero, while the volume fraction of the cells remains fixed. Using the two-scale convergence, we show that the sequence of solutions of the original problem converges to the solution of the so called macroscopic problem. To show the convergence of the nonlinear terms on the surfaces we use the periodic modulation (unfolding method).

Christof Eck *(Erlangen)*
Homogenization for Phase Transitions with Microstructures

Many phase transition processes exhibit microstructures of various types, important examples are dendritic and eutectic microstructures in the solidification of metallic alloys or microstructures in epitaxial growth processes of semiconductors. These microstructures are not given a priori, their computation is part of the solution process for the problems. Homogenization of such processes therefore does not lead to a purely macroscopic model, but to a two- or multiscale model that combines different models for the different relevant length scales. The derivation and analysis of such models is described for applications in solidification and epitaxial growth. The models are justified by an estimate for the model error. The numerical implementation of the models is briefly discussed and examples of numerical simulations are presented.

Julia Orlik *(Kaiserslautern)*
Homogenization of Strength, Fatigue and Creep Durability of Composites with Near Periodic Structure

The composite macro-strength and -durability is estimated using the approximation to the micro-stress field, known from the asymptotic theory of homogenization, and presented in terms of a non-local strength and durability condition. The macro-strength and -durability functional over the homogenized stress-field is determined by micro-geometry, elastic and strength properties of the periodicity cell. The uniform in time convergence of the micro- to the macro-strength and -durability condition is also proved based on the two-scale convergence of the micro-stresses to their first approximation. The approach is applicable to the durability description at fatigue, creep, impact loading and their combination.

Reference:

J. Orlik, Homogenization of strength, fatigue and creep durability of composites with near periodic structure, Mathematical Models and Methods in Applied Sciences, Vol. 15, No. 9(15), pp. 1329-1347, 2005.

Malte Peter *(Bremen)*
Homogenisation of chemical degradation mechanisms inducing the evolution of the microstructure of the porous media

Chemical degradation mechanisms of porous materials often induce a change of the pore geometry. A typical situation is when the reaction products take up more volume than the reactants. This effect cannot be captured by the standard periodic homogenisation method due to the local evolution of the microscopic domain. Using elements of two-scale convergence and periodic unfolding, a mathematically rigorous approach is suggested which allows the treatment of such problems. In particular, it makes use of a transformation to a stationary (periodic) reference domain on which the homogenisation can be performed. A physical interpretation also allows the direct modelling of the transformed problem. This is performed for the particular problem of concrete carbonation. It is shown that the resulting system of coupled semi-linear and quasi-linear parabolic pdes is well-posed and a-priori estimates are obtained allowing its homogenisation.

Minisymposium 9

Nichtlineare Evolutionsgleichungen und Probleme mit freiem Rand

Leiter des Symposiums:

Prof. Dr. Günther Grün
Universität Erlangen-Nürnberg
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PD Dr. Michael Winkler
Universität zu Köln

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Zahlreiche Phänomene in Natur- und Ingenieurwissenschaften lassen sich mathematisch durch Probleme mit freiem Rand oder nichtlineare Evolutionsgleichungen beschreiben.

Daraus ergeben sich vielfältige mathematische Fragestellungen. Sie reichen von Existenzaussagen für Lösungen über Regularitätsaussagen freier Ränder bis hin zu Untersuchungen zur Zeitasymptotik.

In diesem Mini-Symposium sollen neueste Resultate aus Analysis und Numerik vorgestellt werden. Im Mittelpunkt sollen dabei Ergebnisse stehen, die für die Anwendungsgebiete

- Mehrphasenströmung,
- Verbrennungsvorgänge,
- Reaktions-Diffusions-Gleichungen in Biologie und Chemie,
- Strukturbildung in Festkörpern

relevant sind.

Dienstag, 19. September

Seminarraum 1 (Raum 205), Institut für Physikalische und Theoretische Chemie
Wegelerstr. 12

15:00 – 15:50 **Lorenzo Giacomelli** *(Rom)*
A non-local degenerate parabolic system arising from strain-gradient plasticity

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16:00 – 16:50 **Matthias Röger** *(Eindhoven)*
Sharp and diffuse interface models in phase transitions

17:00 – 17:20 **Nicolas Dirr** *(MPI Leipzig)*
Nonlinear PDEs with noise

17:30 – 17:50 **Tobias Weth** *(Giessen)*
Existence and asymptotic shape of solutions to a nonlinear Schrödinger system

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18:00 – 18:20 **Kianhwa C. Djie** *(Aachen)*
An Upper Bound for the Waiting Time for Doubly Nonlinear Parabolic Equations

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Mittwoch, 20. September

Seminarraum 1 (Raum 205), Institut für Physikalische und Theoretische Chemie
Wegelerstr. 12

15:00 – 15:50 **Joost Hulshof** *(Amsterdam)*
A free boundary problem for combustion with radiative effects

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16:00 – 16:50 **Ben Schweizer** *(Basel)*
Homogenization of degenerate two-phase flow equations with a free boundary approach

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17:00 – 17:20 **Dirk Horstmann** *(Köln)*
Analysis of some Lotka-Volterra competition model in the presence of cross-diffusion

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17:30 – 17:50 **Adrian Muntean** *(Bremen)*
Mathematical issues concerning evolving sharp-reaction interfaces in unsaturated reactive porous materials: global well-posedness of a moving-boundary system with a kinetic condition

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Vortragsauszüge

Lorenzo Giacomelli *(Rom)*
A non-local degenerate parabolic system arising from strain-gradient plasticity

Size effects which metals display at micron length-scales are typically described by strain-gradient dependent theories, one of which has been recently proposed by Gurtin (J. Mech. Phys. Solids, 2004): it is characterized by a free energy which depends on the density of dislocations through the Burgers tensor (the curl of the plastic displacement gradient) and which is dissipated through the plastic spin (the time derivative of the skew part of the plastic displacement gradient). Under suitable symmetry assumptions, this model leads to a non-local and degenerate parabolic system complemented with mixed boundary conditions.

I will describe the gradient flow structure of the problem and how it leads to the existence and uniqueness of solutions, as follows from a joint work with Michiel Bertsch (IAC-CNR and U. Rome “Tor Vergata”), Roberta Dal Passo and Giuseppe Tomassetti (U. Rome “Tor Vergata”). I will also discuss heuristics and open questions related both to the presence of interfaces –the boundaries of dislocation-free regions– and to two singular limits: the first one, as the ratio between the microscopic length-scale associated with the Burgers tensor and the macroscopic size of the sample vanishes, is expected to produce boundary layer effects; the second one, as the model approaches a rate-independent formulation, brings out a prototype for (possibly non-local) “infinity-curl^{2}öperators and their evolution.

Matthias Röger *(Eindhoven)*
Sharp and diffuse interface models in phase transitions

We report on recent advances in some sharp and diffuse interface models for phase transitions. In particular we study the Gamma-convergence of functionals arising in the Van der Waals-Cahn-Hilliard theory. The corresponding limit functional is given as the sum of the area and the Willmore functional. This problem was proposed as modification of a conjecture of De Giorgi.

Nicolas Dirr *(MPI Leipzig)*
Nonlinear PDEs with noise

The qualitative and quantitative analysis of solutions of nonlinear partial differential equations has proven to be a valuable tool in describing the behavior of complex materials. However in many situations the influence of thermal fluctuations cannot be neglected, in particular if the system is near an unstable equlibrium, or the long-time behavior is of interest. This leads to a perturbation of the nonlinear evolution equation by noise. We give examples where the highest order part of the PDE is not linear. Then analysis needs a combination of tools from the theory of nonlinear PDEs and from probability theory.

Tobias Weth *(Giessen)*
Existence and asymptotic shape of solutions to a nonlinear Schrödinger system

We consider the two coupled Schrödinger equations

$$-\Delta u + u = u3 + \beta v2u, \qquad -\Delta v + v = v3 + \beta u2v$$

with coupling parameter $\beta \in \mathbb{R}$. Of physical interest are bound states, i.e., positive solutions defined on the whole space and decaying exponentially at infinity. While for $\beta > 0$ all bound states are known to be radial, we show the existence of infinitely many nonradial solutions (with prescribed symmetries) in the repulsive case $\beta < -1$ in dimensions $N = 2, 3$. For the corresponding homogeneous Dirichlet problem in a ball, we also study the asymptotic shape of radial solutions in the segregation limit $\beta \to -\infty$. This is joint work with Juncheng Wei.

Kianhwa C. Djie *(Aachen)*
An Upper Bound for the Waiting Time for Doubly Nonlinear Parabolic Equations

There is a wide class of equations with the property that their solutions exhibit a waiting time phenomenon, i. e. they have a strict positive waiting time in the following sense: Let $\Omega := \mathrm{supp}(u_0) \subset \mathbb{R}^N$. Then

$$t^\star_\Omega := \sup\{t \geq 0 \mid u(x,\tau) = 0 \text{ for all } x \in \mathbb{R}^N \setminus \Omega \text{ and } \tau \in [0,t]\}$$

is called the *waiting time* for u.
We will sketch the proof for a quantitative upper bound for the waiting time for weak solutions of the doubly nonlinear parabolic equation

$$\begin{cases} (|u|^{q-2}u)_t - \operatorname{div}(|\nabla u|^{p-2}\nabla u) &= 0 & \text{in } \mathbb{R}^N \times [0,\infty)\ , \\ u(x,0) &= u_0(x) & \text{for all } x \in \mathbb{R}^N\ , \end{cases}$$

with parameters $p \geq 2,\ 1 < q < p$ depending on the growth of the initial value u_0 near $x_0 \in \partial\Omega$. This upper bound coincides (apart from a constant factor) with the lower bound given by Giacomelli-Grün [Interfaces Free Bound. **8** No. 1 $(2006),\ 111$–129]. The technique is inspired by Chipot-Sideris [Trans. Am. Math. Soc. **288** $(1985),\ 423$–427].

Joost Hulshof *(Amsterdam)*
A free boundary problem for combustion with radiative effects

Adding radiative effects to the standard thermo-diffusive model for combustion in gaseous mixtures leads to non-trivial bifurcation diagrams for travelling wave solutions and radial flame ball solutions if one varies the parameters. I plan to concentrate my talk on the changes of stability in these diagrams.

Ben Schweizer *(Basel)*
Homogenization of degenerate two-phase flow equations with a free boundary approach

We consider the one-dimensional degenerate two-phase flow equations as a model for water-drive in oil recovery. The effect of oil trapping is observed in strongly heterogeneous materials with large variations in the permeabilities and in the capillary pressure curves. In such materials, a vanishing oil saturation may appear at interior interfaces and inhibit the oil recovery. We introduce a free boundary problem that separates a critical region with vanishing permeabilities from a strictly parabolic region and give a rigorous derivation of the effective conservation law.

Dirk Horstmann *(Köln)*

Analysis of some Lotka-Volterra competition model in the presence of cross-diffusion

In this talk we analyze the effect of cross-diffusion terms on some Lotka-Volterra models. Some aspects that will be discussed is the existence and the nonexistence of nontrivial steady state solution. Furthermore, we will look for traveling wave solutions for some explicit systems. In particular, we will analyze the following cross-diffusion system:

$$\begin{aligned} u_t &= \Delta u + e\Delta v + u^p(1-u-cv) \\ v_t &= d\Delta v + f\Delta u + v^q(a-bu-v) \end{aligned}$$

We will establish some existence results for traveling wave solutions of this system and we will analyze their stability properties.

Adrian Muntean *(Bremen)*

Mathematical issues concerning evolving sharp-reaction interfaces in unsaturated reactive porous materials: global well-posedness of a moving-boundary system with a kinetic condition

A variety of reaction-diffusion scenarios taking place in unsaturated reactive porous materials involve the formation and propagation of moving-sharp interfaces, where fast chemical reactions are assumed to happen. When spatially separated reactants meet, the separation boundary may be assumed as sharp provided that the characteristic time scale of reaction is much smaller than that of transport. We illustrate this situation by means of a non-equilibrium one-dimensional moving-boundary system with a kinetic condition modeling the driving force. We employ this formulatoion in order to study the evolution of the carbonation reaction in concrete-based materials. The model relies on the idea that carbonation might be considered to be localized on a sharp interface. It consists of a set of semi-linear mass-balance equations coupled with a non-linear ordinary differential equation, which accounts for the motion of the interface. We refer to this differential equation driving the sharp-reaction interface into the material as the *kinetic (non-equilibrium) condition*. The model equations are non-linearly coupled by the *a priori* unknown position of the moving-reaction interface and non-linearities in the production terms. We show that if the model parameters are selected such that

local strict positive weak solutions to our model exist, then the kinetic condition can be suitably used to extend these local solutions globally in time. Finally, we present numerical predictions of penetration depths and show expected qualitative behaviors and feasibility of both the model and numerical approach. This is joint work with Michael Böhm (University of Bremen) supported by the DFG through the special priority program SPP 1122 *Prediction of the Course of Physicochemical Damage Processes involving Mineral Materials*.

Minisymposium 10

The use of proof theory in mathematics

Leiter des Symposiums:

PD Dr. Peter Schuster
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The objective is to present the developments that are taking place in the fields of proof mining, exhibiting the constructive content of classical proofs, formalisation of proofs, program extraction from proofs, and the like. The stress is on the proof-theoretic methods that have been used to improve on mathematical results by, for instance, enriching them systematically with algorithms and effective bounds. Examples are the formal approach to commutative algebra performed by Coquand and Lombardi, the monotone functional interpretation used by Kohlenbach in functional analysis, and the refined A-translation applied by Berger, Buchholz, and Schwichtenberg.

Donnerstag, 21. September

Zeichensaal, Mathematisches Institut, Wegelerstr. 10

15:00 – 15:50 **Henri Lombardi** *Besançon, France()*
The Elimination of Prime Ideals

16:00 – 16:50 **Ulrich Kohlenbach** *(Darmstadt)*
Logical Metatheorems and their Use in Functional Analysis and Hyperbolic Geometry

17:00 – 17:50 **Bas Spitters** *(Nijmegen, The Netherlands)*
Observational Integration Theory with Applications to Riesz Spaces

Freitag, 22. September

Zeichensaal, Mathematisches Institut, Wegelerstr. 10

15:00 – 15:50 **Ulrich Berger** *(Swansea, UK)*
Program Extraction from Proofs: Theory and Practice

16:00 – 16:50 **Helmut Schwichtenberg** *(München)*
Logic for Computable Functionals and their Approximations

17:00 – 17:50 **Thomas Streicher** *(Darmstadt)*
Shoenfield = Gödel after Krivine

Vortragsauszüge

Henri Lombardi *(Besançon, France)*

The Elimination of Prime Ideals

Contrarily to André Weil, who wanted to “eliminate the elimination”, i.e. eliminate computations, we think that it is important to use abstract settings in order to make computations. Unfortunately the mathematicians who invented the abstract objects did not always tell us which “concrete objects” they started from. One reason is that they had a direct intuition of these objects. Without being able to explain the mystery, we nevertheless propose concrete objects as supports of abstract ones. Here we try to understand how prime ideals can be eliminated from abstract proofs in order to obtain constructive proofs using concrete substitutes for prime ideals.
For short, when a generic prime ideal is used in order to get an algebraic result, we can often understand this machinery as a way to prove that a certain ring is trivial. The proof is ad absurdum: if the ring were not trivial, then a prime ideal would exist in this ring. There are two variants: first, if the ring were not trivial, then a maximal prime ideal would exist in this ring; secondly, if the ring were not trivial, then a minimal prime ideal would exist in this ring. We will explain the computations that are involved when deciphering several classical uses of prime ideals.

Ulrich Kohlenbach *(Darmstadt)*

Logical Metatheorems and their Use in Functional Analysis and Hyperbolic Geometry

In recent years logical metatheorems have been developed which guarantee the extractability of effective strongly uniform bounds from large classes of proofs in functional analysis and hyperbolic geometry. “Strongly uniform” refers to the fact that the bounds are independent from parameters in abstract metric, hyperbolic, CAT(0) or normed spaces as long as some local bounds on certain metric distances between these parameters are given.
We will present some recent applications in metric fixed point theory where this has led to effective uniformity results which not even ineffectively were known before. We also give a new extension of the previously known metatheorems by a powerful “nonstandard” uniform bounded principle and indicate its use.

Bas Spitters *(Nijmegen, The Netherlands)*
Observational Integration Theory with Applications to Riesz Spaces

In this talk I will present a constructive theory of integration. It illustrates the general theme of developing mathematics observationally, connecting ideas by Kolmogorov, von Neumann and Segal on the one hand and point-free (also known as formal) topology on the other. This provides a nice illustration how ideas from logic (proof theory) can be used to obtain mathematical results. As an example I will show how to mechanically remove the axiom of choice from a proof in Riesz space (vector lattice) theory, thus obtaining an elementary proof and a more general result.

Ulrich Berger *(Swansea, UK)*
Program Extraction from Proofs: Theory and Practice

This talk will give an overview of various techniques for extracting computational content from formal proofs emphasising the gap between pure methods that work in principle and refined techniques that can be applied to nontrivial examples with practically useful results.

Helmut Schwichtenberg *(München)*
Logic for Computable Functionals and their Approximations

An attempt is made to develop a constructive theory of formal neighborhoods for continuous functionals, in a direct and intuitive style. Guided by abstract domain theory, we consider a more concrete and (in the case of finitary free algebras) finitary theory of representations. As a framework for this we use Scott's information systems.

Thomas Streicher *(Darmstadt)*
Shoenfield = Gödel after Krivine

In the 1960s J. Shoenfield came up with a functional interpretation $(-)^S$ of Peano arithmetic (PA). Recently, G. Mints raised the question whether one can express $(-)^S$ as

$(A^K)^D$ where D is Gödel's Dialectica interpretation and $(-)^K$ is an appropriately chosen negative translation.
We present such a translation $(-)^K$ going back to J.-L. Krivine and elaborated by B. Reus and T. Streicher, and prove that if

$$A^S \equiv \forall u \exists x A_S(u,x) \quad \text{and} \quad (A^K)^D \equiv \exists f \forall u A_D^K(f,u)\,,$$

then $A_D^K(f,u)$ and $A_S(u,f(u))$ are provably equivalent in HA_ω.
The content of this talk is joint work with Ulrich Kohlenbach.

Minisymposium 11

Geometrische Analysis

Leiter des Symposiums:

Prof. Dr. Ulrich Dierkes
Universität Duisburg-Essen
Campus Duisburg
Fachbereich Mathematik
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Prof. Dr. Karsten Große-Brauckmann
Technische Universität Darmstadt
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Montag, 18. September

HS III, Hauptgebäude, Regina-Pacis-Weg

14:00 – 14:50 **Sven Winklmann** *(Pisa)*

Curvature estimates for graphs with prescribed mean curvature and flat normal bundle

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15:00 – 15:20 **Matthias Bergner** *(Darmstadt)*

Minimizers of generalized nonparametric area functional

15:30 – 15:50 **Steffen Fröhlich** *(Darmstadt)*

On two-dimensional immersions of prescribed mean curvature in R^n

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16:00 – 16:50 **Heiko von der Mosel** *(Aachen)*

A fully nonlinear elliptic boundary value problem arising in conformal geometry on hyperbolic space

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Dienstag, 19. September

Hörsaal 118, AVZ I, Endenicher Allee 11-13

15:00 – 15:50 **Ruben Jakob** *(ETH Zürich)*

Endlichkeit der Lösungsmenge des Plateauschen Problems bei polygonalen Randkurven

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16:00 – 16:20 **Michael Pingen** *(Duisburg-Essen)*

A-priori Abschätzungen harmonischer Abbildungen

16:30 – 16:50 **Christoph Scheven** *(Düsseldorf)*

Regularitätstheorie für stationäre harmonische Abbildungen mit allgemeinen Randbedingungen

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17:00 – 17:50 **Andreas Gastel** *(Düsseldorf)*

Über extrinisch polyharmonische Abbildungen und ihren Wärmefluss

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Mittwoch, 20. September

Hörsaal 118, AVZ I, Endenicher Allee 11-13

15:00 – 15:50 **Simon Blatt** *(Aachen)*
Chord-Arc Submanifolds of Arbitrary Codimension

16:00 – 16:20 **Philipp Reiter** *(Aachen)*
Does finite knot energy imply differentiability?

16:30 – 16:50 **Jens Dittrich** *(Ulm)*
A-priori Abschätzungen für konjugiert-konforme Abbildungen im Rahmen des Weylschen Einbettungsproblems

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17:00 – 17:50 **Frank Müller** *(Cottbus)*
On the reularity of surfaces with prescribed mean curvature and partially free boundaries

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17:00 – 17:50 **Tobias Lamm** *(ETH Zürich)*
Conservation laws for fourth order systems in four dimensions

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Vortragsauszüge

Sven Winklmann *(Pisa)*
Curvature estimates for graphs with prescribed mean curvature and flat normal bundle

We consider graphs $\Sigma^n \subset \mathbb{R}^m$ with prescribed mean curvature and flat normal bundle. Using techniques of Schoen-Simon-Yau and Ecker-Huisken, we derive the interior curvature estimate

$$\sup_{\Sigma \cap B_R} |A|^2 \leq \frac{C}{R^2}$$

up to dimension $n \leq 5$, where C is a constant depending on natural geometric data of Σ only. This generalizes previous results of Smoczyk-Wang-Xin and Wang for minimal graphs with flat normal bundle.

Joint work with Steffen Fröhlich.

Matthias Bergner *(Darmstadt)*

Minimizers of generalized nonparametric area functional

We consider the generalized nonparametric area functional

$$A(\zeta) := \int_\Omega \Big(a(x,y,\zeta)\sqrt{1+|\nabla\zeta|^2} + b(x,y,\zeta) \Big) dxdy$$

for functions $a, b : \mathbb{R}^3 \to \mathbb{R}$ with $a > 0$. The Euler equation leads to a Dirichlet problem for graphs of prescribed mean curvature, where the mean curvature function depends on both the point in space as well as on the normal of the surface. Under certain assumptions on a and b we will solve the Dirichlet problem and thus construct minimizers of the functional A.

Steffen Fröhlich *(Darmstadt)*

On two-dimensional immersions of prescribed mean curvature in R^n

Using methods of Erhard Heinz and Friedrich Sauvigny for nonlinear elliptic systems in two variables we establish an estimate of the principal curvatures of two-dimensional graphs with prescribed mean curvature in Euclidean space $\mathbb{R}^n$.

Heiko von der Mosel *(Aachen)*

A fully nonlinear elliptic boundary value problem arising in conformal geometry on hyperbolic space

joint work with W. Reichel

For an n-dimensional Riemannian manifold (M, g) with metric g, Ricci tensor Ric, and scalar curvature R, let

$$A := \frac{1}{n-2}\left[Ric - \frac{R}{2(n-1)} g \right], \quad n \geq 3,$$

be the *Schouten tensor*, which contains the relevant information of the Riemannian curvature tensor under conformal deformation. An important class of problems in conformal geometry consists in finding a metric $h := e^{2u}g$ conformal to the background metric g such that the Schouten tensor A_h associated to h has special properties, e.g.

$$\sigma_k(A_h) = f \tag{2}$$

for a given function $f > 0$, where $\sigma_k(A_h)$ denotes the k-th elementary symmetric function of the eigenvalues of A_h. For $k = 1$ one has $\sigma_1(A_h) = \text{trace}(A_h)$, and (2) is the *Yamabe equation*, for $k = n$ one obtains with $\sigma_n(A_h) = \det A_h$ an equation of Monge-Ampére-type. The study of the geometrically particularly interesting situation $k = 2$ in dimenstion $n = 4$ has seen major advances by recent works of A. Chang, M. Gursky, J. Viaclovsky and many others, in the context of compact manifolds.
In contrast to that we consider here equation (2) for $k = 2$ on hyperbolic 4-space modelled as the conformal ball with the standard hyperbolic metric, and prove the existence of solutions to this fully nonlinear elliptic equation with the desired blow-up behaviour near the boundary.

Ruben Jakob *(ETH Zürich)*
Endlichkeit der Lösungsmenge des Plateauschen Problems bei polygonalen Randkurven

Im Jahre 1978 formulierte Nitsche das folgende Problem:

Man beweise, dass ein einfaches, geschlossenes Polygon nur endlich viele Lösungen des Plateauschen Problems berandet. Der Autor konnte zunächst das folgende Teilresultat beweisen:

Theorem 1. *Ein einfaches geschlossenes extremes Polygon $\Gamma \subset \mathbb{R}^3$ kann nur endlich viele immergierte stabile Minimalflächen beranden.*

Anschließend konnte der Autor dieses Resultat verallgemeinern zu

Theorem 2. *Sei $\Gamma^* \subset \mathbb{R}^3$ ein beliebiges extremes einfaches geschlossenes Polygon, an dessen Ecken die Winkel von $\frac{\pi}{2}$ verschieden sind. Dann existiert eine Umgebung O von Γ^* in $\mathbb{R}^3$ und eine Zahl β, abhängig von Γ^*, so dass die Anzahl der immergierten stabilen Minimalflächen, welche von einem beliebigen einfachen geschlossenen Polygon innerhalb O berandet werden, durch β beschränkt ist.*

Hierbei heiße das Polygon Γ extrem, falls es auf dem Rand einer beschränkten, konvexen Teilmenge des $\mathbb{R}^3$ liege und nicht in einer Ebene enthalten ist. Desweiteren heiße eine Minimalfläche X (vom Typ der Kreisscheibe $B := B_1(0)$) strikt verzweigungspunktfrei, falls $\inf_B \mid DX \mid > 0$ erfüllt ist. Sie heiße zusätzlich stabil, falls die zweite Variation $\delta^2\mathcal{A}(X, \varphi\,\xi) := \frac{d2}{d\epsilon^2}\mathcal{A}(X + \epsilon\varphi\,\xi) \mid_{\epsilon=0}$ des Flächeninhalts $\mathcal{A}$ von X in Normalenrichtung $\xi := \frac{X_u \wedge X_v}{|X_u \wedge X_v|}$ für kein $\varphi \in C_c^\infty(B)$ einen negativen Wert annimmt.

Michael Pingen *(Duisburg-Essen)*

A-priori Abschätzungen harmonischer Abbildungen

Im Vortrag wird ein neuer Beweis der a-priori Abschätzungen für schwache harmonische Abbildungen von Giaquinta-Hildebrandt [2] vorgestellt. Dieser Beweis verwendet Ideen aus einer Arbeit von Caffarelli [1], in der Hölderstetigkeit von beschränkten, schwachen Lösungen gewisser elliptischer Systeme gezeigt wurde. Wichtigstes Hilfsmittel ist eine schwache Harnack-Ungleichung für Superlösungen, die auf geeignete Translationen der harmonischen Abbildung in lokalen Koordinaten angewendet wird. Durch Iteration folgt dann die Stetigkeit und später die Hölderstetigkeit der harmonsichen Abbildung.

[1] Caffarelli, L.A., *Regularity Theorems for weak solutions of some nonlinear systems*, Comm. Pure Appl. Math. **35**, 1982, p.833-838

[2] Giaquinta, M. und Hildebrandt, S., *A priori estimates for harmonic mappings*, Journal Reine Angew. Mathematik **336**, 1982, p.124-164

Christoph Scheven *(Düsseldorf)*

Regularitätstheorie für stationäre harmonische Abbildungen mit allgemeinen Randbedingungen

Die Regularitätstheorie für harmonische Abbildungen $u \in W^{1,2}(M, N)$ zwischen Riemannschen Mannigfaltigkeiten M und N, d.h. für stationäre Punkte des Energiefunktionals $E(u) = \int_M |Du|^2\,dx$, hat sich in den letzten Jahrzehnten zu einer gut verstandenen Theorie entwickelt. Regularitätsaussagen am Rand des Definitionsbereiches waren bisher allerdings in voller Allgemeinheit nur für Energieminimierer bekannt. Der Vortrag dagegen stellt eine Regularitätstheorie vor, die nur Voraussetzungen an die erste Variation der Energie stellt. Die behandelten Randbedingungen umfassen unter

anderem die freie Randbedingung $u(\partial M) \subset \Gamma$ für eine vorgegebene Untermannigfaltigkeit $\Gamma \subset N$ sowie die Dirichlet-Randbedingung $u|_{\partial M} = g|_{\partial M}$ für eine gegebene Abbildung $g \in C^2(\partial M, N)$. Die Ähnlichkeit der Beweismethoden bei diesen beiden Typen von Randbedingungen legt nahe, beide als Spezialfälle einer allgemeineren Klasse von Randbedingungen zu betrachten, unter welchen alle Regularitätsaussagen in ähnlicher Form gelten.

Andreas Gastel *(Düsseldorf)*
Über extrinisch polyharmonische Abbildungen und ihren Wärmefluss

Extrinsisch polyharmonische Abbildungen $u : M \to N \subset \mathbb{R}^n$ zwischen Riemannschen Mannigfaltigkeiten M und N sind die kritischen Punkte der Poly-Energie $E_m(u) := \frac{1}{2}\int_M |D^m u|^2\, dx$. Sie lösen ein partielles Differentialgleichungssystem der Ordnung $2m$ mit kritischen Nichtlinearitäten. Während Existenz schwacher Lösungen leicht zu sehen ist, ist über Regularität schwacher oder Existenz klassischer Lösungen noch relativ wenig bekannt. Analog zum harmonischen [Struwe] und biharmonischen Fall [Lamm] funktioniert der Wärmeleitungs-Zugang recht gut für die konforme Dimension $\dim M = 2m$ und alle kleineren. Wir diskutieren diesen Zugang sowie einige Implikationen für die Existenz und Regularität polyharmonischer Abbildungen.

Simon Blatt *(Aachen)*
Chord-Arc Submanifolds of Arbitrary Codimension

A rectifiable Jordan curve Γ that goes through ∞ is called a *chord-arc curve with constant* κ, iff

$$|s-t| \leq (1+\kappa)|z(s)-z(t)|$$

for all $s, t \in \mathbb{R}$, where $z(.)$ denotes an arc length parametrization of Γ.
In [1,2,3] S. Semmes introduces several different analogs to the chord-arc constant for hypersurfaces of Euclidean spaces. Among other things he proves that each of these constants is small, if one of them is small, and moreover he shows that surfaces with a small chord-arc constant are homeomorphic to a hyperplane.
We extend the notion of chord-arc surfaces and constants to submanifolds of arbitrary codimension. Following ideas of Semmes one can show that they contain big pieces of

Lipschitz graphs, if the chord-arc constant is sufficiently small. Using this and a smoothing argument, we are able to show that n-dimensional submanifolds with small chord-arc constants are not only homeomorphic to Euclidean n-space, but even unknotted.

References:

[1] Stephen Semmes. Chord-Arc with small constant. I. *Adv. Math.*, 85(2), 198-223, 1991

[2] Stephen Semmes. Chord-Arc with small constant. II. Good parametrizations. *Adv.Math.*, 88(2), 170-199, 1991[1.7mm]

[3] Stephen Semmes. Hypersurfaces in $\mathbb{R}^n$ whose unit normal has small BMO norm. *Proc. Amer. Math. Soc.*, 112(2), 403-412, 1991

Philipp Reiter *(Aachen)*

Does finite knot energy imply differentiability?

In 1991/92 J. O'HARA [1] introduced the family of (j,p)-knot functionals

$$E^{j,p}(\gamma) := \mathscr{L}(\gamma)^{jp-2} \iint\limits_{(\mathbb{R}/(\ell\mathbb{Z}))^2} \left(\frac{1}{|\gamma(s)-\gamma(t)|^j} - \frac{1}{D_\gamma(s,t)^j} \right)^p |\dot\gamma(s)|\,|\dot\gamma(t)|\,\mathrm{d}s\,\mathrm{d}t,$$

where $\gamma \in C^{0,1}(\mathbb{R}/(\ell\mathbb{Z}),\mathbb{R}^3)$ is a curve of length $\mathscr{L}(\gamma)$, the term $D_\gamma(s,t)$ denotes the distance of $\gamma(s)$ and $\gamma(t)$ on γ, and $j,p>0$. The general idea is to produce nice representatives within a given knot class by minimizing these energies, which are self-avoiding iff $jp \geq 2$. In 1994 M. FREEDMAN, Z.-X. HE, and Z. WANG [2] showed for the MÖBIUS *energy* (i. e. $j=2$, $p=1$) that finite energy curves have a local bi-LIPSCHITZ constant arbitrarily close to 1.
Surprisingly there are curves of finite MÖBIUS energy that are not differentiable. In this talk we will present an example of such a curve and ask about the situation for other values of j,p. If we exclude the range of high singularity $\{(j-2)p \geq 1\}$, the answer only depends on the product jp.

This is joint work with SIMON BLATT *(RWTH Aachen).*

References:

[1] Jun O'Hara. Family of energy functionals of knots. *Topology Appl.*, 48(2):147–161, 1992.

[2] Michael H. Freedman, Zheng-Xu He, and Zhenghan Wang. Möbius energy

of knots and unknots. *Ann. of Math. (2)*, 139(1):1–50, 1994.

[3] Simon Blatt, Philipp Reiter. Does finite knot energy imply differentiability? *Preprints Inst. f. Math. RWTH Aachen*, to appear.

Jens Dittrich *(Ulm)*

A-priori Abschätzungen für konjugiert-konforme Abbildungen im Rahmen des Weylschen Einbettungsproblems

In diesem Vortrag betrachten wir Lösungen des Weylschen Einbettungsproblems $\mathbf{X} : \bar{B} \to \mathbb{R}^3$ mit $(d\mathbf{X})^2 = ds^2$ zu vorgeschriebenen Randwerten $\mathbf{Y} : \partial B \to \mathbb{R}^3$. Dabei ist ds^2 eine positiv-definite Riemannsche Metrik mit positiver Gaußscher Krümmung auf ganz $\bar{B}$ der Klasse $C^{4,\alpha}(\bar{B}) \cap C^{5,\alpha}(B)$. Wir drücken die geometrischen Invarianten der Randkurve in Termen der zweiten Fundamentalform $-(d\mathbf{X},\, d\mathbf{N})$ der Fläche aus. Hier bezeichnet $\mathbf{N}$ eine Einheitsnormale, so dass $(\mathbf{X}_{uu}, \mathbf{N}) > 0$ richtig ist. Damit können wir die mittlere Krümmung H bis zum Rand abschätzen und die zweite Fundamentalform in Termen der Invarianten der Randkurve auf dem Rand ausdrücken. Dies alles ermöglicht uns, für eine konjugiert-konforme Abbildung dieser Fläche einen Satz von F. Sauvigny aus dem Jahre 1999 anzuwenden, welcher die gewünschten a-priori Abschätzungen der $C^{2,\alpha}(\bar{B})$ Norm und der Jakobischen dieser Abbildung liefert.

Frank Müller *(Cottbus)*

On the reularity of surfaces with prescribed mean curvature and partially free boundaries

We discuss continuous, stationary surfaces with prescribed mean curvature and partially free boundaries $\{\Gamma, S\}$ in the Euclidean 3-space. At first, we present a new result concerning the regularity at the free boundary for a smooth support surface S. Then we report on the behaviour near meeting points of the Jordan arc Γ with S and near "edge type" singular points of S itself. These results generalize G. Dziuk's investigations on minimal surfaces.

Tobias Lamm *(ETH Zürich)*

Conservation laws for fourth order systems in four dimensions

In the first part of the talk we show that a certain class of fourth order elliptic system for maps between a domain in $\mathbb{R}^4$ and an arbitrary Riemannian manifold is equivalent to a conservation law. The class of systems under investigation includes both intrinsic and extrinsic biharmonic maps.

In the second part of the talk we use the conservation law to give an easy proof of the continuity and the weak compactness property of solutions of the fourth order systems.

This is a joint work with Tristan Rivière (ETH Zürich).

Minisymposium 12

Representation Theory of Algebras

Leiter des Symposiums:

Prof. Dr. Jan Schröer
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Donnerstag, 21. September

Hörsaal 118, AVZ I, Endenicher Allee 11-13

15:00 – 15:50 **Idun Reiten** *(Trondheim)*
Relative Calabi-Yau duality

16:00 – 16:50 **Bernard Leclerc** *(Caen)*
Cluster algebra structures on coordinate rings of partial flag varieties

17:00 – 17:50 **Markus Reineke** *(Münster)*
Smooth models of quiver moduli

Mittwoch, 20. September

Hörsaal 118, AVZ I, Endenicher Allee 11-13

15:00 – 15:50 **Christof Geiss** *(UNAM, Mexico)*
Examples of higher Auslander algebras which are quasi-hereditary

16:00 – 16:50 **Henning Krause** *(Paderborn)*
Adams resolutions for modular representations

17:00 – 17:50 **Claus Michael Ringel** *(Bielefeld)*
Take-off subcategories

Vortragsauszüge

Idun Reiten *(Trondheim)*
Relative Calabi-Yau duality

Triangulated categories of Calabi-Yau dimension 2 have turned out to be important in connection with cluster algebras, since for example the cluster categories and the stable categories of preprojective algebras of Dynkin diagrams have this property. In these examples, the triangulated categories contain cluster-tilting objects (i.e. maximal exceptional objects) and are closely related to the module category of the endomorphism algebra of each cluster-tilting object. We call such endomorphism algebras 2-Calabi-Yau tilted (and cluster-tilted if they arise from cluster categories). We show that they are Gorenstein of dimension at most one and that their stable categories of Cohen-Macaulay modules are Calabi-Yau of dimension 3. Often, a 2-Calabi-Yau tilted algebra naturally arises as a quotient of an algebra of finite global dimension. This algebra then satisfies a relative 3-Calabi-Yau property, as first shown by Geiss-Leclerc-Schroer in the context of modules over preprojective algebras. In contrast to its "absolute" variant, this relative Calabi-Yau property generalizes to higher dimensions.

Bernard Leclerc *(Caen)*
Cluster algebra structures on coordinate rings of partial flag varieties

This is a joint work with Christof Geiss and Jan Schröer. We investigate subcategories of the category of modules over a preprojective algebra Λ of Dynkin type (A,D,E) of the form Sub Q, where Q is an injective Λ-module. In particular, we construct explicit maximal rigid modules in Sub Q and define a mutation operation between maximal rigid modules. This is then applied to introduce a cluster algebra structure on the homogeneous coordinate rings of the generalized flag varieties G/P where G is the complex semisimple simply connected algebraic group with the same Dynkin type as Λ, and P is a parabolic subgroup.

Markus Reineke *(Münster)*

Smooth models of quiver moduli

Quiver moduli parametrize isomorphism classes of (poly-)stable representations of quivers up to isomorphism. Analogous to the case of moduli of vector bundles, there is a distinction between a (numerically defined) coprime case, with quite well-understood non-singular projective moduli, and a non-coprime case, leading either to non-compact, or to highly singular moduli.
The aim of the talk is to formulate and study a closely related moduli problem, which always produces smooth projective moduli. Their topology and geometry (in particular, their Betti numbers) will be described, and the representation-theoretic significance will be discussed.

Christof Geiss *(UNAM, Mexico)*

Examples of higher Auslander algebras which are quasi-hereditary

This is a report on joint work in progress with B. Leclerc (Caen) and J. Schröer (Bonn). Let Q be a Dynkin quiver, $\bar{Q}$ its double and $\Lambda = k\bar{Q}/(\sum_{a\in Q_1}[a,\bar{a}])$ the corresponding preprojective algebra. Let R be a maximal 1-orthogonal Λ-module and $E = \mathrm{End}_\Lambda(R)$, so this is a higher Auslander algebra in the sense of Iyama. Then $F_R = \mathrm{Hom}_\Lambda(-,R)$ induces an anti-equivalence from Λ-modules to the E-modules of projective dimension at most 1. If R is produced by pushing the projective modules of the (ordinary) Auslander algebra of kQ to Λ then E is canonically quasi-hereditary. The image of F_R are precisely the Δ-good modules, the Δ_i are just $F_R(X)$ where X runs over the indecomposable kQ^{op}-modules viewed as Λ-modules, and $\mathrm{Ext}^1_\Lambda(F_R(X),F_R(Y)) \cong D\,\mathrm{Ext}^1_{Q^{\mathrm{op}}}(X,Y)$.
The Δ-dimension vectors should in this way provide usefull invariants of Λ-modules.

Henning Krause *(Paderborn)*

Adams resolutions for modular representations

For any modular representation (of some finite group) an Adams resolution is constructed. This resolution helps to determine the cohomological support. The talk presents recent joint work with Dave Benson and Srikanth Iyengar.

Claus Michael Ringel *(Bielefeld)*

Take-off subcategories

Let Λ be an artin algebra and mod Λ the category of left Λ-modules of finite length. A full subcategory of mod Λ will be said to be a *take-off subcategory* provided it is closed under cogeneration, contains infinitely many isomorphism classes of indecomposable modules, and is minimal with these properties. We show the existence of take-off subcategories (provided, of course, that Λ is representation-infinite).

Minisymposium 13

Approximationsmethoden für Probleme auf der Sphäre

Leiter des Symposiums:

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Die Approximationstheorie für Probleme auf sphärischen Geometrien hat in den letzten Jahren sehr aktuelle und interessante Weiterentwicklungen erfahren und vielfältige neue Anwendungen solcher Methoden sind studiert worden. Dies trifft besonders zu auf Aufgaben der Geomathematik wie die satellitengestützte Bestimmung des Gravitationsfeldes der Erde, die mathematischen Algorithmen für bildgebende Verfahren wie CT und MRI oder die elektronenmikroskopische Analyse von Makromolekülen und Kristallen. All diesen Anwendungen ist gemeinsam, dass die durch moderne Messverfahren gewonnenen riesigen Datenmengen von Funktionen auf der Sphäre effizient ausgewertet werden müssen. Die mathematischen Methoden, die hier eingesetzt werden und die wir diskutieren wollen, reichen von inversen Problemen, Multiskalenanalyse, Wavelets, radialen Basisunktionen, polynomialer Approximation bis hin zu Fehlerabschätzungen und schnellen Algorithmen.

Donnerstag, 21. September

Seminarraum 2, AVZ I, Endenicher Allee 11-13

15:00 – 15:50 **Matthias Holschneider** *(Potsdam)*
Wavelet Frames auf der 2-Sphäre: Konstruktion und Anwendung

16:00 – 16:20 **Dirk Langemann** *(Lübeck)*
Threedimensional approximation of the total ponderomotive force on round uncharged objects in an electric field

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16:30 – 16:50 **Martin Gutting** *(Kaiserslautern)*
The spherical Bernstein wavelet

17:00 – 17:50 **Volker Michel** *(Kaiserslautern)*
Die Modellierung und Approximation der Ausbreitung von Erdbebenwellen mittels Produktkernansätzen

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Freitag, 22. September

Seminarraum 2, AVZ I, Endenicher Allee 11-13

15:00 – 15:50 **Daniel Potts** *(Chemnitz)*
Fast summation of radial functions on the sphere

16:00 – 16:20 **Jens Keiner** *(Lübeck)*
Fast evaluation of quadrature formulae on the sphere

16:30 – 16:50 **Ralf Hielscher** *(Bergakademie TU Freiberg)*
Numerical inversion of the one–dimensional Radon transform on SO(3)

17:00 – 17:50 **Frank Filbir** *(Institute of Biomathematics and Biometry, GSF National Research Center, Neuherberg, Germany)*
Convolution structures and polynomial approximation on the sphere

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Vortragsauszüge

Matthias Holschneider *(Potsdam)*
Wavelet Frames auf der 2-Sphäre: Konstruktion und Anwendung

Wir konstruieren ein kontinuierliches Frame von Poisson Wavelets auf der 2-Sphäre. Diese erlauben es, Quadratische Formen mit polynomialem Symbol, wie sie als a priori Information in geomagnetischen Modellen auftauchen, durch Punktauswertungen zu berechnen. Des Weiteren zeigen wir, wie durch Diskretisierung ein diskretes Frame von sphärischen Wavelets kontruiert werden kann.

Dirk Langemann *(Lübeck)*
Threedimensional approximation of the total ponderomotive force on round uncharged objects in an electric field

Droplets on outdoor high-voltage equipment suffer a total ponderomotive force which is non-vanishing in general. We consider a model problem of a round uncharged test-body. We show that the total force can be given as a series of inhomogeneity indicators of the undisturbed electric field. While the series is derived rather easily in 2d, it involves interesting aspects of the spherical harmonics in the use of 3d Fourier techniques. The found series expansion establishes a relation between the solutions of two Poisson equations on different domains. It is found that the expansion converges fast. The results are applied for droplets on realistically shaped insulators.

Martin Gutting *(Kaiserslautern)*
The spherical Bernstein wavelet

In this work we introduce a new bandlimited spherical wavelet: The Bernstein wavelet. It possesses a couple of interesting properties. To be specific, we are able to construct bandlimited wavelets free of oscillations. The scaling function of this wavelet is investigated with regard to the spherical uncertainty principle, i.e., its localization in the space domain as well as in the momentum domain is calculated and compared to the well-known Shannon scaling function. Surprisingly, they possess the same localization in space although one is highly oscillating whereas the other one shows no oscillatory

behavior. Moreover, the Bernstein scaling function turns out to be the first bandlimited scaling function known to the literature whose uncertainty product tends to the minimal value 1.

This is joint work with M. J. Fengler and W. Freeden.

Volker Michel *(Kaiserslautern)*
Die Modellierung und Approximation der Ausbreitung von Erdbebenwellen mittels Produktkernansätzen

Das elastische Verhalten der Erde lässt sich näherungsweise durch die Cauchy–Navier–Gleichung beschreiben. Für ein relativ einfaches Erdmodell ist hier ein Lösungssystem im Frequenzraum aus so genannten Hansenvektoren bekannt. Damit können normale Erdbebenwellen aber auch Eigenschwingungen, wie sie nach sehr schweren Beben auftreten, modelliert werden. In dem Vortrag wird nach der Einführung in diesen bekannten Teil der Theorie gezeigt, dass mittels einer inversen Fouriertransformation ein Orthonormalsystem von zeit- und ortsabhängigen Funktionen berechnet werden kann. Diese dienen dann dazu, um Produktkerne zu definieren, auf deren Basis spezielle Spline- und Waveletverfahren entwickelt werden können. Der Vorteil dieser Approximationsmethoden liegt in ihrer Lokalisierung. Als Anwendung wird die Approximation von sich ausbreitenden Erdbebenwellen auf der Basis zeitlich und räumlich diskreter Verschiebungswerte (Seismogramme) auf der (näherungsweise) sphärischen Oberfläche numerisch untersucht. Als Daten werden eine einfache Referenzwelle und eine realistische Simulation eines Bebens in Japan verwendet.

P. Kammann, V. Michel: Time–Dependent Cauchy–Navier Splines and their Application to Seismic Wave Front Propagation, *Schriften zur Funktionalanalysis und Geomathematik*, Preprint Nr. 26 (2006), TU Kaiserslautern;
V. Michel: Theoretical Aspects of a Multiscale Analysis of the Eigenoscillations of the Earth, *Revista Matematica Complutense*, 16 (2003), 519-554.

Daniel Potts *(Chemnitz)*
Fast summation of radial functions on the sphere

Radial functions are a powerful tool in many areas of multidimensional approximation, especially when dealing with scattered data. We present a fast approximate algorithm

for the evaluation of linear combinations of radial functions on the sphere $\mathbb{S}^2$. The approach is based on a particular rank approximation of the corresponding Gram matrix and fast algorithms for spherical Fourier transforms. The proposed method takes $\mathcal{O}(L)$ arithmetic operations for L arbitrarily distributed nodes on the sphere. In contrast to other methods, we do not require the nodes to be sorted or pre-processed in any way, thus the pre-computation effort only depends on the particular radial function and the desired accuracy. We establish explicit error bounds for a range of radial functions and provide numerical examples covering approximation quality, speed measurements, and a comparison of our particular matrix approximation with a truncated singular value decomposition.

This talk is based on joint work with J. Keiner (University of Lübeck) and S. Kunis (Chemnitz University of Technology).

Jens Keiner *(Lübeck)*
Fast evaluation of quadrature formulae on the sphere

Recently, a fast approximate algorithm for the evaluation of expansions in terms of standard $\mathrm{L}^2(\mathbb{S}^2)$-orthonormal spherical harmonics at arbitrary nodes on the sphere $\mathbb{S}^2$ has been proposed in $[2]$. Our aim is to develop a fast algorithm for the adjoint problem, hence the computation of expansion coefficients from sampled data by means of quadrature rules.
We give a formulation in matrix-vector notation and an explicit factorisation of the corresponding spherical Fourier matrix that is based on the first algorithm. Starting from this factorisation, we obtain the corresponding adjoint factorisation and are able to implement the corresponding transform. This 'adjoint' algorithm can be employed to evaluate quadrature rules for arbitrary quadrature nodes and weights on the sphere $\mathbb{S}^2$.
We provide results of test computations with respect to stability, accuracy and performance of the obtained algorithm. As examples, we consider a variety of proposed test functions using classical Gauß-Legendre and Clenshaw-Curtis quadrature rules. Furthermore, we also consider an equidistribution from $[3]$ and the HEALPix pixelation scheme ($[1]$), each with equal weights for all nodes to obtain a convenient quadrature rule. Especially the HEALPix scheme has great relevance as data storage standard in certain applications like cosmic microwave background estimation.

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[1] K. M. Górski, E. Hivon, A. J. Banday, B. D. Wandelt, F. K. Hansen, M. Reinecke, and M. Bartelmann. Healpix: A framework for high-resolution discretization and fast analysis of data distributed on the sphere. *The Astrophysical Journal*, 622:759–771, 2005.

[2] S. Kunis and D. Potts. Fast spherical Fourier algorithms. *J. Comput. Appl. Math.*, 161:75 – 98, 2003.

[3] W. Freeden, T. Gervens, and M. Schreiner. *Constructive Approximation on the Sphere*. Oxford University Press, Oxford, 1998.

Ralf Hielscher *(Bergakademie TU Freiberg)*
Numerical inversion of the one–dimensional Radon transform on SO(3)

We are concerned with the numerical inversion of the one–dimensional Radon transform on the rotational group SO(3) subject to a non–negativity constraint. While the Radon transform on $\mathbb{R}^3$ attracted much attention during the last fifteen years due to its connection to tomography the Radon transform on SO(3) did not. Our problem has practical applications in texture analysis, i.e. the analysis of crystallographic preferred orientation in polycrystalline materials as metals or rocks. We characterize the Radon transform on SO(3) as an operator between Sobolev spaces and present a spline based inversion algorithm that is especially well suited for scattered data as they are provided by the application in mind. A core item of our algorithm is the fast non–uniform spherical Fourier transform.

Additionally, we introduce a framework that allows for some basic error estimates of the inverse transform.

Frank Filbir *(Institute of Biomathematics and Biometry, GSF National Research Center, Neuherberg, Germany)*
Convolution structures and polynomial approximation on the sphere

We introduce convolution structures on $\mathbb{N}_0$ and on the intervall $[-1,1]$ established by so-called product formulas for orthogonal polynomials. After that we will show how to use these structures in order to construct good kernels. Due to the polynomial preproduction property of the associated approximation process the de la Vallée Poussin kernel for

Jacobi expansions is of special interest. This operator is then used to approximate functions f defined on the unit sphere $S^d \subset \mathbb{R}^{d+1}$, using samples of f at scattered sites. We are going to show how to obtain so-called Marcinkiewicz-Zygmund inequalities and establish concrete error estimates. Finally we show how to use these results in order to derive positive quadrature rules on S^d of high accuracy and based on function values at scattered point on S^d.

Minisymposium 14

Stochastische Marktmodelle

Leiter des Symposiums:

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Prof. Dr. Manfred Schäl
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Die Mathematik ist eine Schlüsseltechnologie zum Verständnis der Finanzmärkte. Seit den 70er Jahren hat sich eine reiche mathematische Theorie entwickelt, die immer wieder von neuen Fragestellungen der Praxis fruchtbar beeinflusst wird. In diesem Symposion werden neue Trends in der Finanzmathematik und mathematischen Ökonomie vorgestellt. Inhaltlich beschäftigen wir uns mit Fragen des Kreditrisikos, illiquiden Finanzmärkten, der Quantifizierung von Risiken (monetäre Risikomaße) sowie robusten optimale Portefeuilles.

Dienstag, 19. September

Zeichensaal, Mathematisches Institut, Wegelerstr. 10

14:00 – 14:50 **Peter Bank** *(Columbia University)*
Pricing and Hedging in Illiquid Financial Markets

15:00 – 15:50 **Christoph Kühn** *(Fankfurt)*
Optimal investment in financial markets with different liquidity effects

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16:00 – 16:50 **Michael Kupper** *(TU Wien)*
Composition of Time-Consistent Dynamic Monetary Risk Measures in Discrete Time

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17:00 – 17:50 **Christian-Oliver Ewald** *(Leeds)*
Malliavin differentiability of the Heston Volatility and an extension of the Hull & White pricing formula

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Mittwoch, 20. September

Zeichensaal, Mathematisches Institut, Wegelerstr. 10

14:00 – 14:50 **Ralf Korn** *(TU Kaiserslautern and Fraunhofer ITWM Kaiserslautern)*
Stocks paying discrete dividends: modelling, option pricing and optimal portfolios

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15:00 – 15:50 **Kay Giesecke** *(Stanford University)*
Pricing credit from the top down with affine point processes

16:00 – 16:50 **Stefan Weber** *(Cornell University)*
Optimal Portfolio Choice under Model Uncertainty

17:00 **Jörn Sass** *(RICAM Linz)*
Utility maximization with partial information and further constraints

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17:45 **Manfred Schäl** *(Bonn)*
The numeraire portfolio under transaction cost

Vortragsauszüge

Peter Bank *(Columbia University)*
Pricing and Hedging in Illiquid Financial Markets

Ever since the seminal work of Black, Scholes, and Merton, typical models studied in Mathematical Finance specify price dynamics exogenously via some more or less explicit semimartingale dynamics. This is contrast to the basic economic paradigm that prices ought to be determined by demand and supply. We propose a new model which bridges the gap (or at least tries to) between these two approaches by studying the dynamics of utility indifference prices. For exponential utility, the resulting nonlinear wealth dynamics allow for explicit solutions to the classical problems of pricing, hedging, and utility maximization in complete and incomplete financial markets.

Christoph Kühn *(Frankfurt)*
Optimal investment in financial markets with different liquidity effects

In an illiquid financial market trades of a large investor can move market prices quite significantly. In the last years different models have been suggested to capture the interdependency of the evolution of the asset price and the dynamic trading strategy of a large investor in the asset. Roughly speaking, there are two competing approaches in the literature. In Çetin, Jarrow, Protter (2004), Rogers, Singh (2006) and others, a transaction of a large trader only has a short-term price impact and the asset price jumps back to its previous level. By contrast, in Bank, Baum (2004), Esser, Mönch (2002), Frey, Stremme (1997) and Platen, Schweizer (1998) the market price stays at the new level after a transaction of the large investor.
We give a new microeconomic motivation of different illiquid market models and propose a continuous-time model which unifies both liquidity effects. The continuous-time self-financing condition for this model is obtained as a limit from so-called simple strategies. We analyze the large investor's utility maximization problem for utility functions which are finite on the whole real line and characterize the optimal strategy by a marginal utility property generalizing a well-known relationship in frictionless markets.

Michael Kupper *(TU Wien)*
Composition of Time-Consistent Dynamic Monetary Risk Measures in Discrete Time

In discrete time, every time-consistent dynamic monetary risk measure can be written as a composition of one-step risk measures. We exploit this structure to give new dual representation results for time-consistent convex monetary risk measures in terms of one-step penalty functions. We first study risk measures for random variables modelling financial positions at a fixed future time. Then we consider the more general case of risk measures that depend on stochastic processes describing the evolution of financial positions. In both cases the new representations allow for a simple composition of one-step risk measures in the dual. We discuss several explicit examples and provide connections to the recently introduced class of dynamic variational preferences.
It is joint work with Patrick Cheridito (Princeton University).

Christian-Oliver Ewald *(Leeds)*
Malliavin differentiability of the Heston Volatility and an extension of the Hull & White pricing formula

The talk is based on results obtained jointly with Elisa Alos, UPF Barcelona. We show that the Heston volatility or equivalently the Cox-Ingersoll-Ross process satisfying

$$dv_t = \kappa\left(\theta - v_t\right)dt + \nu\sqrt{v_t}dW_t$$

is Malliavin differentiable and give an explicit expression for the derivative. This result assures the applicability of Malliavin calculus in the framework of the Heston stochastic volatility model and the Cox-Ingersoll-Ross model for interest rates. Furthermore we derive conditions on the parameters κ,θ and ν which guarantee the existence of the second Malliavin derivative of the Heston volatility. We apply this result in order to obtain an extension of the classical Hull and White formula to the Heston model with correlation and derive an approximate option pricing formula. Our numerical experiments document that the approximation delivers excellent results.

Ralf Korn *(TU Kaiserslautern and Fraunhofer ITWM Kaiserslautern)*
Stocks paying discrete dividends: modelling, option pricing and optimal portfolios

Usually any dividends on stocks are modelled as continuously paid streams, but in reality dividends are always paid discretely, often after some announcement of the amount of the dividend. It is not entirely clear how such discrete dividends are to be handled; simple perturbations of the Black-Scholes model often fall into contradictions. The approach presented here is to recognise the stock price as the net present value of all future dividends, and to model the (discrete) dividend process directly. The stock price process is then deduced, and various option-pricing formulae derived. Further, the standard portfolio problem will be solved.

Kay Giesecke *(Stanford University)*
Pricing credit from the top down with affine point processes

The value of any credit derivative is a function of market wide risk factors generated by the complex web of relationships in the economy. To incorporate these factors, we estimate the value of credit derivatives from the top down by modeling aggregate credit losses directly. We show how to make this approach computationally tractable within the class affine point processes, which are intensity-based jump processes driven by affine jump diffusions. An affine point process is sufficiently flexible to account for both cyclical dependence in the economy and market contagion. Further, it supports Fourier transform based pricing and calibration. We illustrate our top down approach in the context of CDS index and tranche spreads.

Stefan Weber *(Cornell University)*
Optimal Portfolio Choice under Model Uncertainty

We consider the problem of utility maximization under model uncertainty in the presence of both cost and risk constraints. Downside risk is measured by *utility-based shortfall risk*.
We first review the properties of utility-based shortfall risk. The acceptance sets of these risk measures are defined in terms of a convex loss function and a fixed threshold level.

Second, we discuss utility maximization under both cost and risk constraints, if there is no model uncertainty. By means of its dual problem, the optimization problem can explicitly be solved.
Finally, we characterize the solution of the robust utility maximization problem under robust constraints. In this case, model uncertainty involves three aspects: the measurement of the utility, the cost and the downside risk. We assume that investors take a worst case approach.

Jörn Sass *(RICAM Linz)*
Utility maximization with partial information and further constraints

We consider a multi-stock market model where prices satisfy a stochastic differential equation with instantaneous rates of return modeled as an unobserved stochastic process, e.g. a continuous time, finite state Markov chain. The investor wishes to maximize the expected utility of terminal wealth but for his investment decisions only the prices are available to him.
It is convenient to use continuous-time models to approximate the discrete-time trading on the market, since these models often allow us to derive optimal trading strategies quite explicitly, in this case by using HMM filtering results and Malliavin calculus. But in these models where the drift of the stock returns is not constant, the optimal strategy may lead to extreme long and short positions which can result in bankruptcy if we trade in discrete time only.
In this talk we compare different constraints and model reformulations which may lead to more stable strategies: E.g. using non-constant volatility models, Levy-noise, convex costraints (no short selling), or risk constraints like e.g. bounded shortfall risk.

Manfred Schäl *(Bonn)*
The numeraire portfolio under transaction cost

This is joint work with Joern Sass. The existence of the numeraire portfolio is studied for a discrete – time financial market under proportional transaction cost. For pricing derivative securities, expectation of the claim is carried through with respect to a martingale measure. The numeraire portfolio allows to replace this usual change of measure by a change of numeraire. For models with transaction cost, the concept of a martingale

measure and thus the concept of a numeraire portfolio have to be modified. A well-known approach (for models without transaction cost) is maximization of the log-utility. The same approach turns out to work for the present models with transaction cost.

Minisymposium 15

Operatortheorie

Leiter des Symposiums:

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Die Operatortheorie beschäftigt sich mit der Analyse linearer Abbildungen auf unendlichdimensionalen Räumen. Einen besonderen Schwerpunkt bildet dabei die Spektraltheorie, die Erweiterungstheorie symmetrischer Operatoren, die Fredholmtheorie und die Theorie der Halbgruppen.

Montag, 18. September

HS IV, Hauptgebäude, Regina-Pacis-Weg

14:30 – 15:20 **Klaus-Jochen Engel** *(University of L'Aquila, Italy)*
Boundary control of flows in networks

15:30 – 15:50 **Andras Bátkai** *(ELTE TTK/Institute of Mathematics)*
Differenzialgleichungen mit Verzögerung in L^p Phasenräumen

16:00 – 16:20 **Peer Kunstmann** *(Karlsruhe)*
L^q-Eigenschaften elliptischer Randwertprobleme

16:30 – 16:50 **Markus Biegert** *(Ulm)*
Elliptic Problems on Varying Domains

Dienstag, 19. September

Hörsaal 411 AVZ I, Endenicher Allee 11-13

15:00 – 15:50 **Christiane Tretter** *(Bremen)*
Spectral problems for block operator matrices in hydrodynamics

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16:00 – 16:20 **Matthias Langer** *(University of Strathclyde, Glasgow)*
Variational principles for eigenvalues of the Klein–Gordon equation

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16:30 – 16:50 **Monika Winklmeier** *(Bremen)*
Estimates for the eigenvalues of the angular part of the Dirac equation in the Kerr-Newman metric

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17:00 – 17:20 **Annemarie Luger** *(TU Berlin)*
On a result for differential operators with singular potentials

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17:30 – 17:50 **Jussi Behrndt** *(University of Groningen)*
Open Quantum Systems

Mittwoch, 20. September

Hörsaal 411 AVZ I, Endenicher Allee 11-13

15:00 – 15:50 **Hagen Neidhardt** *(WIAS Berlin)*
Perturbation theory of semi-groups and evolution equations

16:00 – 16:20 **Bernhard Haak** *(TU Delft)*
A stochastic Datko-Pazy theorem

16:30 – 16:50 **Tanja Eisner** *(Tübingen)*
Fast schwache Konvergenz von Operatorhalbgruppen

17:00 – 17:20 **Carsten Trunk** *(TU Berlin)*
Location of the spectrum of operator matrices which are associated to second order equations

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17:30 – 17:50 **Birgit Jacob** *(TU Delft)*
A resolvent test for admissibility of Volterra observation operators

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Vortragsauszüge

Klaus-Jochen Engel *(University of L'Aquila, Italy)*

Boundary control of flows in networks

We investigate a boundary control problem on a network. We study a transport equation in the network, controlling it in a single vertex. We describe all the possible reachable states and prove a criterium of Kalman type for the vertices in which the problem is controllable.

This is joint work with Marjeta Kramar Fijav (Ljubljana), Rainer Nagel (Tübingen) and Eszter Sikolya (Budapest).

Andras Bátkai *(ELTE TTK/Institute of Mathematics)*

Differenzialgleichungen mit Verzögerung in L^p Phasenräumen

Im Vortrag wird ein halbgruppentheoretischer Zugang zu Differenzialgleichungen mit Verzögerung in L^p Phasenräumen präsentiert. Dies ermöglicht uns die Verzögerung in eine additive Störung zu verwandeln und ermöglicht dadurch die Anwendung der reichen Störungstheorie der Halbgruppen. Neben diesem Zugang werden auch die Ergebnisse neuester spektraltheoretischer Untersuchungen gezeigt.

Referenzen:

Bátkai, A., Piazzera, S., "Semigroups for Delay Equations in L^p-Phase Spaces", Research Notes in Mathematics vol. 10, A. K. Peters: Wellesley MA, 2005.
Bátkai, A., Eisner, T., Latushkin, Y., *The spectral mapping property of delay semigroups*, submitted

Peer Kunstmann *(Karlsruhe)*

L^q-Eigenschaften elliptischer Randwertprobleme

Wir untersuchen L^q-Eigenschaften elliptischer Randwertprobleme

$$\begin{aligned} \lambda u - Au &= f \quad \text{in } \Omega \subset \mathbb{R}^n \\ Bu &= g \quad \text{auf } \partial\Omega. \end{aligned}$$

Hierbei ist im einfachsten Fall $A = \sum_{jk} a_{jk}\partial_j\partial_k$ ein Differentialoperator mit $a_{jk} \in L^\infty$, $B = \sum_j b_j\partial_j$ ein Differentialoperator erster Ordnung mit $b_j \in C^{0,1}$, sowie $f \in L^q(\Omega)$ und $g \in W^{1,q}(\Omega)$. Ausgehend von Abschätzungen wie

$$|\lambda|\|u\|_q + \|\nabla^2 u\|_q \leq C(\|f\|_q + |\lambda|^{1/2}\|g\|_q + \|\nabla g\|_q)$$

für ein festes $q \in (1,\infty)$ und hinreichend große λ in einem geeigneten Sektor zeigen wir verallgemeinerte Gauß-Abschätzungen und mit deren Hilfe weitere Eigenschaften wie R-Sektorialität, R-Beschränktheit der Lösungsoperatoren und maximale L^p-L^q-Regularität für die induzierte analytische Halbgruppe.

Markus Biegert *(Ulm)*

Elliptic Problems on Varying Domains

The aim of this talk is to show optimal results on local and global uniform convergence of solutions to elliptic equations with Dirichlet boundary conditions on varying domains. We assume that the limit domain be stable in the sense of Keldyš. We further assume that the approaching domains satisfy a necessary condition in the inside of the limit domain, and only require L^2-convergence outside. As a consequence, uniform and L^2-convergence are the same in the trivial case of homogenisation of a perforated domain.

Christiane Tretter *(Bremen)*

Spectral problems for block operator matrices in hydrodynamics

In the linear stability analysis of hydrodynamics, the spectra of non-symmetric systems of coupled differential equations have to be studied. As examples, we consider the Ekman boundary layer problem and the Hagen Poiseuille flow with non-axisymmetric disturbances. In both cases we investigate the essential spectrum by means of operator theoretic methods.

(joint work with M. Marletta, Cardiff)

Matthias Langer *(University of Strathclyde, Glasgow)*
Variational principles for eigenvalues of the Klein–Gordon equation

We consider eigenvalues of the Klein–Gordon equation, which can be written as a quadratic eigenvalue problem. Under certain assumptions the continuous spectrum has a gap and we can characterise eigenvalues in this gap even in the presence of complex eigenvalues. This quadratic eigenvalue problem can also be linearised in a Pontryagin space. Connections between the negative index of the Pontryagin space and the index shift in the variational principle are presented.

Monika Winklmeier *(Bremen)*
Estimates for the eigenvalues of the angular part of the Dirac equation in the Kerr-Newman metric

The radial part of the Dirac equation describing a fermion in the Kerr-Newman background metric has an operator theoretical realisation as a block operator matrix $\mathcal{A} = \left(\begin{smallmatrix} -D & B \\ B^* & D \end{smallmatrix}\right)$ with domain $\mathcal{D}(\mathcal{A}) = \mathcal{D}(B^*) \oplus \mathcal{D}(B)$ in the Hilbert space $\mathcal{H} = L_2(0,\pi)^2$. It can be shown that the spectrum of $\mathcal{A}$ consists of eigenvalues only. We will show that the expression $\mathcal{A} - \lambda$ allows for a factorisation into three factors such that all the information about the spectrum of $\mathcal{A}$ is contained in a scalar operator valued function. From this function we obtain a lower bound for the smallest eigenvalue in modulus of $\mathcal{A}$. Another method to obtain such a bound is to use techniques related to the quadratic nuermical range of block operator matrices.

Annemarie Luger *(TU Berlin)*
On a result for differential operators with singular potentials

We explore the connection between a (generalized) Titchmarsh-Weyl-coefficient for the singular Sturm-Liouville operator

$$\ell(y) := -y''(x) + \Big(\frac{q_0}{x^2} + \frac{q_1}{x}\Big)y(x) \quad \text{on } x \in (0,\infty),$$

with $q_0 > \frac{3}{4}$ and $q_1 \in \mathbb{R}$, and a certain singular perturbation of this operator.

This talk is based on joint work with Pavel Kurasov (Lund).

Jussi Behrndt *(University of Groningen)*
Open Quantum Systems

Open quantum systems are often described with a maximal dissipative operator A_D, a so-called pseudo-Hamiltonian, and a self-adjoint operator A_0 in some Hilbert space $\mathcal{H}$. If L denotes a minimal self-adjoint dilation of A_D, i.e., L acts in a Hilbert space $\mathcal{H} \oplus L^2(\mathbb{R}, \mathfrak{K})$ such that $P_{\mathcal{H}}(L-\lambda)^{-1}|_{\mathcal{H}} = (A_D - \lambda)^{-1}$, and $L_0 = A_0 \oplus -i\frac{d}{dx}$, then the scattering matrix of the closed system $\{L, L_0\}$ can be recovered from the scattering matrix of the dissipative system $\{A_D, A_0\}$. Since in this model L is not semibounded from below serious doubts arise from a physical point of view.
We propose a slightly different approach where instead of a fixed pseudo-Hamiltonian A_D a family of energy dependent pseudo-Hamiltonians $\{A_{-\tau(\lambda)}\}$ is considered. The outer space $L^2(\mathbb{R}, \mathfrak{K})$ is replaced by some Hilbert space $\mathcal{K}$ and the Hamiltonian L in $\mathcal{H} \oplus \mathcal{K}$ satisfies $P(L-\lambda)^{-1}|_{\mathcal{H}} = (A_{-\tau(\lambda)} - \lambda)^{-1}$ and is often semibounded from below. We show that the scattering matrix of the closed system can be recovered in a similar way as above and that the model with one fixed pseudo-Hamiltonian can be regarded as an approximation. The abstract theory is illustrated with some examples.

The talk is based on joint work with Mark M. Malamud (Donetsk National University, Ukraine) and Hagen Neidhardt (WIAS, Berlin).

Hagen Neidhardt *(WIAS Berlin)*
Perturbation theory of semi-groups and evolution equations

The aim of the present talk is to develop an approach to the Cauchy problem for linear evolution equations of type

$$\frac{\partial}{\partial t}u(t) + A(t)u(t) = 0, \quad u(s) = u_s, \quad a < s \leq t < b,$$

on a separable Banach space X, where (a, b) is a finite open interval and $\{A(t)\}_{t\in(a,b)}$ is a family of closed linear operators on the separable Banach space X. The main question concerning the Cauchy problem is to find a so-called "solution operator" or propagator $U(t, s)$. We are going to solve this problem embedding it into a perturbation problem for generators of semi-groups in the Banach space $L^p([0, T], X)$, $1 < p < \infty$. The abstract existence results are applied to Schrödinger operators with time-dependent point interactions.

Bernhard Haak *(TU Delft)*

A stochastic Datko-Pazy theorem

The well-known Datko-Pazy theorem states that if $(T(t))_{t\geq 0}$ is a strongly continuous semigroup on a Banach space E such that all orbits $T(\cdot)x$ belong to the space $L^p(\mathbb{R}_+, E)$ for some $p \in [1, \infty)$, then $(T(t))_{t\geq 0}$ is uniformly exponentially stable, or equivalently, there exists an $\epsilon > 0$ such that all orbits $t \mapsto e^{\epsilon t}T(t)x$ belong to $L^p(\mathbb{R}_+, E)$. We show that a similar result also hold for so-called γ–radonifying operators, namely the equivalence of

1. For all $x \in E$, $T(\cdot)x \in \gamma(\mathbb{R}_+, E)$.
2. There exists an $\epsilon > 0$ such that for all $x \in E$, $t \mapsto e^{\epsilon t}T(t)x \in \gamma(\mathbb{R}_+, E)$.

If E is a Hilbert space, $\gamma(\mathbb{R}_+, E) = L^2(\mathbb{R}_+, E)$ and we reobtain Datko's theorem mentioned above. γ–radonifying operators play an important role in the study abstract stochastic Cauchy problems on E whence the result can also be seen as a perturbation result for stochastic Cauchy problems.

References:

B. Haak, M. Veraar, J. van Neerven: *A stochastic Datko-Pazy theorem*, submitted; avaiable on ArXiv.

Tanja Eisner *(Tübingen)*

Fast schwache Konvergenz von Operatorhalbgruppen

Für C_0-Halbruppen auf Banachräumen diskutieren wir den Zusammenhang zwischen Spektraleigenschaften des Generators und der Konvergenz der Halbgruppe für $t \to \infty$ (insbesondere für die schwache Topologie).

Carsten Trunk *(TU Berlin)*

Location of the spectrum of operator matrices which are associated to second order equations

We study second order equations of the form

$$\ddot{z}(t) + A_o z(t) + D\dot{z}(t) = 0.$$

Here the stiffness operator A_o is a possibly unbounded positive operator on a Hilbert space H, which is assumed to be boundedly invertible, and D, the damping operator, is an unbounded operator, such that $A_o^{-1/2} D A_o^{-1/2}$ is a bounded non negative operator on H. This second order equation is equivalent to the standard first-order equation $\dot{x}(t) = Ax(t)$, where $A : \mathcal{D}(A) \subset \mathcal{D}(A_o^{1/2}) \times H \to \mathcal{D}(A_o^{1/2}) \times H$, is given by

$$A = \begin{bmatrix} 0 & I \\ -A_o & -D \end{bmatrix},$$

$$\mathcal{D}(A) = \left\{ \left[\begin{smallmatrix} z \\ w \end{smallmatrix} \right] \in \mathcal{D}(A_o^{1/2}) \times \mathcal{D}(A_o^{1/2}) \mid A_o z + Dw \in H \right\}.$$

This block operator matrix has been studied in the literature for more than 20 years.
It is well-known that A generates a C_0-semigroup of contraction, and thus the spectrum of A is located in the closed left half plane.
We are interested in a more detailed study of the location of the spectrum of A in the left half plane. In general the (essential) spectrum of A can be quite arbitrary in the closed left half plane. Under various conditions on the damping operator D we describe the location of the spectrum and the essential spectrum of A.

The talk is based on joint work with Birgit Jacob (Delft).

Birgit Jacob *(TU Delft)*
A resolvent test for admissibility of Volterra observation operators

Necessary and sufficient conditions are given for finite-time admissibility of a linear system defined by a Volterra integral equation when the underlying semigroup is equivalent to a contraction semigroup. These necessray and sufficient conditions are in terms of a pointwise bound on the resolvent of the infinitesimal generator. This generalizes an analogous result known to hold for the standard Cauchy problem.

The talk is based on joint work with Jonathan R. Partington (University of Leeds).

Minisymposium 16

Set Theory

Leiter des Symposiums:

Prof. Dr. Ernest Schimmerling
Dept. of Mathematical Sciences

Carnegie Mellon University
Pittsburgh, PA 15213-3890, USA

Prof. Dr. Ralf Schindler
Institut für Mathematische Logik
und Grundlagenforschung
Universität Münster
Einsteinstr. 62
48145 Münster, Germany

Set theory originally grew out of analysis and topology, and was later influenced by combinatorics. The minisymposium lectures reflect these roots. What distinguishes set theory from these other fields is its strong connection to logic, which also figures prominently in the topics and techniques represented in the talks. In fact, each of the results to be discussed has dual appeal, applied and foundational.

Donnerstag, 21. September

Kleiner Hörsaal, Mathematisches Institut, Wegelerstr. 10

15:00 – 15:50 **Matteo Viale** *(Torino)*
Applications of the Proper Forcing Axiom to cardinal arithmetic

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16:00 – 16:50 **Boban Veličkovič** *(Paris)*
The consistency strength of a five element basis for uncountable linear orderings

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17:00 – 17:20 **Jordi Lopez-Abad** *(Paris)*
Sequences on Banach spaces and finite sets of integers

17:30 – 17:50 **Ilijas Farah** *(Toronto)*
Submeasures, Lévy groups and extremely amenable groups

Freitag, 22. September

Kleiner Hörsaal, Mathematisches Institut, Wegelerstr. 10

15:00 – 15:20 **Gunter Fuchs** *(Münster)*
Degrees of Rigidity for Souslin Trees and Changing the Heights of Automorphism Towers

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15:30 – 15:50 **David Aspero** *(Bristol)*
Definable well–orders of $H(\omega_2)$ and forcing axioms

16:00 – 16:20 **Natasha Dobrinen** *(Wien)*
Co-stationarity of the ground model

16:30 – 16:50 **Otmar Spinas** *(Kiel)*
Perfect Set Theorems

17:00 – 17:50 **Jouko Väänänen** *(Helsinki)*
Strong Logics

Vortragsauszüge

Matteo Viale *(Torino)*

Applications of the Proper Forcing Axiom to cardinal arithmetic

I will survey the effects of the Proper Forcing Axiom on cardinal arithmetic.

Boban Veličkovič *(Paris)*

The consistency strength of a five element basis for uncountable linear orderings

Moore showed in 2004 that the Proper Forcing Axiom implies that there is a five element basis for the class of uncountable linear orders, thus confirming a well known conjecture of Shelah. The assumptions needed in the original proof have consistency strength of at least infinitely many Woodin cardinals. In this talk we will show that the upper bound on the consistency strength of the existence of such a basis is less than a Mahlo cardinal, a hypothesis which can hold in the constructible universe. The key notion in our proof is the saturation of an Aronszajn tree, a concept which was studied by Baumgartner in the 1970s. In particular, we show that the saturation of an Aronszajn tree together with the Bounded Proper Forcing Axiom suffices for the existence of a five element linear basis.

This is joint work with B. Koenig, P. Larson and J. Moore.

Jordi Lopez-Abad *(Paris)*

Sequences on Banach spaces and finite sets of integers

The purpose of this talk is to present a framework for studying the structure of subsequences of a given infinite sequence in a real Banach space X using combinatorics of finite sets of integers. We focus mainly on weakly-null sequences. The main combinatorial tool is the notion of barrier introduced by Nash-Williams.

Ilijas Farah *(Toronto)*

Submeasures, Lévy groups and extremely amenable groups

Given a locally compact group H and a submeasure ϕ on clopen subsets of 2^N, consider the group $S(\phi, H)$ of simple H-valued functions with respect to the topology of convergence in ϕ. These groups can be used to distinguish some of the standard classes of 'massive' topological groups.

This is a joint work with S. Solecki.

Gunter Fuchs *(Münster)*

Degrees of Rigidity for Souslin Trees and Changing the Heights of Automorphism Towers

Various strong notions of rigidity for Souslin trees are investigated and separated, assuming the diamond principle, into a hierarchy. Most of these rigidity properties state that a tree has a certain rigidity property in any model obtained by forcing with the tree itself.
An application to the automorphism tower problem is given, showing that, again assuming diamond, there is a group the height of whose automorphism tower is highly malleable by forcing with certain Souslin trees. Carrying out the construction at higher cardinality levels gives the full statement on changing the heights of automorphism towers, that was realized by Hamkins and Thomas using proper class forcing, in L.

David Aspero *(Bristol)*

Definable well–orders of $H(\omega_2)$ and forcing axioms

This talk deals with the problem of building set-forcing extensions in which there is a simple definition, over the structure $\langle H(\omega_2), \in\rangle$ and without parameters, of a prescribed member of $H(\omega_2)$ or of a well–order of $H(\omega_2)$, possibly together with some strong forcing axiom.
I will present two theorems. The first one is an optimal result, with respect to the logical complexity of the definitions involved, at the level of the structure $\langle H(\omega_2), \in, NS_{\omega_1}\rangle$. This

result is a particular case of a much more general theorem applying to $H(\kappa^+)$ for every uncountable regular cardinal κ.
The second theorem I will present says that, under the assumption that there is a super-compact cardinal, there is a partial order forcing both the existence of a well–order of $H(\omega_2)$ definable, over $\langle H(\omega_2), \in \rangle$, by a formula without parameters, and that the forcing axiom PFA^{++} holds.

Natasha Dobrinen *(Wien)*
Co-stationarity of the ground model

The bulk of this talk is based on joint work with Sy-David Friedman. Given $V \subseteq W$ models of ZFC with the same ordinals and $\kappa < \lambda$ cardinals in W with κ regular, let $\mathcal{P}_\kappa(\lambda)$ denote the collection of subsets of λ of size less than κ in W. We say that the ground model is *co-stationary* if $\mathcal{P}_\kappa(\lambda) \setminus V$ is stationary in $\mathcal{P}_\kappa(\lambda)$. Gitik showed the following: Suppose κ is a regular cardinal in W, and λ is greater than or equal to $(\kappa^+)^W$. If there is a real in $W \setminus V$, then the ground model is co-stationary in $\mathcal{P}_\kappa(\lambda)$.
We consider problems of generalizing Gitik's Theorem to forcing extensions in which no reals are added. In particular, we show that the analogue of Gitik's Theorem for $\aleph_2$-c.c. forcings which add a new subset of $\aleph_1$ (but no new ω-sequences) is equiconsistent with a class of Erdös cardinals. The necessity of ω_1-Erdös cardinals follows from a covering theorem of Magidor. For regular $\kappa \geq \aleph_2$ with $\aleph_\kappa > \kappa$, the co-stationarity of the ground model in the $\mathcal{P}_{\kappa^+}(\aleph_\kappa)$ of a κ-Cohen forcing extension is equiconsistent with κ measureable cardinals.
For $\nu \geq \aleph_1$ we present some consistency results concerning partial orderings which add a new ν-sequence but no new subset of ν. We also include some more recent work with Justin Moore concerning partial orderings which add a new ω-sequence without adding a new real.

Otmar Spinas *(Kiel)*
Perfect Set Theorems

I will present several results and open problems in the context of searching for perfect set theorems for the following largeness conditions for subsets of Cantor or Baire space: splitting property, refining property, infinitely often equal property.

Jouko Väänänen *(Helsinki)*
Strong Logics

I will describe strong logics that arise naturally in database theory. I will discuss set theoretic questions related to their model theory in the infinite context. In particular, I will talk about recent joint work with Magidor on Löwenheim-Skolem type properties of strong logics.

Minisymposium 17

Globale Analysis

Leiter des Symposiums:

Prof. Dr. Matthias Lesch
Mathematisches Institut
Universität Bonn
Beringstraße 1
53115 Bonn, Germany

Prof. Dr. Sebastian Goette
NWF I – Mathematik
Universität Regensburg

93040 Regensburg, Germany

Globale Analysis ist ein aktives Feld mathematischer Forschung. Sie vereinigt Methoden aus Analysis (Partielle Differentialgleichungen), Topologie und (nichtkommutativer) Geometrie. Themen der Konferenz werden sein:

- Index Theorie geometrischer Differentialoperatoren
- Methoden der nichtkommutativen Geometrie in der Globalen Analysis
- Algebren von Pseudodifferentialoperatoren auf singulären Konfigurationen
- Verbindungen zur Mathematischen Physik, insbesondere Quantisierungstheorie

Sprecher:

- Ilka Agricola *(HU Berlin)*
- Daniel Grieser *(Oldenburg)*
- Kai Köhler *(Düsseldorf)*
- Markus Pflaum *(Frankfurt)*
- Werner Müller *(Bonn)*
- Elmar Schrohe *(Hannover)*
- Gregor Weingart *(Bonn)*

Dienstag, 19. September
Hörsaal 116, AVZ I, Endenicher Allee 11-13

(Details lagen bei Redaktionsschluss noch nicht vor.)

Mittwoch, 20. September
Hörsaal 116, AVZ I, Endenicher Allee 11-13

(Details lagen bei Redaktionsschluss noch nicht vor.)

Minisymposium 18

Hypergraphen

Leiter des Symposiums:

Junior-Prof. Dr. Christian Bey
Fakultät für Mathematik
Otto-von-Guericke-Universität
Magdeburg
Universitätsplatz 2
39016 Magdeburg, Germany

Dr. Benjamin Doerr
Department 1: Algorithms and Complexity
Max-Planck-Institut für Informatik

Stuhlsatzenhausweg 85
66123 Saarbrücken, Germany

Dienstag, 19. September

Übungsraum 2, Geographisches Institut, Meckenheimer Allee 166

15:00 – 15:50 **Mathias Schacht** *(Berlin)*
Generalizations of the removal lemma for hypergraphs

16:00 – 16:20 **Harout Aydinian** *(Bielefeld)*
t.b.a.

16:30 – 16:50 **Akos Kisvölscey** *(Budapest)*

17:00 – 17:20 **Christian Sohler** *(Paderborn)*
Sublinear-time approximation of the average degree in hypergraphs

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17:30 – 17:50 **N.N.**
t.b.a.

Mittwoch, 20. September

Übungsraum 2, Geographisches Institut, Meckenheimer Allee 166

15:00 – 15:20 **Anand Srivastav** *(Kiel)*
Lower bound proofs for hypergraph discrepancy

15:30 – 16:00 **Mahmoud Fouz** *(Saarbrücken)*
Hereditary discrepancies in different numbers of colours

16:00 – 16:50 **Nils Hebbinghaus** *(Saarbrücken)*
Ales Privetivy *(Prag)*
Discrepancy of sums of arithmetic progressions

17:00 – 17:20 **Martin Kutz** *(Saarbrücken)*
A decomposition-conjecture on weak positional games on hypergraphs

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17:30 – 17:50 **N.N.**
t.b.a.

Vortragsauszüge

Mathias Schacht *(Berlin)*
Generalizations of the removal lemma for hypergraphs

Ruzsa and Szemerédi established the *triangle removal lemma* by proving that: Every n-vertex graph with $o(n3)$ triangles can be made triangle free by removing $o(n2)$ edges. More general statements of that type regarding graphs were successively proved by several authors. In particular, Alon and Shapira obtained a generalization (which extends all the previous results of this type), where the triangle is replaced by a possibly infinite family of graphs and containment is induced.
We prove the corresponding result for k-uniform hypergraphs and show that: *For every (possibly infinite) family $\mathcal{F}$ of k-uniform hypergraphs and every $\eta > 0$ there exist constants $c > 0$ and $C > 0$ such that every sufficiently large k-uniform hypergraph on n vertices, which contains at most cn^{v_F} induced copies of any hypergraph $F \in \mathcal{F}$ on $v_F \leq C$ vertices can be changed by adding and deleting at most $\eta\binom{n}{k}$ edges in such a way that it contains no induced copy of any member of $\mathcal{F}$*. As a consequence we obtain that every decidable, hereditary property of uniform hypergraphs is testable with one-sided error.
The proof is based iterated applications of the hypergraph generalizations of Szemerédi's regularity lemma. This is joint work with Vojtěch Rödl from Emory University.

Harout Aydinian *(Bielefeld)*
t.b.a.

(Abstrakt lag bei Redaktionsschluss noch nicht vor.)

Akos Kisvölscey *(Budapest)*
t.b.a.

(Abstrakt lag bei Redaktionsschluss noch nicht vor.)

Christian Sohler *(Paderborn)*
Sublinear-time approximation of the average degree in hypergraphs

(Abstrakt lag bei Redaktionsschluss noch nicht vor.)

N.N.
t.b.a.

(Abstrakt lag bei Redaktionsschluss noch nicht vor.)

Anand Srivastav *(Kiel)*
Lower bound proofs for hypergraph discrepancy

In this talk we discuss proofs for lower bounds on the geometric discrepancy function starting with classical results of K. Roth for geometric as well combinatorial hypergraph discrepancy. We then proceed to szenarios with discrepancy like functions appearing in Koksma-Hlawka type inequalities of the integration error of smooth functions, for example functions in Haar wavelet spaces or Sobolev spaces. Here some new and interesting discrepancy notions arise, for which lower bounds sometimes can be proved with an variation of Roths method.

Mahmoud Fouz *(Saarbrücken)*
Hereditary discrepancies in different numbers of colours

We examine the hereditary discrepancy problem of hypergraphs in different numbers of colors. We show that the hereditary discrepancies for a hypergraph in different numbers of colors differ only by factors depending linearly on the respective numbers of colors, i.e., for any hypergraph $\mathcal{H}$ and arbitrary numbers $a, b \in \mathbb{N}_{\geq 2}$ of colors, we have

$$\text{herdisc}(\mathcal{H}, b) \leq O(a)\text{herdisc}(\mathcal{H}, a).$$

Furthermore, this bound is proven to be almost tight.

Nils Hebbinghaus *(Saarbrücken)*
Ales Privetivy *(Prag)*
Discrepancy of sums of arithmetic progressions

(Abstrakt lag bei Redaktionsschluss noch nicht vor.)

Martin Kutz *(Saarbrücken)*
A decomposition-conjecture on weak positional games on hypergraphs

(Abstrakt lag bei Redaktionsschluss noch nicht vor.)

N.N.
t.b.a.

(Abstrakt lag bei Redaktionsschluss noch nicht vor.)

Minisymposium 19

Random Discrete Structures and Algorithms

Leiter des Symposiums:

Dr. Stefanie Gerke
ETH Zürich
Institute of Theoretical
Computer Science
CAB H 36.2
Universitätsstraße 6
8092 Zürich, Switzerland

Prof. Dr. Anusch Taraz
Technische Universität München
Angewandte Geometrie und

Diskrete Mathematik
Boltzmannstraße 3
85747 Garching bei München, Germany

Donnerstag, 21. September

Übungsraum 2, Geographisches Institut, Meckenheimer Allee 166

15:00 – 15:25 **Ralph Neininger** *(Frankfurt)*
Probabilistic analysis of game tree evaluation

15:30 – 15:55 **Christian Scheideler** *(TU München)*
Adversarial mixing in virtual space

16:00 – 16:25 **Benjamin Doerr** *(MPI Saarbrücken)*
Dependant Randomized Rounding

16:30 – 16:55 **Bernd Gärtner** *(ETH Zürich)*
Clarkson's randomized linear programming algorithms revisited

17:00 – 17:25 **Anand Srivastav** *(Kiel)*
Euclidean Nearest Neighbor Problems for Random Points

17:30 – 17:55 **Berthold Vöcking** *(Aachen)*
Probabilistic Analysis of Local Search Algorithms for TSP

Freitag, 22. September

Übungsraum 2, Geographisches Institut, Meckenheimer Allee 166

15:00 – 15:25 **Volker Kaibel** *(TU Berlin, ZIB)*
0/1-Polytopes With Exponentially Small Vertex-Expansion

15:30 – 15:55 **Mihyun Kang** *(HU Berlin)*
Zufällige planare Strukturen

16:00 – 16:25 **Amin Coja-Oghlan** *(HU Berlin)*
Central and local limit theorems for the giant component

16:30 – 16:55 **Dieter Rautenbach** *(Bonn)*
Beyond Acyclic Colorings

17:00 – 17:25 **Mathias Schacht** *(HU Berlin)*
On the bandwidth conjecture of Bollobás and Komlós

Vortragsauszüge

Ralph Neininger *(Frankfurt)*

Probabilistic analysis of game tree evaluation

In the analysis of game-searching methods a basic problem is to determine the value of the root of a minimax tree with certain given numbers at its leaves (the input). Various models for the input and related evaluation algorithms have been proposed and analyzed.
We review some of these models, in particular models with input from the set $\{0,1\}$ and probabilistic models such as Pearl's model and the (random) incremental model. We discuss the complexity of evaluation algorithms under these models: a new tail bound for the complexity of Snir's randomized evaluation algorithm is given improving upon a Gaussian tail bound due to Karp and Zhang. Also a limit law of the root's value in Pearl's model is given leading to a conjecture on the asymptotic distribution of the complexity of α-β pruning.

The talk is based on the papers

Ali Khan, T. and R. Neininger (2004) Probabilistic analysis for randomized game tree evaluation. *Mathematics and Computer Science III (Vienna 2004)*, 163-174, Trends in Mathematics, Birkhuser, Basel.

Ali Khan, T., Devroye, L. and R. Neininger (2005) A limit law for the root value of minimax trees. *Electronic Communications in Probability* **10**, 273-281.

Christian Scheideler *(TU München)*

Adversarial mixing in virtual space

In this talk I will study the problem of how to keep honest and adversarial nodes well-spread in a virtual space. More precisely, I will be focusing on the space [0,1) of real numbers. At any time, every node in the system is assigned to some point in that space, and nodes may join or leave the system as they like. The problem is to find simple and efficient join and leave protocols for the nodes that are oblivious to their state yet can preserve the property that, given n nodes in the system, the following conditions are met: For any interval I of size $(c \log n)/n$, where c is a sufficiently large constant,

- I contains $\Theta(|I| \cdot n)$ nodes, and
- the honest nodes in I are in the majority.

First, I consider the case that the adversary can only issue adaptive join/leave requests for adversarial nodes and then the case that the adversary can issue adaptive join/leave requests for all nodes. For both cases, simple join and leave protocols can be constructed that preserve the conditions above, with high probability. This has interesting applications for peer-to-peer systems.

Benjamin Doerr *(MPI Saarbrücken)*
Dependant Randomized Rounding

A very successful approach to rounding problems is the one of *randomized rounding* introduced by Raghavan and Thompson (1987). Here, if $x \in [0,1]^n$, its (independent) randomized rounding y satisfies $\Pr(y_j = 1) = x_j$ and $\Pr(y_j = 0) = 1 - x_j$ independently for all $j \in [n]$. Rounding independently allows to use large deviation bounds for sums of independent random variables, which makes this a powerful method in algorithmics.
A recent development in this field are dependent approaches. Of particular interest are randomized roundings that satisfy certain cardinality constraints (sums of some variables remain unchanged). In addition to satisfying such constraints we still want the roundings to be independent enough to admit large deviation bounds.
In the talk, I will present a fairly general approach to such problems. It provides simpler and faster solutions to such rounding problems regarded in the past and has new applications that could not be solved with the earlier approaches.

Bernd Gärtner *(ETH Zürich)*
Clarkson's randomized linear programming algorithms revisited

Unique sink orientations and *violator spaces* are abstract problem classes that cover linear programming but also more general problems on which simplex-type methods may cycle even in nondegenerate situations. In this talk, I will discuss the behavior of Clarkson's randomized linear programming algorithms on problems from these classes. The goal is to extract the combinatorial properties that make the algorithms work (efficiently).

Anand Srivastav *(Kiel)*
Euclidean Nearest Neighbor Problems for Random Points

In this talk we give a probabilistic analysis for the all nearest neighbor problem for two point sets uniformly distributed in the d-dimensional unit cube. While the computation of the total nearest neighbor graph can be done with basic combinatorial arguments, the proof of concentration results seems to depend on the dimension.

The paper is joint work with Andreas Baltz and Soeren Werth, Institut für Informatik, Universität zu Kiel.

Berthold Vöcking *(Aachen)*
Probabilistic Analysis of Local Search Algorithms for TSP

2-Opt is probably the most basic and widely used local search heuristic for TSP. This heuristic achieves amazingly good results on “real world” instances both with respect to running time and approximation ratio. We present a probabilistic analysis showing that the expected number of improvement steps until 2-Opt terminates on Euclidean instances in which n points are placed uniformly at random in the plane is $\tilde{O}(n^{3+5/6})$ when starting with an initial tour computed by any greedy insertion heuristic. The best previous bound was $\tilde{O}(n^{10})$.

Our probabilistic analysis is not restricted to uniformly random instances. In principle, points can be placed by arbitrary independent continuous distributions with finite support and bounded density. In particular, different points can have different distributions. Our results can be expressed in terms of a *smoothed analysis* in which an adversary selects the initial set of points from $[0,1]^2$ and then these points are randomly perturbed with a Gaussian distribution with standard deviation σ. In this model, we obtain an upper bound of $\tilde{O}(n^{3+5/6}/\sigma)$ on the running time of 2-Opt.

Furthermore, we investigate the behavior of 2-Opt on other input models, e.g., randomly perturbed graphs, and we present an analysis of the approximation achieved by 2-Opt.

Joint work with Matthias Englert and Heiko Roeglin, RWTH Aachen.

Volker Kaibel *(TU Berlin, ZIB)*
0/1-Polytopes With Exponentially Small Vertex-Expansion

A long-standing conjecture by Mihail and Vazirani states that the graphs of 0/1-polytopes have edge-expansion at least one. A proof of this conjecture would have many important implications in the theory of randomized approximate counting. By a probabilistic construction, we show that there are d-dimensional 0/1-polytopes whose graphs have exponentially small (in d) vertex-expansion. While this may be seen as an indication that the Mihail-Vazirani conjecture is not true, we also show that our approach does not lead to a counterexample to this conjecture.

Mihyun Kang *(HU Berlin)*
Zufällige planare Strukturen

In letzter Zeit haben zufällige planare Strukturen, wie planare Graphen und outerplanare Graphen, viel Aufmerksamkeit auf sich gezogen. Typischerweise stellt man die folgenden Fragen:

- Wieviele planare Strukturen gibt es?
- Kann man eine zufällige planare Struktur gleichverteilt generieren?
- Welche Eigenschaften hat eine zufällige planare Struktur mit hoher Wahrscheinlichkeit?

Um diese Fragen zu beantworten, zerlegt man die planaren Strukturen in Teile mit höherer Konnektivität. Für die asymptotische Enumeration interpretiert man die Zerlegung mit Hilfe von generierenden Funktionen und dann verwendet man Singularitätenanalyse. Für die exakte Enumeration und zufällige Erzeugung verwendet man die sogenannte rekursive Methode. Für die typische Eigenschaften verwendet man die Probabilistische Methode bei asymptotischer Anzahl.

In meinem Vortrag zeige ich, wie man diese Methoden an einigen numerierten planaren Strukturen, z.B. outerplanaren Graphen, planaren Graphen und kubischen planaren Graphen, anwendet.

Amin Coja-Oghlan *(HU-Berlin)*
Central and local limit theorems for the giant component

Erdős and Rényi observed that in a random graph $G_{n,p}$ (or $G_{n,m}$) there occurs a *phase transition* as the average degree np (resp. $2m/n$) passes 1: if $np < 1-\epsilon$ for an arbitrarily small but fixed $\epsilon > 0$, then all connected components of $G_{n,p}$ have at most logarithmic size, while for $np > 1+\epsilon$ there is a "giant" component of linear size asymptotically almost surely as $n \to \infty$. Erdős and Rényi also computed the expected number of vertices/edges in the giant component. In this talk I present a novel approach to determining the actual *distribution* of the number of vertices/edges inside of the giant component. The techniques are purely probabilistic and include "Stein's method" as well as a bit of Fourier analysis. As a by-product, these techniques yield a new proof of Bender, Canfield, and McKay's forumla for the asymptotic number of connected graphs with a given number of vertices/edges.

This is joint work with Michael Behrisch and Mihyun Kang.

Dieter Rautenbach *(Bonn)*
Beyond Acyclic Colorings

Acyclic colorings of graphs have received a lot of attention in recent years and the probabilistic method has been applied to them quite successfully. The first notable probabilistic result about acyclic colorings is certainly Alon, McDiarmid and Reed's proof that every graph of maximum degree Δ can be acyclically (and properly) colored using $O(\Delta^{\frac{4}{3}})$ colors which implied a conjecture of Erdős. The deepest non-probabilistic result about acyclic colorings is probably Borodin's proof that every planar graph has an acyclic 5-coloring. Extending acyclicity Borodin conjectured in 1976 that every planar graph has a 5-coloring such that the union of every k color classes with $1 \leq k \leq 4$ induces a k-degenerate graph. We present results related to this conjecture.p

Mathias Schacht *(HU Berlin)*
On the bandwidth conjecture of Bollobás and Komlós

The study of sufficient degree conditions, on a given graph G, which imply that G contains a particular spanning subgraph H is one of the central areas in graph theory. A

well known example of such a result is Dirac's theorem. It asserts that any graph G on n vertices with minimum degree at least $n/2$ contains a spanning, so called Hamiltonian, cycle.

In my talk we discuss related results for 3-chromatic graphs H of bounded maximum degree and small bandwidth. In particular we show that: *For every Δ and $\gamma > 0$ there exist a constant $\beta > 0$ such that for sufficiently large n the following holds. If G is an n-vertex graph with minimum degree $\delta(G) \geq (2/3 + \gamma)n$, then it contains a spanning copy of every 3-chromatic n-vertex graph H with maximum degree $\Delta(H) \leq \Delta$ and bandwidth $\mathrm{bw}(H)$ at most βn, where $\mathrm{bw}(H) = \min_\sigma \max_{uv \in E(H)} |\sigma(u) - \sigma(v)|$ with the minimum ranging over all bijections from $V(H)$ to $[n]$.* This settles a conjecture of Bollobás and Komlós for the special case of 3-chromatic graphs H. It is known that the minimum degree condition on G is asymptotically best possible.

The proof is based on Szemerédi's regularity lemma and the so called blow-up lemma.

This is joint work with Julia Böttcher and Anusch Taraz from TU München.

Minisymposium 20

Nonlinear and Stochastic Optimization

Leiter des Symposiums:

Prof. Dr. Rüdiger Schultz
FB Mathematik
Universität Duisburg-Essen
Campus Duisburg
Lotharstraße 65
47048 Duisburg, Germany

Prof. Dr. Volker Schulz
FB 4 – Mathematik
Universität Trier

54286 Trier, Germany

Donnerstag, 21. September

Hörsaal 411 AVZ I, Endenicher Allee 11-13

15:00 – 15:50 **Stefan Volkwein** *(Graz)*
Proper orthogonal Decompostion (POD) for parametric PDEs and for optimaliy systems

16:00 – 16:20 **Roland Griesse** *(RICAM Linz)*
Elliptic Optimal Control Problems with Mixed Constraints

16:30 – 16:50 **Arnd Rösch** *(RICAM Linz)*
On optimal control problems with mixed control-state constraints

17:00 – 17:20 **Ilia Gherman** *(Trier)*
Efficient Methods for Aerodynamic Optimization

17:30 – 17:50 **Harald Held** *(Duisburg-Essen)*
Shape Optimization Under Uncertainty – A Stochastic Programming Perspective

Freitag, 22. September

Hörsaal 411 AVZ I, Endenicher Allee 11-13

15:00 – 15:50 **Werner Römisch** *(HU Berlin)*
Multistage stochastic programs: Stability and scenario trees

16:00 – 16:50 **Marc C. Steinbach** *(Zuse Institute Berlin, FH Vorarlberg)*
Optimal Control of Gas and Water Networks

17:00 – 17:50 **Oliver Stein** *(Aachen)*
Adaptive convexification for robust optimization problems

Vortragsauszüge

Stefan Volkwein *(Graz)*
Proper orthogonal Decompostion (POD) for parametric PDEs and for optimaliy systems

POD is a powerful technique for model reduction of linear and non-linear systems. It is based on a Galerkin type discretization with basis elements created from the dynamical system itself. First, POD is used to derive low-order models for a so-called λ-ω-system that is a universal model to investigate two-species reaction-diffusion problems. In the case of fast reaction kinetics and small diffusion, these systems evolve to turbulent behavior. The performance of the POD model reduction is studied in dependence on the parameters of the λ-ω-system. With increasing turbulence more POD modes are needed to capture the dynamics of the full system in a satisfactory way. Secondly, POD is applied to estimate parameters in elliptic partial differential equations. The parameter estimation is formulated in terms of an optimal control problem that is solved by an augmented Lagrangian method combined with a sequential quadratic programming algorithm. In the context of optimal control this approach may suffer from the fact that the basis elements are computed from a reference trajectory containing features which are quite different from those of the optimally controlled trajectory. Finally, a method is proposed which avoids this problem of unmodelled dynamics in the proper orthogonal decomposition approach to optimal control. It is referred to as optimality system proper orthogonal decomposition (OS-POD). The results are joined work with M. Kahlbacher, K. Kunisch, and H. Müller at the University of Graz.

Roland Griesse *(RICAM Linz)*
Elliptic Optimal Control Problems with Mixed Constraints

In this talk we consider the following class of linear-quadratic optimal control problems with state y and control u:

$$(\mathbf{P}(\delta)) \qquad \text{Minimize } \frac{1}{2}\|y - y_d\|^2_{L^2(\Omega)} + \frac{\gamma}{2}\|u - u_d\|^2_{L^2(\Omega)} - \int_\Omega y\,\delta_1\,dx - \int_\Omega u\,\delta_2\,dx$$

subject to $u \in L^2(\Omega)$ and the elliptic state equation

$$\begin{aligned} -\Delta y &= u + \delta_3 \quad \text{on } \Omega \\ y &= 0 \quad \text{on } \partial\Omega \end{aligned} \tag{3}$$

as well as pointwise pure and mixed control-state constraints

$$\begin{aligned} u - \delta_4 &\geq 0 \quad \text{on } \Omega \\ \varepsilon u + y - \delta_5 &\geq y_c \quad \text{on } \Omega. \end{aligned} \tag{4}$$

Problem $(\mathbf{P}(\delta))$ depends on a parameter $\delta = (\delta_1, \delta_2, \delta_3, \delta_4, \delta_5)$, and we prove the Lipschitz stability of the unique optimal solution in $L^\infty(\Omega)$, with respect to perturbations in δ. The presence of simultaneous control and mixed constraints (4) requires a refinement of previously used techniques.

Arnd Rösch *(RICAM Linz)*

On optimal control problems with mixed control-state constraints

Optimal control problems with mixed control-state constraints exhibit a lot of the positive properties of control constrained problems: Lagrange multiplier are measurable and bounded, optimal solutions are Lipschitz continuous for distributed elliptic control problems. Moreover, such problems can approximate optimal control problems with pure state constraints. If control constraints are given in addition, then the approximation error can be estimated. Moreover, we will show new results concerning the discretization error for this class of problems.

Ilia Gherman *(Trier)*

Efficient Methods for Aerodynamic Optimization

Constructing a new optimization method for geometric design of an aircraft is a very challenging task. It is clear that the optimization should be based on the existing flow solvers. A further demand on the optimization method is that it should have a low relative computational complexity.

In the MEGADESIGN project, we developed a *one-shot* method which is based on (partially) reduced SQP methods. The idea is to solve all of the equations simultaneously.

The method uses existing flow solvers provided to us by the German Airspace Center. Within this framework, also additional state constraints can be included.

The developed one-shot method was efficiently applied to 2D and 3D drag minimization problems with and without additional state constraints. In this talk we will present the method as well as the numerical results.

Harald Held *(Duisburg-Essen)*
Shape Optimization Under Uncertainty – A Stochastic Programming Perspective

Harald Held (Department of Mathematics, University of Duisburg-Essen)
Martin Rumpf (Institute for Numerical Simulation, University of Bonn)
Rüdiger Schultz (Department of Mathematics, University of Duisburg-Essen)

We consider an elastic body subjected to internal and external forces which are uncertain. The deformations are described by PDEs that are solved efficiently by Composite Finite Elements. The objective is, for example, to minimize a least square error compared to a target displacement. A gradient method using the shape derivative together with a level-set method is employed to solve the problem.

We show that the structure of this problem is similar to that of a two-stage stochastic linear programming problem: In the first stage, the non-anticipative decision on the shape has to be taken. Afterwards, the realizations of the random forces are observed, and the variational formulation of the elasticity system takes the role of the second-stage problem.

Werner Römisch *(HU Berlin)*
Multistage stochastic programs: Stability and scenario trees

Multistage stochastic programs are regarded as optimization problems in spaces of integrable functions. The stability of such optimization problems with respect to perturbations of the stochastic input process is adressed. We review some recent stability results and discuss their use for designing scenario tree approximations of the stochastic input process. We present a general algorithmic framework for the generation of such tree approximations and report on its implementation. Numerical experience is

provided for scenario tree approximations of multivariate processes in electricity portfolio management.

Marc C. Steinbach *(Zuse Institute Berlin, FH Vorarlberg)*
Optimal Control of Gas and Water Networks

Operative planning in supply networks with nonlinear fluid dynamics leads to large-scale discrete-continuous optimization problems over graphs. The lecture focuses on the structural analysis of such DAE and PDE network models under fixed combinatorial decisions. We present topological index criteria for DAE arising in the incompressible case and discuss implications of the index on boundary value problems resulting from full discretizations in space and time. Observing that the associated large, structured KKT systems permit a decoupling of space and time based on parallel spatial projections, we develop highly efficient solution algorithms using interior methods. Comments on the issue of discrete decisions (pump switching) are also provided. For the municipal water supply network of Berlin, we finally present results of minimum-cost operation under reliable demand forecast.

Oliver Stein *(Aachen)*
Adaptive convexification for robust optimization problems

We present a new numerical solution method for robust optimization problems in the absence of convexity. Its main idea is to adaptively construct convex relaxations of the lower level problem, replace the relaxed lower level problems equivalently by their Karush-Kuhn-Tucker conditions, and solve the resulting mathematical programs with complementarity constraints. In contrast to the commonly used approaches, this approximation produces *feasible iterates* for the original robust problem.

The convex relaxations are constructed with ideas from the αBB method of global optimization. The necessary upper bounds for functions on box domains can be determined using the techniques of interval arithmetic, where our algorithm already works if only one such bound is available for the problem.

We show convergence of stationary points of the approximating problems to a stationary point of original robust problem within arbitrarily given tolerances. Numerical examples illustrate the performance of the method.

Minisymposium 21

Automorphic forms and their applications

Leiter des Symposiums:

PD Dr. Nils Scheithauer
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Universität Heidelberg
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69120 Heidelberg, Germany

Prof. Dr. Jan H. Bruinier
Mathematisches Institut
Universität zu Köln
Weyertal 86-90
50931 Köln, Germany

Montag, 18. September

HS V, Hauptgebäude, Regina-Pacis-Weg

15:00 – 15:50 **Don Zagier** *(MPI Bonn)*
t.b.a.

16:00 – 16:20 **Viacheslav Nikulin** *(Liverpool)*
Correspondences of a K3 surface with itself via moduli of sheaves

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16:30 – 16:50 **Kathrin Bringmann** *(Madison)*
Freeman Dyson's "Challenge for the Future": The mock theta functions

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17:00 – 17:20 **Geoffrey Mason** *(Santa Cruz)*
Ghosts and the Riemann theta functions

17:20 – 17:50 **Ulf Kühn** *(HU Berlin)*
Arakelov theory on modular curves

Dienstag, 19. September

Hörsaal 116, AVZ I, Endenicher Allee 11-13

15:00 – 15:50 **Eduard Looijenga** *(Utrecht)*
ocally symmetric divisors in locally symmetric varieties

16:00 – 16:20 **Hironori Shiga** *(Chiba)*
AGMs and some Picard modular forms

16:30 – 16:50 **Bernhard Heim** *(MPI Bonn)*
Special values of automorphic L-functions

17:00 – 17:20 **Amanda Folsom** *(MPI Bonn)*
Modular units

17:30 – 17:50 **Rainer Weissauer** *(Heidelberg)*
t.b.a.

Mittwoch, 20. September

Hörsaal 116, AVZ I, Endenicher Allee 11-13

15:00 – 15:50 **Gerard van der Geer** *(Amsterdam)*
Siegel modular forms and curves over finite fields

16:00 – 16:20 **Özlem Imamoglu** *(ETH Zürich)*
Zeroes of the Weierstrass p-function and hypergeometric series

16:30 – 16:50 **Shuichi Hayashida** *(Siegen)*
The Ikeda lifting and Jacobi forms of scalar index of general degree

17:00 – 17:20 **Tobias Mühlenbruch** *(Clausthal)*
Hurwitz continued fractions and Ruelle's transfer operator

17:30 – 17:50 **Nils-Peter Skoruppa** *(Siegen)*
Jacobi forms of weight 1 and applications

Vortragsauszüge

Don Zagier *(MPI Bonn)*
t.b.a.

(Abstrakt lag bei Redaktionsschluss noch nicht vor.)

Viacheslav Nikulin *(Liverpool)*
Correspondences of a K3 surface with itself via moduli of sheaves

I shall review my (some of them joint with Carlo Madonna) results about correspondences of a K3 surface with itself. Surprisingly, sometimes elements of the Picard lattice of a K3 surface permit to construct interesting 2-dimensional algebraic cycles on the product of the K3 surface with itself. E.g. see recent preprint math.AG/0605362.

Kathrin Bringmann *(Madison)*
Freeman Dyson's "Challenge for the Future": The mock theta functions

In his last letter to Hardy, Ramanujan defined 17 peculiar functions which are now referred to as his mock theta functions. Although these mysterious functions have been investigated by many mathematicians over the years, many of their most basic properties remain unknown. This inspired Freeman Dyson to proclaim

> "The mock theta-functions give us tantalizing hints of a grand synthesis still to be discovered. Somehow it should be possible to build them into a coherent group-theoretical structure, analogous to the structure of modular forms which Hecke built around the old theta-functions of Jacobi. This remains a challenge for the future."

Freeman Dyson, 1987, Ramanujan Centenary Conference

Here we announce a solution to Dyson's "challenge for the future" by providing the "coherent group-theoretical structure" that Dyson desired in his plenary address at the 1987 Ramanujan Centenary Conference. In joint work with Ken Ono, we show that Ramanujan's mock theta functions, as well a natural generalized infinite class of mock theta functions may be completed to obtain Maass forms, a special class of modular

forms. We then use these results to prove theorems about Dyson's partition ranks. In particular, we shall prove the 1966 Andrews-Dragonette Conjecture, whose history dates to Ramanujan's last letter to Hardy, and we shall also prove that Dyson's ranks 'explain' Ramanujan's partition congruences in an unexpected way.

Geoffrey Mason *(Santa Cruz)*
Ghosts and the Riemann theta functions

We sketch the general connection between vertex operators and automorphic forms and show that genus 2 partition functions associated with the ghost system, which is part of the bosonic string, are the corresponding Riemann theta functions.

Ulf Kühn *(HU Berlin)*
Arakelov theory on modular curves

Using the rich and well understood arithmetic of elliptic modular curves and their automorphic forms we calculate upper bounds for the Arakelov self intersection number ω^2.

Eduard Looijenga *(Utrecht)*
Locally symmetric divisors in locally symmetric varieties

A locally symmetric variety that possesses a locally symmetric divisor is either a ball quotient or of orthogonal type (IV in the Cartan classification). In algebraic geometry, one often encounters the situation that certain algebraic objects (varieties, usually) are parameterized by a locally symmetric variety as above and that the degenerate objects are parameterized by a locally symmetric divisor. After giving some examples we shall explain why it is that the degeneracy locus tends to be like this. We also go into the question of when such a divisor is definable by an automorphic form.

Hironori Shiga *(Chiba)*
AGMs and some Picard modular forms

We present some arithmetic-geometric means (we say AGM) with three terms extending classical AGMs with two terms. We can see such an AGM as a function of two variables with normalized initial data, and this function has an expression via the Appell hypergeometric function F_1. We can introduce these AGMs based on the theory of modular forms on the complex hyperball with respect to some Picard modular groups and the expression of some special CM-isogenies of abelian varieties.

Bernhard Heim *(MPI Bonn)*
Special values of automorphic L-functions

The Saito-Kurokawa conjecture and a certain Hecke invariant subspace, the Maass Spezialschar, play a fundamental role in studying the Siegel three-fold. In this talk a model of the space of Siegel modular forms of the three-fold is introduced, which recovers the special values of corresponding L-functions predicted by the Gross-Prasad conjecture. The vanishing orders of these special values give a precise description of the property if a modular form is a Saito-Kurokawa lift or not. This leads to applications for Siegel modular forms of arbitrary even degree.

Amanda Folsom *(MPI Bonn)*
Modular units

In this talk I will discuss a particular family of modular units constructed using functional solutions to q-difference equations found in the work of Selberg. Arising in this way, these objects are of interest for various analytic properties and combinatorial interpretations. Dually, we exhibit fundamental algebraic roles played by these modular units, including those within the modular function fields, the modular unit groups, the cuspidal divisor class groups, class field theory, and the cyclotomic theory.

Rainer Weissauer *(Heidelberg)*
t.b.a.

(Abstrakt lag bei Redaktionsschluss noch nicht vor.)

Gerard van der Geer *(Amsterdam)*
Siegel modular forms and curves over finite fields

The cohomology of local systems on moduli spaces of curves and abelian varieties can be expressed in terms of modular forms. Moduli spaces of curves over finite fields can thus be used to obtain information about Siegel modular forms. In the lecture we will try to explain joint work with Carel Faber on Siegel modular forms of genus 2.

Özlem Imamoglu *(ETH Zürich)*
Zeroes of the Weierstrass p-function and hypergeometric series

Surprisingly the location of the zeroes of the Weierstrass $\wp$-function was not known until 1982, when Eichler and Zagier found for them a beautiful integral formula. In a joint paper with W. Duke we were able to “deuniformizethe Eichler Zagier formula and write the zeroes in terms of generalized hypergeometric series. Our formulas can be thought as the analog of classical formulas for the periods in terms of the Gauss hypergeometric series.

Shuichi Hayashida *(Siegen)*
The Ikeda lifting and Jacobi forms of scalar index of general degree

T. Yamazaki showed a relation between Fourier-Jacobi coefficients of Siegel Eisenstein series by using certain Hecke operators which change the index of Jacobi forms. (In case of degree 1, this Hecke operator coincides with the V_m operator introduced by Eichler-Zagier.) This relation gave a generalization of the Maass-relation for Siegel Eisenstein series. In this talk, we prove a similar relation for the Siegel cusp forms which are obtained by Ikeda lifting.

Tobias Mühlenbruch *(Clausthal)*

Hurwitz continued fractions and Ruelle's transfer operator

We report a recent development concerning the transfer operator associated to a dynamical system. This is joint work with Dieter Mayer and Fredrik Strömberg (TU Clausthal). We present the well known Hurwitz continued fractions and the associated dynamical system. We present also a Ruelle transfer operator L_β for this dynamical system. The transfer operator L_β is related to the Selberg ζ-function associated to the geodesic flow on the modular surface $\mathrm{SL}_2(\mathbf{Z})\backslash\mathbf{H}$. Moreover, certain eigenfunctions of the transfer operator L_β have a cocycle interpretation. These cocycles are associated to Maass cusp forms using a theorem due to Bruggeman, Lewis and Zagier. Interestingly, all these connections between the stated areas in dynamical systems, ergodic theory and number theory also seem to hold for Hecke triangle groups. Finally, we present numerical calculations of the spectrum of the transfer operator for some selected Hecke triangle groups, pointing out the relation to Maass cusp forms.

Nils-Peter Skoruppa *(Siegen)*

Jacobi forms of weight 1 and applications

In the study of Siegel modular forms of critical weight and in the context of certain conjectures on product formulas for Jacobi forms the weight 1 Jacobi forms on subgrous of $SL(2,\mathbb{Z})$ play an important role. We report on the computation of dimension formulas for weight 1 Jacobi forms, some applications and open questions.

Minisymposium 22

Gitterfreie Diskretisierungstechniken und Partikelmethoden

fällt aus / canceled

Minisymposium 23

Mathematische Physik und Informationstheorie

Leiter des Symposiums:

Prof. Dr. Rüdi Seiler
Technische Universität Berlin
Institut für Mathematik, MA 7-2
Straße des 17. Juni 136
10623 Berlin, Germany

Donnerstag, 21. September

Seminarraum 1 (Raum 205), Institut für Physikalische und Theoretische Chemie
Wegelerstr. 12

(Details lagen bei Redaktionsschluss noch nicht vor.)

Freitag, 22. September

Seminarraum 1 (Raum 205), Institut für Physikalische und Theoretische Chemie
Wegelerstr. 12

(Details lagen bei Redaktionsschluss noch nicht vor.)

Minisymposium 24

Probability and Geometry

Leiter des Symposiums:

Prof. Dr. Shizan Fang
Université de Bourgogne
Institute de Mathématiques
BP 47 870

21078 Dijon, France

Prof. Dr. Alexander Grigor'yan
Universität Bielefeld
Fakultät für Mathematik
Universitätsstraße 25
Postfach 10 01 31
3501 Bielefeld, Germany

Dr. Anton Thalmaier
Université de Poitiers
Département de Mathématiques
Téléport 2 – BP 30179
86962 Futuroscope Chasseneuil Cedex, France

The goal of this special session is to bring together people working in Analysis, Geometry or Probability and to focus on recent developments in *Geometric Analysis on Riemannian manifolds, Diffusion processes on fractal and singular spaces, Stochastic differential geometry, Stochastic analysis in infinite dimensions*.

It is well-known that Brownian motion and martingales on manifolds or vector bundles connect local and global geometry in an intrinsic way, and that many questions related to the geometry of Laplace operators have a direct probabilistic counterpart. Furthermore probabilistic methods often extend naturally to areas, like singular spaces or infinite dimensional spaces, where standard tools of differential analysis or PDE methods fall short. This Mini-Symposium intends to focus on recent progress in these areas.

Donnerstag, 21. September

Übungsraum 3, Geographisches Institut, Meckenheimer Allee 166

14:00 – 14:45 **Thierry Coulhon** *(Cergy)*
Large time behavior of heat kernels on forms

14:45 – 15:30 **Shigeki Aida** *(Osaka)*
Semi-classical limit of the bottom of spectrum of a Schrödinger operator on a path space over a compact Riemannian manifold

15:30 – 16:00 *Coffee break*

16:00 – 16:45 **Ana Bela Cruzeiro** *(Lisbon)*
On a stochastic Euler equation

16:45 – 17:30 **Feng-Yu Wang** *(Beijing)*
Estimates of the first Neumann eigenvalue and the log-Sobolev constant on non-convex manifolds

17:30 – 18:15 **Fuzhou Gong** *(Beijing)*
Exponential ergodicity, spectral gap, and their applications

Freitag, 22. September

Übungsraum 3, Geographisches Institut, Meckenheimer Allee 166

14:00 – 14:45 **Ichiro Shigekawa** *(Kyoto)*
One dimensional diffusions conditioned to be non-explosive

14:45 – 15:30 **Roland Friedrich** *(MPI Bonn)*
Diffusions on moduli spaces and generalised Stochastic Loewner Evolutions

15:30 – 16:00 *Coffee break*

16:00 – 16:45 **José A. Ramírez** *(Costa Rica)*
Beta ensembles, stochastic Airy spectrum, and a diffusion

16:45 – 17:30 **Peter K. Friz** *(Cambridge)*
Stochastic processes as rough paths and Carnot-Caratheodory geometry

17:30 – 18:15 **Marc Arnaudon** *(Poitiers)*
Gradient estimates for positive harmonic functions, Harnack inequalities and heat kernel estimates on Riemannian manifolds, by stochastic analysis

18:15 – 19:00 **Jinghai Shao** *(Beijing)*
Optimal transportation maps for Monge-Kantorovich problem on loop groups

Vortragsauszüge

Thierry Coulhon *(Cergy)*

Large time behavior of heat kernels on forms

This is a report on a joint work with Qi S. Zhang. We derive large time upper bounds for heat kernels on vector bundles of differential forms on a class of non-compact Riemannian manifolds under certain curvature conditions.

Shigeki Aida *(Osaka)*

Semi-classical limit of the bottom of spectrum of a Schrödinger operator on a path space over a compact Riemannian manifold

We determine the limit of the bottom of spectrum of Schrödinger operators with variable coefficients on Wiener spaces and path spaces over finite dimensional compact Riemannian manifolds under semi-classical limit. The problem on path spaces over Riemannian manifolds are considered as a problem on Wiener spaces by Ito's map. However the coefficient operator is not a bounded linear operator and the dependence on the path is not continuous in the uniform convergence topology if the Riemannian curvature tensor on the underling manifold is not equal to 0. The difficulties are solved by using unitary transformations of the Schrödinger operators by approximate ground state functions and estimates in the rough path analysis.

Ana Bela Cruzeiro *(Lisbon)*

On a stochastic Euler equation

We follow Arnold's approach of Euler equation as a geodesic on the group of diffeomorphisms and prove the existence of a stochastic perturbation of this equation when the underlying manifold is the two dimensional torus.

This is joint work with F. Flandoli and P. Malliavin.

Feng-Yu Wang *(Beijing)*
Estimates of the first Neumann eigenvalue and the log-Sobolev constant on non-convex manifolds

A number of explicit lower bounds are presented for the first Neumann eigenvalue on non-convex manifolds. The main idea to derive these estimates is to make a conformal change of the metric such that the manifold is convex under the new metric, which enables one to apply known results obtained in the convex case. This method also works for more general functional inequalities. In particular, some explicit lower bounds are presented for the log-Sobolev constant on non-convex manifolds.

Fuzhou Gong *(Beijing)*
Exponential ergodicity, spectral gap, and their applications

In this talk, first we give some reason for ergodic theory from our knowledge. Secondly, we present a characterization of spectral gap for positive operators and positive C_0-semigroups in L^p-space with $1 < p < +\infty$, and we describe an equivalent relation between spectral gap and exponential ergodicity of Markov chains or Markov processes. As application, we give the existence of spectral gap to Donsker's invariance principle and Strassen's strong invariance principle for Markov chains or Markov processes, as well as some results on the existence of spectral gap for Schroedinger operators and Girsanov semigroups. Finally, we introduce background and mathematical framework of the mass gap (or spectral gap) problem on loop spaces; we give a survey on this problem and formulate some important open problems on loop spaces concerning this problem.

Ichiro Shigekawa *(Kyoto)*
One dimensional diffusions conditioned to be non-explosive

We consider one dimensional diffusions conditioned to be non-explosive. Suppose we are given a minimal diffusion process $\{X_t, P_x\}$ on an interval (l_1, l_2). Let ζ be its explosion time. If $P_x[\zeta = \infty] > 0$, then the measure conditioned to be non-explosive is defined

by

$$P_x[\,\cdot\,|\,\zeta=\infty] = P_x[\,\cdot\,\cap\zeta=\infty]/P_x[\zeta=\infty].$$

If $P_x[\zeta=\infty]=0$, then the measure conditioned to be non-explosive is defined as the limit

$$\lim_{T\to\infty} P_x[\,\cdot\,|\,\zeta>T].$$

If the limit exists and the limit is a diffusion process, we call it a *surviving diffusion*. We are interested in the following problems:

(1) When does the surviving diffusion exist?
(2) Characterization of the surviving diffusion.

The surviving diffusion is characterized as a h-transform of the original process by the λ-harmonic function φ, λ being the principal eigenvalue.

Roland Friedrich *(MPI Bonn)*
Diffusions on moduli spaces and generalised Stochastic Loewner Evolutions

In this talk we shall discuss a very general construction principle of measures on paths on Riemann surfaces. These curves naturally arise e.g. as the fluctuating phase boundaries of statistical mechanics models in the scaling limit. The fundamental observation is that a certain class of diffusion processes on a dressed moduli space generates random paths / sets on the surfaces themselves.
In our framework we obtain the “ordinarySStochastic Lœwner Evolution (SLE), as a special case; thereby showing the underlying global geometric structure, as well.
Further, via the representation theory of infinite dimensional Lie algebras, we shall make contact with other mathematical / physical fields, in particular with Conformal Field Theory (CFT).

José A. Ramírez *(Costa Rica)*
Beta ensembles, stochastic Airy spectrum, and a diffusion

This talk will be about a connection between stochastic differential operators and the standard ensembles of Random Matrix Theory. It is joint work with B. Rider.
Building on earlier work of A. Edelman, I. Dumitriu, and B. Sutton we prove that the largest eigenvalues of the general beta-ensemble of Random Matrix Theory, properly

centered and scaled, converge in distribution to the law of the low lying eigenvalues of a random operator of Schrödinger type. The latter is

$$-\frac{d^2}{dx^2} + x + \frac{2}{\sqrt{\beta}}\, b'(x)$$

acting on $L^2(R_+)$ with Dirichlet boundary condition at $x = 0$. Here $b'(x)$ denotes a standard White Noise and the $\beta > 0$ is that of the original ensemble.
Based on this convergence, we provide a new characterization of the Tracy-Widom type laws (for all β) in terms of the explosion/non-explosion a one-dimensional diffusion.

Peter K. Friz *(Cambridge)*
Stochastic processes as rough paths and Carnot-Caratheodory geometry

Brownian motion on the step-n free nilpotent group with d generators is a well-known object; in particular, there are Gaussian heat-kernel bounds in term of the Carnot-Caratheodory metric. The resulting sample path regularity is exactly the required regularity in the sense of Lyons' rough path theory. In fact, it suffices to consider n=2, that is, standard Brownian motion and Levy's area.
If one replaces standard Brownian motion by (i) a continuous martingale or (ii) a suitable Gaussian process there are alternative ways to construct Levy's area. The required sample path regularity in the rough path sense can be shown via old ideas from Lepingle and Wiener-Ito chaos integrability respectively.
Finally, if one considers (iii) Markov process with uniformly sub-elliptic generators the theory of Dirichlet forms yields Gaussian heat-kernel bounds and we obtain a large class of rough paths. A support description on path space was conjectured by T. Lyons and we will report on some progress in this direction.

Joint work with N. Victoir.

Marc Arnaudon *(Poitiers)*
Gradient estimates for positive harmonic functions, Harnack inequalities and heat kernel estimates on Riemannian manifolds, by stochastic analysis

The talk is divided into three parts; we report on recent work with Bruce Driver, Anton Thalmaier and Feng-Yu Wang.

In the first part we prove gradient estimates for positive harmonic functions on Riemannian manifolds by using a Bismut type inequality which is derived by an integration by parts argument from an underlying submartingale. A crucial but elementary ingredient is that positive local martingales have moments of order $\beta \in]0,1[$ dominated by $C_\beta\, z$ where C_β is a universal positive constant and z is the starting point of the local martingale.
In the second part, coupling by parallel translation, along with Girsanov's theorem, is used to establish a new version of a dimension-free Harnack inequality for diffusion semigroups on Riemannian manifolds with Ricci curvarture unbounded below. As an application, in the symmetric case, a Li-Yau type heat kernel bound is presented for such semigroups.
In the third part we prove Li-Yau and Hamilton estimates for heat kernels in compact manifolds by replacing classical maximum principle by submartingale arguments. For Hamilton's estimate, we demonstrate that a certain quadratic form valued semimartingale can not exit the set of nonpositive quadratic forms, outside of which it would have a drift contradicting its known asymptotic behaviour.

Jinghai Shao *(Beijing)*
Optimal transportation maps for Monge-Kantorovich problem on loop groups

Monge-Kantorovich problem is to consider how to move one distribution to another one as efficiently as possible. The efficiency is measured w.r.t. a cost function $c(x,y)$. It is naturally connected with the Wasserstein distance between two measures and also with the transportation cost inequality. In this work, we consider the Monge-Kantorovich problem on loop groups. Let G be a compact Lie group, and consider the loop group $\mathcal{L}_eG := \{\ell \in C([0,1],G);\, \ell(0) = \ell(1) = e\}$. Let ν be the heat kernel measure at time 1. For any density function F w.r.t. ν on $\mathcal{L}_eG$ with $\mathrm{Ent}_\nu(F) < \infty$, we shall show that there exists a unique optimal transportation map $\mathcal{T} : \mathcal{L}_eG \to \mathcal{L}_eG$ which pushes ν forward to $F\nu$. Our work is based partly on McCann's result on the Riemannian manifold (2001) and partly on the Feyel and Üstünel's work (2002), where they treated the Monge-Kantorovich problem in the abstract Wiener space.

Minisymposium 25

Inverse Probleme und Inkorrektheits-Phänomene

Leiter des Symposiums:

HD Dr. Sybille Handrock-Meyer
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TU Chemnitz
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Prof. Dr. Bernd Hofmann
Fakultät für Mathematik
TU Chemnitz
09107 Chemnitz, Germany

Inverse problems and ill-posedness phenomena as their intrinsic properties play a central role in several areas of mathematical research. Among others, they appear in connection with the detemination of system parameters from input-output measurements, and the reconstruction of not directly observable physical quantities from indirect measurements. The aim of the symposium is to bring together analytical, numerical and stochastical aspects of inverse problems theory. New theoretical results, interesting applications and numerical case studies will be presented.

Dienstag, 19. September

Seminarraum 17, AVZ I, Endenicher Allee 11-13

15:00 – 15:25 **Hans-Jürgen Reinhardt** *(Siegen)*
Approximate Solutions to Inverse Problems for Elliptic Equations

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15:30 – 15:55 **Sungwhan Kim** *(Daejeon-Korea)*
Inversion of Gravitational Potential Field Data: Isolated Interpretation Model

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16:00 – 16:25 **Thorsten Hohage** *(Göttingen)*
Convergence rate analysis of regularized Newton methods with random noise

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16:30 – 16:55 **Sybille Handrock-Meyer** *(Chemnitz)*
An inverse problem for the Grad-Schafranov equation

17:00 – 17:25 **Bernd Büchler** *(Kaiserslautern)*
The Error Localizing Property of Absolutely a-Compatible Operators

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17:30 – 17:55 **Bernd Hofmann** *(Chemnitz)*
Some new results on approximate source conditions

18:00 – 18:25 **Torsten Hein** *(Chemnitz)*
The potential of descriptive multiparameter regularization approaches

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18:30 – 18:55 **Horst Heck** *(Darmstadt)*
Stability Estimates for the Inverse Conductivity Problem with Partial Cauchy Data

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Vortragsauszüge

Hans-Jürgen Reinhardt *(Siegen)*

Approximate Solutions to Inverse Problems for Elliptic Equations

In this contribution we study Cauchy problems for 2-d. elliptic partial differential equations. These consist in determining a function – and its normal derivative – on one side of a rectangular domain from Cauchy data on the opposite side. With Cauchy data we mean the function itself and its normal derivative. On the other parts of the boundary Dirichlet or Neumann data are given. This type of problems is known to be illposed. Hadamard gave a classical example in 1923 demonstrating its illposedness. It should be noted that such Cauchy problems are conditionally well-posed which means that under certain restrictions on the data the problems are well-posed. Approximate solutions can be obtained by a semidiscretization of the rectangular domain which leads to a coupled system of boundary value problems for ordinary differential equations. The system can be decoupled by solving an eigenvalue problem in advance.
We study its stability (with respect to perturbations in the data) as well as the error behaviour in terms of the discretization parameter (for the semidiscretization).

References:

Charton, M., Reinhardt, H.-J.: Approximation of Cauchy problems for elliptic equations using the method of lines, WSEAS Transactions on Math., 4/1 (2005), 64-69.

Sungwhan Kim *(Daejeon-Korea)*

Inversion of Gravitational Potential Field Data: Isolated Interpretation Model

Gravity data inversion is an important technique for understanding the Earth's interior through its surface gravitational potential and has the wide variety of applications in exploration geophysics, mainly in finding deposits of ores, estimating the shape and depth extent of base of salt diapirs containing oil or gas, and determining the geological basement structure. Most of significant inverse problems in gravitational potential fields use one of three interpretation models : ore type, structural type or complicated distribution of sources (Mudretsova and Veselov ed., Gravirazvedka. Nedra. Moskva. (Gravimetry. Nedra, Moscow), p.228-235). We give our attention to the first one, ore type. Explorations of ores, deposits of oil and gas, and cavities through gravitational potential can be reduced to the ore category to determine the geometrical shape of isolated bodies with

constant physical parameters. This presentation is devoted to mathematical analysis of gravity data inversion. We have a great interest in finding a prior information on a gravity source and understanding how much the information makes the gravity inversion problem stable. We also propose a quite simple reconstruction algorithm of a gravity source.

Thorsten Hohage *(Göttingen)*
Convergence rate analysis of regularized Newton methods with random noise

We consider the problem to estimate a quantity a in a separable Hilbert space given measurements of a function u related to a by $F(a) = u$ with a nonlinear operator F. The measurements are perturbed by random noise. In typical applications a is an unknown coefficient in a partial differential equation, and u is (part of) the solution to the differential equation.
We show that for regularized Newton methods the same rates of convergence can be achieved as for the underlying linear regularization method if the smoothness of the solution is known. For unknown smoothness we show that Lepskij's method yields a rate of convergence which differs from the optimal rate only by a logarithmic factor. The theoretical results are illustrated by numerical experiments.

Sybille Handrock-Meyer *(Chemnitz)*
An inverse problem for the Grad-Schafranov equation

This talk presents research which obtained as a joint work with A.S. Demidov (Moscow). We consider the Grad-Schafranov equation

$$\Delta u = a\,u + b \geq 0 \qquad \text{in} \qquad \Omega,$$

with homogeneous boundary conditions, where a and b are real constants. An inverse problem consists in the following: Under which conditions one can identify the constants a and b simultaneously from knowledge of the outward normal derivative. Some results in the cases $n = 2$ and $n = 3$ are discussed

Bernd Büchler *(Kaiserslautern)*

The Error Localizing Property of Absolutely a-Compatible Operators

On certain function spaces X compactly disturbed multiplication operators $T = \Lambda_a - K : X \to X$ usually lead to ill-posed inverse problems (T, X, X), if the multiplier function a has zeros on its domain of definition. In this context, we present a classification of compact perturbations K in dependence on the multiplier functions a, such that the corresponding ill-posed problems (T, X, X) behave like the reduced ill-posed problems of the form (Λ_a, X, X) with respect to a suitably chosen regularization method. Compact perturbations having the above mentioned property are called absolutely a-compatible – they lead to an error localizing phenomenon, that occurs in the framework of regularizing (T, X, X). We give examples and discuss classes of absolutely a-compatible operators in case of X being the Banach space of continuous functions on a compact interval and in case of X being the Hilbert space of square-integrable functions on a compact interval. Moreover, we explain for a special class of absolutely a-compatible operators the connection with the Lavrentiev resolvent condition. One will see, that dealing with ill-posed inverse problems (T, X, X) there is a strong interaction between multiplication operators, classes of absolutely a-compatible operators and suitably chosen regularization methods.

Bernd Hofmann *(Chemnitz)*

Some new results on approximate source conditions

This talk presents research which was in various combinations partly done in collaboration with Dana Düvelmeyer (TU Chemnitz), Peter Mathé (WIAS Berlin) and Masahiro Yamamoto (Univ. Tokyo). There are given some new ideas and results for finding convergence rates in regularization for ill-posed linear inverse problems with compact and non-compact forward operators based on the consideration of approximate source conditions. In this context, we exploit distance functions measuring the violation of a source condition that works as a benchmark. Under specific range inclusions the decay rate of distance functions is verified explicitly. Applications to non-compact multiplication operators are given. An important new result is that we can show for compact operators a one-to-one correspondence between the maximal power type decay rates for the distance functions and maximal exponents of Hölder rates in Tikhonov regularization

linked by the specific singular value expansion of the solution element. Some numerical studies on simple integration illustrate the compact operator case and the specific situation of discretized problems.

Torsten Hein *(Chemnitz)*
The potential of descriptive multiparameter regularization approaches

Tikhonov-Phillips regularization is probably one of the most popular and best-understood regularization methods. Besides the regularization parameter which can be chosen for example by the discrepancy principle the choice of the penalty functional seems to be very crucial. In particular, if the solution which has to be determined has inhomogeneous properties or the noise-level is known only partially there probably does not exist an 'optimal' penalty term. We can overcome such problems with multi-parameter regularization. Instead a single regularization parameter and penalty we introduce a vector of regularization parameters with corresponding penalty functionals. The applications are various. So we can combine (partial) Tikhonov regularization with (partial) descriptive regularization approaches if we know a priori information about our solution. We present a discrepancy-like parameter choice based on Lagrangian techniques. An algorithm for solving the corresponding problem is proposed and illustrated by a numerical example.

Horst Heck *(Darmstadt)*
Stability Estimates for the Inverse Conductivity Problem with Partial Cauchy Data

We consider the parameter identification problem for the conductivity equation as well as for the Schrödinger equation using partial Cauchy data. We derive stability estimates for the local Dirichlet-to-Neumann maps associated with these inverse problems.

Minisymposium 26

Mathematics in the Biosciences

Leiter des Symposiums:

Prof. Dr. Wolfgang Alt
Theoretische Biologie (IZMB)
Universität Bonn
Kirschallee 1
53115 Bonn, Germany

During the last years, modern biosciences have opened their doors widely: they do not only call for informatics and data processing techniques in order to master their huge amounts of experimental results, but they particularly need and want to implement appropriate tools of mathematical modelling and analysis. This minisymposium is intended to offer a selected view into this still growing field of “Biomathematics”, by presenting a series of talks on some typical biological questions together with the suggested mathematical solutions. In-between the presentations, enough time will be reserved for critical discussion and fruitful exchange of ideas.

The talks shall show that, for modelling biological processes and for understanding their particular theoretical stuctures, interesting and often newly stimulated mathematical methods are required, used and invented. The presented topics include: Nonlinear renewal equations for structured population dynamics, models for cell-cell communication in immune systems, stochastic and continuum descriptions of cell movement and membrane deformation as well as statistics of polymer cleavage fragmentation, multiple sequence alignment, and genetic association analysis.

Donnerstag, 21. September

Übungsraum 4, Geographisches Institut, Meckenheimer Allee 166

15:00 – 15:50 **Odo Diekmann** *(Utrecht)*
General Theory of Nonlinear Renewal Equations with Applications

16:00 – 16:20 **Thomas Hoefer** *(HU Berlin)*
Cell Communication in Immune Systems

16:30 – 16:50 **Sven Rahman** *(Bielefeld)*
Cleavage fragment statistics

17:00 – 17:20 **Tobias Müller** *(Würzburg)*
A New View on Multiple Alignment

17:30 – 17:50 **Tim Becker** *(Bonn)*
Haplotype Sharing and Association Analysis

Donnerstag, 21. September

Übungsraum 4, Geographisches Institut, Meckenheimer Allee 166

15:00 – 15:50 **Benoit Perthame** *(ENS, Paris)*
Cell Movement and Interactions

16:00 – 16:20 **Florentin Wörgötter** *(Göttingen)*
Predicitve Mechanisms in Closed-Loop Sensori-Motor Systems: The Convergence of Differential Hebbian Learning

16:30 – 16:50 **Axel Voigt** *(caeser, Bonn)*
Surface Flow Models for Biomembranes

Vortragsauszüge

Odo Diekmann *(Utrecht)*
General Theory of Nonlinear Renewal Equations with Applications

By doing the bookkeeping for structured populations in terms of the history of the population birth rate and the history of the environmental interaction variables, one obtains delay equations.
A delay equation is a rule for extending (in one direction, the future) a function that is originally defined on an interval. The rule either specifies the derivative in the right end point or the function itself. Perturbation theory for dual semigroups (also called sun-star calculus) provides a convenient abstract framework for dealing with both of these cases in a unified manner.
Sun-star versions of the Principle of Linearized Stability and the Hopf Bifurcation Theorem therefore apply to structured population models and one can make rigorous inferences concerning dynamic behaviour from information about the position of the roots of a characteristic equation in the complex plane, and how these change as a function of a parameter.
As an example, we show how variable maturation delay can lead to oscillations.

The lecture is based on joint work with Philipp Getto, Mats Gyllenberg and Hans Metz.

Thomas Hoefer *(HU Berlin)*
Cell Communication in Immune Systems

T cells are critical players in immune responses whose activation is tightly regulated. I will discuss networks of gene regulation and intercellular signalling involved in the control of T cell proliferation and differentiation of memory T cells. Cell-biological research has identified multiple feedbacks loops acting both within the cells and in an autocrine fashion via secreted signals. Mathematical models will be introduced that demonstrate how feedbacks can support all-or-none cellular decisions and the imprinting of immunological memory. Moreover, a model of intercellular communication between T cell subsets suggests that signalling via readily diffusible cytokines –the main messengers in the immune system– can be strongly controlled in spatial range by autocrine feedbacks. Experimental approaches that were triggered by the theoretical work will be discussed.

Sven Rahman *(Bielefeld)*
Cleavage fragment statistics

Peptide mass fingerprinting is a technique to identify a protein from its fragment masses obtained by mass spectrometry after enzymatic fragmentation: An experimental mass fingerprint is compared with reference fingerprints obtained from protein databases by in-silico digestion. Recently, much attention has been given to the questions of how to score such an alignment of mass spectra and how to evaluate its significance; results have been developed mostly from a combinatorial perspective. In particular, existing methods generally do not (or only at the price of a combinatorial explosion) capture the fact that the same amino acid can have different masses because of, e.g., isotopic distributions or variable chemical modifications.
We offer several new contributions: We introduce the notions of a probabilistically weighted alphabet, where each character can have different masses according to a specified probability distribution, and the notion of a random weighted string as a fundamental model for a random protein. We then develop a general computational framework, which we call Weight Accumulating Markov Models (WAMMs), to obtain various cleavage fragment statistics of random proteins. We obtain general formulas for the length distribution of a fragment, the number of fragments, the joint length-mass distribution, and for fragment mass occurrence probabilities, and special results for so-called standard cleavage schemes (e.g., for the enzyme Trypsin).

Tobias Müller *(Würzburg)*
A New View on Multiple Alignment

Many molecular sequence analyses start with a collection of aligned homologous sequences to infer certain features of the considered group or subgroup of sequences. We focus on the general question: what are the general sequence pattern inside the multiple sequence alignment discriminating and defining subgroups. Such patterns could later be mapped to structioral or functional features of the sequence family. The proposed problem becomes more and more challenging when the number resp. the length of the considered sequences increases. We propose a singular value based approach based on paramters of a Hidden Markov Model to give a structured view of the multiple sequence alignment. Finally we show and discuss biological examples.

Tim Becker *(Bonn)*
Haplotype Sharing and Association Analysis

Ziel der Genetischen Epidemiologie ist es, Veränderungen im Genom zu finden, die für das Entstehen einer bestimmten Krankheit verantwortlich sind. Formal gesehen ist das Genom eine Sequenz aus den vier chemischen Grundbausteinen Adenin, Cytosin, Guanin und Thymin. Der Austausch eines einzigen Bausteins kann bereits das Erkrankungsrisiko einer Person ändern. Fixe Stellen im Genom die zwischen Personen variieren, bezeichnet man als SNPs, deren Ausprügungen A,C,G ,T als Allele. Der einfachste Ansatz kausale SNPs zu identifizieren, besteht darin, die Allelverteilung aller SNPs zwischen Fällen und Kontrollen zu vergleichen. Da es im Genom 3 Millionen verschiedene SNPs gibt, ist dieser Ansatz nicht durchführbar. Aufgrund der Entstehungsgeschichte sind SNPs jedoch lokal hoch korreliert. Dadurch ergibt sich zum einen die Möglichkeit ohne einen zu großen Powerverlust nur eine Auswahl der SNPs zu testen. Zu anderen ist es sinnvoll die lokalen Abfolgen der Ausprägungen der SNPs zu betrachten. Diese werden als Haplotyp bezeichnet. Die Assoziationsanalyse mit Haplotypen stellt einige statistische Herausforderungen: der Mensch ist diploid, d.h. er trägt die Sequenzfolge der Grundbausteine in doppelter Ausführung. Selbst wenn also für verschiedene SNPs die Allele eine Person bekannt sind, so ist i.A. unbekannt, wie sie sich in zwei Haplotypen, aufteilen. Es sind deshalb statistische Methoden nötig, um Haplotypfrequenzen zu schätzen. Für die Assoziationsanalyse muss die zusätzliche Varianz beachtet werden. Es werden Monte-Carlo-Simulationen zur P-Wert-Bestimmung eingesetzt. Darüber hinaus muss die zu betrachtende Länge der Haplotypen festgelegt werden. Eine Möglichkeit besteht darin, alle Längen innerhalb eines zu betrachten und eine Korrektur für multiples Testen anzuwenden, die die Korrelation angemessen berücksichtigt. Andere Ansätze versuchen die Entstehungsgeschichte der SNPs und Haplotypen zu rekonstruieren und somit zu sinnvoll zu betrachtenden Einheiten zu kommen.

Benoit Perthame *(ENS, Paris)*
Cell Movement and Interactions

Several evolution equations arising in biology share the same qualitative aspect. When some parameters of the model are small, the solutions concentrate as Dirac masses that moves with a finite speed. This occurs in two examples:

(i) Adaptative evolution at the population level. This describes the selection of individuals with a trait that is better adapted to an environment shared by all the population when 'small' mutations occur.
(ii) Nonlinear parabolic equations that exhibit a Turing type instability.

We will give mathematical models of such dynamics and show that an asymptotic method allows us to describe the evolution of the 'concentration points' . Numerically, we can observ jumps in the Dirac locations, bifurcations (which lead to the cohabitation of two different populations) ot transition from dimorphism to monomorphism. In the regular regime, we obtain a canonical equation where the drift is given by a nonlinear problem.
The asymptotic method leads to evaluate the weight and position of a moving Dirac mass desribing the population. We will show that a Hamilton-Jacobi equation with constraints naturally describes this asymptotic. Some more theoretical questions as uniqueness for the limiting H.-J. equation will also be addressed.

Florentin Wörgötter *(ENS, Paris)*
Predicitve Mechanisms in Closed-Loop Sensori-Motor Systems: The Convergence of Differential Hebbian Learning

During the lifetime of a creature there are often events where two sensor signals follow each other in time, which refer to the same situation. Hence the earlier signal acts predictive in comparison to the later signal. For example, heat radiation predicts pain on touching a hot surface. This general situation is due to the fact that we have near sensors like touch, taste and far sensors, like smell, hearing and vision. It is evident that it is advantageous for a creature to react to the earlier far-sensor signal without having to wait for a (potentially damaging) near-sensor signal. Often this requires learning, because, prior to having experienced the first such sensor-signal sequence, the relevance of the correlation between paired signals is unknown to the animal. It is possible to employ differential hebbian plasticity at single simulated synapses to emulate such a learning process. We will specifically show that such a mechanism will lead to improved behavior in closed-loop sensori-motor systems, using some robots for demonstration. Furthermore, it can be proven that the employed mechanism will converge to appropriate synaptic weights which will stabilize as soon as the newly learned behavior has also become stable.

Axel Voigt *(caesar, Bonn)*

Surface Flow Models for Biomembranes

We derive a thermodynamically consistent model for phase seperation in multicomponent vesicles. The model is a refinement of the classical Helfrich model and mathematically can be viewed as a Cahn-Hilliard like equation on an evolving surface, where the evolution is determined through a Willmore like flow. Numerical algorithms for this system of coupled 4th order equations are presented and first simulation results are shown.

This is joint work with Frank Haußer, John Lowengrub and Andreas Rätz.

Minisymposium 27

Computeralgebra

Leiter des Symposiums:

Prof. Dr. Wolfram Koepf
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Universität Kassel
Heinrich-Plett-Str. 40
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Prof. Dr. Gerhard Hiß
Lehrstuhl D für Mathematik
RWTH Aachen
Templergraben 64
52062 Aachen, Germany

Dieses Minisymposium soll einen kleinen Einblick in eine Auswahl aktueller Themen der Computeralgebra vermitteln. In einem je 50-minütigen Übersichtsvortrag berichten Anne Frühbis-Krüger über SINGULAR, einem der weltweit anerkanntesten Computeralgebrasysteme zur algebraischen Geometrie, Bettina Eick über neueste Entwicklungen in der algorithmischen Gruppentheorie sowie Ulrich Kortenkamp, einer der beiden Autoren von CINDERELLA, über die Integration von Computeralgebrasystemen und dynamischer Geometrie-Software.

Daneben wird es sechs 20-minütige Forschungsberichte geben. Diese entstammen so verschiedenen Disziplinen wie der algebraischen Kontrolltheorie, der homologischen Algebra, der algorithmischen Darstellungstheorie, der algorithmischen Kombinatorik sowie der algorithmischen algebraischen Zahlentheorie.

Donnerstag, 21. September

Großer Hörsaal, Mathematisches Institut, Wegelerstr. 10

15:00 – 15:50 **Anne Frühbis-Krüger** *(Kaiserslautern)*
Neuere Features des Computeralgebrasystems SINGULAR

16:00 – 16:20 **Eva Zerz** *(Aachen)*
Zur Umsetzung kontrolltheoretisch relevanter Algorithmen in der SINGULAR Control Library

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16:30 – 16:50 **Mohamed Barakat** *(Aachen)*
homalg – Ein abstraktes Maple-Paket für homologische Algebra

17:00 – 17:20 **Daniel Robertz** *(Aachen)*
Janet-Algorithmus mit Anwendungen in der Kontrolltheorie

17:20 – 17:50 **Gerhard Hiß** *(Aachen)*
Rechnen mit sporadischen Gruppen

Freitag, 22. September

Großer Hörsaal, Mathematisches Institut, Wegelerstr. 10

15:00 – 15:50 **Bettina Eick** *(Braunschweig)*
Algorithmische Gruppentheorie

16:00 – 16:20 **Wolfram Koepf** *(Kassel)*
Multivariate algorithmische Summation

16:30 – 16:50 **Gunter Malle** *(Kaiserslautern)*
Zählen von Zahlkörpern

17:00 – 17:50 **Ulrich Kortenkamp** *(Schwäbisch Gmünd)*
Integration von CAS und DGS – Wege und Konsequenzen

Vortragsauszüge

Anne Frühbis-Krüger *(Kaiserslautern)*
Neuere Features des Computeralgebrasystems SINGULAR

In der letzten Zeit ist die Funktionalität des Computeralgebrasystems SINGULAR um einige interessante Features erweitert worden. Dazu gehören unter anderem Absolute Primärzerlegung, Auflösung von Singularitäten und Nicht-Kommutative Berechnungen. Anhand von Beispielen und konkreten Anwendungen illustriert der Vortrag diese Themenbereiche – mit Ausnahme der nicht-kommutativen Features, deren Darstellung dem direkt anschließenden Vortrag von Frau Zerz überlassen bleibt.

Eva Zerz *(Aachen)*
Zur Umsetzung kontrolltheoretisch relevanter Algorithmen in der SINGULAR Control Library

Gegenstand der Kontrolltheorie ist die gezielte Beeinflussung (Steuerung) dynamischer Systeme; diese sind durch Differential- oder Differenzengleichungen gegeben und sollen durch geeignete Wahl von Stellgrößen und freien Parametern zu einem bestimmten erwünschten Verhalten veranlasst werden.

Der Ansatz der “Algebraischen Analysis” ermöglicht es, die relevanten kontrolltheoretischen Eigenschaften eines linearen Systems in algebraische Eigenschaften eines zugeordneten Moduls über dem (nicht notwendigerweise kommutativen) Ring der Differentialoperatoren zu übersetzen.

Die auftretenden algebraischen Objekte lassen sich mit Hilfe des Computeralgebrasystems SINGULAR (und im nichtkommutativen Fall mit seiner Erweiterung PLURAL) effizient manipulieren und analysieren. Die Resultate dieser Berechnungen können dann in die Sprache der Systemtheorie rückübersetzt und somit interpretiert werden. Der Vortrag stellt eine SINGULAR-basierte Programmbibliothek zur systematischen Umsetzung dieser Routinen vor und beleuchtet ihre theoretischen Hintergründe.

Mohamed Barakat *(Aachen)*
homalg – Ein abstraktes Maple-Paket für homologische Algebra

Homologische Algebra ist eine natürliche Erweiterung der Theorie von Moduln über Ringen. Die Kategorie der Moduln und deren Homomorphismen wird durch die Kategorie der Kettenkomplexe von Moduln und deren Kettenabbildungen ersetzt. Ein Modul wird repräsentiert durch eine seiner Auflösungen. Den Modul gewinnt man wiederum als die einzige nichttriviale Homologie seiner Auflösung. Alle Auflösungen eines Moduls sind in einem exakten Sinne äquivalent. Die Rolle der Kerne und Kokerne in der abelschen Kategorie der Moduln wird in der Kategorie der Komplexe durch sogenannte exakte Dreiecke übernommen. Dabei ist der Begriff des verbindenden Homomorphismus und der daraus resultierenden langen exakten Homologie-Sequenz von zentraler Bedeutung.
Das Maple-Paket homalg ist ein Versuch diese Begriffe handhabbar zu machen. Das Paket ist ein abstraktes Paket, das unabhängig von der Ringarithmetik die üblichen Konstruktionen der homologischen Algebra zur Verfügung stellt. Spezifiziert man einen Ring, in dem man Linksidealmitgliedschaft algorithmisch entscheiden kann, so stehen diese Konstruktionen auf einen Schlag zur Verfügung.
Der zentrale Begriff der homologischen Algebra ist der Begriff des Funktors. In homalg sind diverse grundlegende Funktoren implementiert, woraus man durch Derivation bzw. Komposition andere komplexere gewinnt. All diese Aspekte werden im Vortrag angesprochen und einige Anwendungen vorgestellt.

Daniel Robertz *(Aachen)*
Janet-Algorithmus mit Anwendungen in der Kontrolltheorie

Der Janet-Algorithmus ist im Kontext von (linearen) Differentialgleichungen und polynomialen Gleichungssystemen bekannt. Ausgehend von einem endlichen Erzeugendensystem für einen Teilmodul eines freien Moduls über einem kommutativen Polynomring bzw. einem differentiellen Ring berechnet er ein Erzeugendensystem für den gleichen Modul, mit welchem man Modulmitgliedschaft entscheiden, im zugehörigen Restklassenmodul rechnen und sogar eine freie Auflösung des Restklassenmoduls überblicken kann. In diesem Vortrag wird gezeigt, wie sich der Algorithmus in einfacher Weise auf eine gewisse Klasse von Schiefpolynomringen erweitern lässt. Damit lassen sich dann z. B. auch Systeme von linearen Differenzengleichungen und Kombinationen mit Differentialgleichungen entsprechend behandeln. Die verallgemeinerte

Hilbert-Reihe wird als kombinatorisches Hilfsmittel vorgestellt und ihre Bedeutung für die Aufzählung von formalen Lösungen der betrachteten Gleichungssysteme erklärt. Anwendungen von Maple-Implementationen des Janet-Algorithmus auf Probleme der Kontrolltheorie schließen sich an.

Gerhard Hiß *(Aachen)*

Rechnen mit sporadischen Gruppen

Die 26 sporadischen Gruppen sind endliche einfache Gruppen, die sich keiner unendlichen Serie zuordnen lassen. Die kleinste davon ist die *Mathieu-Gruppe* M_{11} mit 7920, die größte das *Monster* mit etwa $8 \cdot 10^{53}$ Elementen.
Zwei nahe liegende Projekte schließen sich an die Entdeckung und Konstruktion der sporadischen Gruppen an: Die Bestimmung ihrer maximalen Untergruppen und irreduziblen Darstellungen. Während das erste davon nahezu abgeschlossen ist, gibt es beim zweiten noch viel zu tun. In beiden Fällen ist es notwendig, explizit in diesen Gruppen zu rechnen, wobei geeignete Permutations- oder Matrix-Darstellungen verwendet werden. Dies ist beim Monster eine Matrix-Darstellung vom Grad 196882 über dem Körper mit 2 Elementen. Eine einzige solche Matrix beansprucht einen Speicherplatz von etwa 5GB.
In meinem Vortrag will ich zunächst über den Kenntnisstand in den beiden Projekten berichten. Danach werde ich einige Methoden vorstellen, die irreduziblen Matrix-Darstellungen über endlichen Körpern einer gegebenen endlichen Gruppe explizit zu bestimmen. Dabei will ich die oben schon angedeuteten Probleme mit sehr großen Permutations- und Matrix-Darstellungen erläutern und Ideen zu ihrer Überwindung aufzeigen.

Bettina Eick *(Braunschweig)*

Algorithmische Gruppentheorie

In diesem Vortrag wird eine Übersicht über aktuelle Themen in der algorithmischen Gruppentheorie gegeben. Methoden in der Gruppentheorie basieren wesentlich auf der gegebenen Darstellung der betrachteten Gruppe. Die Hauptdarstellungen von Gruppen sind dabei Matrixgruppen, Permutationsgruppen und endlich präsentierte Gruppen. In dem Vortrag wird zu jedem dieser Themen eine kurze Übersicht über den Stand der Technik und über mögliche Anwendungen vorgestellt.

Wolfram Koepf *(Kassel)*
Multivariate algorithmische Summation

Während univariate Reihen der Form $S_n = \sum_{k=-\infty}^{\infty} F(n,k)$ für hypergeometrische Terme $F(n,k)$, für welche also $F(n+1,k)/F(n,k) \in \mathbb{Q}(n,k)$ und $F(n,k+1)/F(n,k) \in \mathbb{Q}(n,k)$ gilt, durch einen Algorithmus von Zeilberger (1991) sehr effizient vereinfacht werden können – dies heißt konkret, der Algorithmus berechnet eine Rekursion und hieraus ggfs. eine geschlossene Formel für S_n –, ist die Vereinfachung im multivariaten Fall i. a. wesentlich komplizierter und die bekannten Algorithmen sind weit weniger effizient.
Wir stellen in diesem Vortrag die zugrunde liegende Theorie vor, die ursprünglich von Celine Fasenmyer stammt (1945), von Wilf und Zeilberger wieder aufgegriffen wurde (1994), aber erst in einer Diplomarbeit von Wegschaider (1997) durch wesentliche neue Ideen implementierfähig gemacht und von Sprenger (2005) in *Maple* implementiert wurde. Wir zeigen an einigen Anwendungsbeispielen die Funktionalität unserer *Maple*-Implementierung.

Gunter Malle *(Kaiserslautern)*
Zählen von Zahlkörpern

Hauptgegenstand des Vortrags ist die Anzahl von Zahlkörpern mit fester Galoisgruppe und beschränkter Absolut-Diskriminante. Wir stellen eine genaue Vermutung über das asymptotische Verhalten dieser Anzahlfunktionen vor, die bisher aber nur in einigen wenigen Spezialfällen bewiesen werden konnte. Diese Vermutung entstand auf der Basis umfangreicher Körpertabellen, die mit Hilfe von Computeralgebrasystemen erstellt wurden. Wir werden kurz über diese Berechnungen, aber auch über theoretische Resultate berichten, die auch Verbindungen zu anderen offenen Fragen in der Zahlentheorie herstellen.

Ulrich Kortenkamp *(Schwäbisch Gmünd)*
Integration von CAS und DGS – Wege und Konsequenzen

Computeralgebrasystem (CAS) und Dynamische Geometrie-Software (DGS) haben ihren Platz im Schulunterricht gefunden. Die weitere Verbreitung dieser Werkzeuge

scheint nur noch eine Frage der Rechnerausstattung an Schulen und den dazu gehörenden Fortbildungen zu sein. Somit ist es an der Zeit, die existierenden Werkzeuge kritisch zu hinterfragen!

Für einen reibungslosen Einsatz liegt es nahe, beide Ansätze zu integrieren und eine gemeinsame Lehr/Lernplattform für Mathematik zu schaffen. Im Vortrag möchte ich einen Überblick über bereits existierende Lösungen geben und die verschiedenen Ansätze diskutieren. Aus den Wünschen an die Bedienbarkeit der Software entstehen neue mathematische Probleme, es ergeben sich aber auch neue, didaktisch verwertbare Gestaltungsmöglichkeiten, die die Mathematik-Lehre verändern können.

Minisymposium 28

Lehrerausbildung

Leiter des Symposiums:

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Universitätsstr. 15
45117 Essen, Germany

In dem Minisymposium soll das gymnasiale Lehramtsstudium im Fach Mathematik aus der Sicht relevanter Bezugsgruppen (Lernende und Lehrende der verschiedenen Ausbildungsphasen, Schulpraxis und Bildungsadministration) betrachtet werden. Die Vortragenden werden aus der je eigenen Ausbildungs- bzw. Berufserfahrung berichten und dabei pointiert Vorzüge und Desiderata des Lehramtsstudiums aufzeigen.

Bitte beachten Sie in diesem Zusammenhang auch das Programm des Symposiums auf Seite 243, welches sich auch mit diesem Thema beschäftigt.

Montag, 18. September

HS IX, Hauptgebäude, Regina-Pacis-Weg

14:30 – 14:35 **Prof. Dr. Lisa Hefendehl-Hebeker** *(Universität Duisburg-Essen)*
Orientierende Einführung

14:35 – 15:00 **Prof. Dr. Andrea Blunck** *(Universität Hamburg)*
Dr. Anina Mischau *(Universität Bielefeld)*
Ergebnisse der Studie “Mathematikstudierende, ihr Studium und ihr Fach”

15:00 – 15:30 **Martin Isbruch** *(Universität Bielefeld)*
StRef Bastian Thielmann *(Studienseminar Siegen)*
Das gymnasiale Lehramtsstudium aus der Sicht eines Studenten und eines Studienreferendars

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15:30 – 16:00 **StD Heinz Haake** *(Gesamtschule der Gemeinde Hille)*
OStR Dr. Andreas Schuster
(Alexander-von-Humbuldt-Gymnasium Schweinfurt)
Das gymnasiale Lehramtsstudium aus der Sicht eines Lehrers und eines Fachleiters

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16:00 – 16:30 **Prof. Dr. Wolfgang Lück** *(Universität Münster)*
Erfahrungen eines Hochschullehrers mit dem Lehramtsstudium

16:30 – 17:00 **Prof. Dr. Elmar Cohors-Fresenborg** *(Universität Osnabrück)*
Das gymnasiale Lehramtsstudium aus der Sicht eines Fachdidaktikers

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17:00 – 17:25 **Ministerialrat Dr. Werner Brandt**
(Ministerium für Schule und Weiterbildung Düsseldorf)
Wie können neue bildungspolitische Ansätze in die Praxis integriert werden

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17:25 – 17:30 **Prof. Dr. Lisa Hefendehl-Hebeker** *(Universität Duisburg-Essen)*
Zusammenfassung der Ergebnisse

Vortragsauszüge

Andrea Bluck *(Universität Hamburg)*
Anina Mischau *(Universität Bielefeld)*
Ergebnisse der Studie “Mathematikstudierende, ihr Studium und ihr Fach”

Im Rahmen eines am Interdisziplinäres Zentrum für Frauen- und Geschlechterforschung der Universität Bielefeld durchgeführten Forschungsprojekts wurden an acht deutschen Universitäten Mathematikstudierende befragt, u.a. zu ihrem Studium, ihrer Studienzufriedenheit und ihrer Einstellung zur Mathematik. Ein Ziel dieses Projekts war zu untersuchen, ob es hierbei eher Unterschiede zwischen den Geschlechtern oder zwischen den Studiengängen (Diplomstudiengänge Mathematik und Wirtschaftsmathematik sowie Lehramtsstudiengang Mathematik / Sekundarstufe I und II) gibt. In unserem Vortrag sollen einige ausgewählte, die Lehramtsstudierenden betreffende Ergebnisse der Studie vorgestellt werden. Diese Ergebnisse geben Hinweise darauf, an welchen Stellen das Lehramtsstudium der Mathematik reformbedürftig ist.

Martin Isbruch *(Universität Bielefeld)*
Bastian Thielmann *(Studienseminar Siegen)*
Das gymnasiale Lehramtsstudium aus der Sicht eines Studenten und eines Studienreferendars

Wieweit und in welcher Hinsicht ein Lehramtsstudium als berufsvorbereitend erlebt wird, ist für Studierende oft eine Frage der vorausschauenden Motivation, für Referendare und Referendarinnen eine Frage der praktischen Bewährung im Alltag der zweiten Ausbildungsphase. Zu diesen Fragen werden Betroffene aus ihrem eigenen Erfahrungsbereich berichten.

Heinz Haake *(Gesamtschule der Gemeinde Hille)*
Andreas Schuster *(Alexander-von-Humboldt-Gymnasium Schweinfurt)*
Das gymnasiale Lehramtsstudium aus der Sicht eines Lehrers und eines Fachleiters

Wieweit das Lehramtsstudium eine hilfreiche Grundausstattung für die Berufstätigkeit und das Erfordernis des lebenslangen Weiterlernens vermittelt, ist auch für die in der

Unterrichtspraxis stehenden Lehrerinnen und Lehrer sowie die Ausbildenden der zweiten Phase eine relevante Frage, zu der aus der Sicht des jeweiligen Erfahrungsbereiches Stellung genommen werden soll.

Wolfgang Lück *(Universität Münster)*
Erfahrungen eines Hochschullehrers mit dem Lehramtsstudium

Lehramtsstudierende artikulieren manchmal für einen Hochschullehrer überraschende Befindlichkeiten hinsichtlich ihrer Motivation und Einstellung zum gewählten Studienfach und ihre Schwerpunktsetzungen in der Studienorganisation. Hierüber soll im Vortrag berichtet werden.

Elmar Cohors-Fresenborg *(Universität Osnabrück)*
Das gymnasiale Lehramtsstudium aus der Sicht eines Fachdidaktikers

Um einen nachhaltig wirksamen Mathematikunterricht erteilen zu können, müssen Lehrerinnen und Lehrer die Mechanismen mathematischer Wissensbildung gründlich verstanden haben. Im Vortrag wird dargelegt, wie diese Zielsetzung schon vom ersten Fachsemester an verfolgt werden kann.

Werner Brandt *(Ministerium für Schule und Weiterbildung Düsseldorf)*
Wie können neue bildungspolitische Ansätze in die Praxis integriert werden?

Die bildungspolitische Diskussion der letzten Jahre hat umfassende Umterrichtsreformen angestoßen. Für den Mathematikunterricht wird eine Öffnung in doppelter Hinsicht angestrebt: inhaltlich geht es um einen verstärkten Realitätsbezug (authentischere Aufgaben, mehr Anwendungsorientierung), methodisch um eine deutlichere Schülerorientierung (individualisierte Lernformen, mehr Schüleraktivität). Andererseits erfolgt aber auch eine klare Standardsetzung für die Unterrichtsergebnisse. Im Vortrag werden Zusammenhänge zwischen Kernlehrplänen, zentralen Leistungsüberprüfungen und Unterrichtsentwicklung aufgezeigt und Maßnahmen zur Entwicklung und Erprobung neuer Unterrichtskonzepte und der Implementierung dieser neuen Unterrichtskultur in der Breite vorgestellt. Darüber hinaus werden Wünsche für ein effizientes Zusammenwirken der verschiedenen Ausbildungsphasen formuliert.

Minisymposium 29

Information, Kommunikation und Bibliotheken für die Mathematik

Leiter des Symposiums:

PD Dr. Katharina Habermann
Niedersächsische Staats- und
Universitätsbibliothek Göttingen
Platz der Göttinger Sieben 1
37073 Göttingen, Germany

Dienstag, 19. September

IuK-Nachmittag

Übungsraum 4, Geographisches Institut, Meckenheimer Allee 166

15:00 – 15:50 **Wolfgang Dalitz** *(Berlin)*

Eine Suchmaschine für die Mathematik

16:00 – 16:50 **Wolfram Sperber** *(Berlin)*

Kann man automatisch klassifizieren? Probleme und Ansätze automatischer Klassifikation

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17:00 – 17:20 **Joachim Lügger** *(Berlin)*

e-Science: Neue IuK-Infrastrukturen für die Wissenschaft

17:30 – 17:50 **Robert Roggenbuck** *(Osnabrück)*

Web Site Erstellung – was leisten Content Management Systeme?

18:00 Sitzung der IuK-Fachgruppe der DMV/ÖMG und Wahl der Sprecher

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Mittwoch, 20. September

Bibliotheksnachmittag

Übungsraum 4, Geographisches Institut, Meckenheimer Allee 166

15:00 – 15:50 **Matthias Schulze** *(Göttingen)*
Bernhard Tempel *(Hannover)*

RusDML – Ein digitales Archiv russischer mathematischer Zeitschriften

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16:00 – 16:50 **Katharina Habermann** *(Göttingen)*

Neue Wege der überregionalen Literaturversorgung für die Mathematik

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17:00 – 17:50 **Christian Herrmann** *(Göttingen)*

Die Virtuelle Fachbibliothek Mathematik – Konzept und Realisierung

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Vortragsauszüge

Wolfgang Dalitz *(Berlin)*
Eine Suchmaschine für die Mathematik

(Abstrakt lag bei Redaktionsschluss noch nicht vor.)

Wolfram Sperber *(Berlin)*
Kann man automatisch klassifizieren? Probleme und Ansätze automatischer Klassifikation

(Abstrakt lag bei Redaktionsschluss noch nicht vor.)

Joachim Lügger *(Berlin)*
e-Science: Neue IuK-Infrastrukturen für die Wissenschaft

Bei e-Science geht es um die Kollaboration bzw. die Kooperation internationaler Forschergruppen im Internet und im World Wide Web. Typischerweise geschieht dieses in sogenannten Virtuellen Organisationen, die einen geeigneten organisatorischen, rechtlichen und technischen Rahmen und damit die notwendige Infrastruktur für die Bereitstellung und den Einsatz der gemeinsamen Ressourcen schaffen.

Hierzu gehören nicht nur Supercomputer, Hochleistungsnetze, -Meßstationen und -Visualisierungsgeräte und andere Basis-Ressourcen des Grid, sondern auch Wissensressourcen, Publikationen, Daten und Werkzeuge des Knowledge Managements. Forschungsdaten, Projektentwürfe, Memoranden und Arbeitsfortschritte müssen neben der in Betracht kommenden Literatur z.B. innerhalb einer Virtuellen Organisation zu einem sehr frühen Zeitpunkt und im Verlauf eines Projektes zur Verfügung stehen und wechselseitig genutzt werden können, nicht erst nach Abschluss in der Publikationsphase der gemeinsamen Forschungstätigkeit

In diesem Kontext entstehen neue Anforderungen an das Informations- und Kommunikationswesen. Der Beitrag skizziert anhand einiger Beipiele aus dem nationalen und internationalen e-Science-Bereich die besondere Natur dieser neuen IuK-Infrastrukturen.

Robert Roggenbuck *(Osnabrück)*
Web Site Erstellung – was leisten Content Management Systeme?

Mit Hilfe von RDF (oder auch nur HTML) den semantischen Inhalt von Webseiten zu beschreiben geht den wenigsten leicht von der Hand. Da RDF jedoch die offizielle Sprache der semantischen Ebene des Internets ist, kommt man nicht darum herum RDF zu erzeugen, um seine im Internet veröffentlichten Informationen auch maschinell und semantisch auswertbar zu formulieren. Daher ist Software, die einem dabei hilft willkommen. Für den Bereich der Website-Erstellung gibt es Content Management Systeme (CMS), die jedoch noch kaum in der Lage sind diese semantische Anforderung zu erfüllen. In diesem Artikel wird eine Auswahl typischerCMS näher betrachtet und einer Eigenentwicklung aus dem Math&Industry-Projekt gegenübergestellt.

Matthias Schulze *(Göttingen)*
RusDML – Ein digitales Archiv russischer mathematischer Zeitschriften

RusDML (Russian Digital Mathematics Library) ist Teil einer global angelegten Bestrebung, die gesamte mathematische Literatur für die Fachwissenschaftler in aller Welt digital zugänglich zu machen. Der Fokus des Projekts RusDML liegt auf der russischsprachigen Literatur. In der ersten Projektphase werden wichtige russischsprachige Zeitschriften von 1866 bis in die Gegenwart hinein digitalisiert. Diese Informationen werden online verfügbar gemacht, wobei das Zentralblatt MATH als ein Portal dienen wird. In dem Projekt RusDML, das von der DFG (Deutsche Forschungsgemeinschaft) gefördert wird, sind drei deutsche Partner eingebunden: Die Technische Universität Berlin (TUB), die Niedersächsische Staats- und Universitätsbibliothek (SUB) Göttingen und die Technische Informationsbibliothek / Universitätsbibliothek (TIB/UB) Hannover. Russischer Partner im Projekt RusDML ist die Staatliche öffentliche Wissenschaftlich-Technische Bibliothek (GPNTB) in Moskau.

Katharina Habermann *(Göttingen)*
Neue Wege der überregionalen Literaturversorgung für die Mathematik

Das von der DFG geförderte kooperative System der überregionalen Literaturversorgung dient der Absicherung des Spitzenbedarfes an wissenschaftlicher Literatur. Im

Rahmen eines verteilten Fachgebietsplan betreut die SUB Göttingen das Sondersammelgebiet “Reine Mathematik” und muss hierfür die entsprechende Literatur so umfassend wie möglich sammeln, vorhalten und über den Leihverkehr und Dokumentenlieferdienste zur Verfügung stellen. Gegenwärtige Herausforderung ist es, die Dienstleistungen nutzerorientiert an die Anforderungen der digitalen Informationslandschaft anzupassen und die Verbindung konventioneller Bestände und elektronischer Medien als spezifische Stärke bibliothekarischer Informationsangebote zu etablieren. Der Vortrag wird über daraus resultierende Aktivitäten und Perspektiven berichten.

Christian Herrmann *(Göttingen)*

Die Virtuelle Fachbibliothek Mathematik – Konzept und Realisierung

Virtuelle Fachbibliotheken sind konsequente virtuelle Erweiterungen der DFG-geförderten Sondersammelgebiete. Das von der DFG finanziell unterstützte und von der SUB Göttingen koordinierte Projekt hat den Aufbau eines mathematischen Informationsportals zum Ziel, welches einen strukturierten Zugang zu unterschiedlichsten Quellen der mathematischen Fachinformation bietet. Als zentrales Fachportal wird die Virtuelle Fachbibliothek Mathematik den gleichzeitigen Zugang zu gedruckten und elektronischen mathematischen Publikationen ermöglichen. Das heißt, unter einer Suchoberfläche werden sowohl konventionelle Medienformen als auch elektronische Ressourcen für die wissenschaftliche Forschung nachgewiesen, erschlossen und bereitgestellt. Der Vortrag stellt die gegenwärtigen Resultate dieses Entwicklungsprojektes vor und läd zum Online-Start des Angebotes ein.

Minisymposium 30

Minisymposium zur Ausstellung “Jüdische Mathematiker in der deutschsprachigen akademischen Kultur”

Leiter des Symposiums:

Prof. Dr. Moritz Epple
Universität Frankfurt
Historisches Seminar
Arbeitsgruppe Wissenschaftsgeschichte
60629 Frankfurt am Main, Germany

Prof. Dr. Walter Purkert
Universität Bonn
Mathematisches Institut
Beringstraße 1
53115 Bonn, Germany

Montag, 18. September

Hörsaal Zoologie, Poppelsdorfer Schloß

14:30 – 15:10 **Birgit Bergmann** *(Frankfurt)*

Mathematik in der Kultur – Zu Rolle und Selbstverständnis jüdischer Mathematiker in der akademischen Öffentlichkeit in Kaiserreich und Weimarer Republik

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15:15 – 15:55 **Reinhard Siegmund-Schultze** *(Kristiansand)*

Internationalität, Marginalität, Originalität: Jüdische Mathematiker in Weimar

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16:00 – 16:40 **Annette Vogt** *(Berlin)*

Mathematik und die Mendelssohn-Familie

16:45 – 17:25 **David Rowe** *(Mainz)*

Emmy Noether and the Reception of Einstein's General Theory of Relativity in Göttingen

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17:30 – 18:10 **Ulf Hashagen** *(München)*

Antisemitismus und Wissenschaft in der Weimarer Republik: Die verhinderte Karriere des Mathematikers Salomon Bochner an der Universität München

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Vortragsauszüge

Birgit Bergmann *(Frankfurt)*
Mathematik in der Kultur – Zu Rolle und Selbstverständnis jüdischer Mathematiker in der akademischen Öffentlichkeit in Kaiserreich und Weimarer Republik

Der Vortrag erläutert zunächst einige prosopographische Daten über Mathematiker aus jüdischen Familien, die an Universitäten des deutschen Kaiserreichs und der Weimarer Republik beschäftigt waren. Im Anschluss daran sollen anhand von Stellungnahmen einiger dieser Mathematiker zur Rolle der Mathematik in der Kultur einige Hinweise zum Selbstverständnis jüdischer Mathematiker in der akademischen Öffentlichkeit gegeben werden.

Reinhard Siegmund-Schultze *(Kristiansand)*
Internationalität, Marginalität, Originalität: Jüdische Mathematiker in Weimar

Es kann nicht darum gehen, allgemein geltende, ‘typisch jüdische’ politische, philosophische oder mathematische Wertvorstellungen oder Verhaltensmuster in der Weimarer Republik aufzuspüren. Man würde sich damit ungewollt aber unweigerlich in gefährliche Nähe zu Nazi-Kategorisierungen begeben, und die von den Nazis als Juden kategorisierten Mathematiker waren ihren fachlichen Interessen und weltanschaulich-religiösen Bindungen nach sehr unterschiedlich. Es war eher der Unterschied zwischen diesen, die Bandbreite ihrer Positionen, was die “jüdischen Mathematiker” von den “nichtjüdischen” abhob. Beispielsweise waren gewisse Elemente von Internationalität (die über die monopolistische Göttinger Internationalität hinausgingen) nur “jüdischen Mathematiker” zugänglich. Gewisse Typen von Marginalität (die zu der verbreiteten Marginalität des Privatdozenten und des Nicht-Göttingers hinzukamen) wurden nur von ihnen erlebt, was gelegentlich zu spezifischer mathematischer Originalität führte, in anderen Fällen zu vorzeitiger (d.h. vor 1933 erfolgender) Emigration. Während sie sich subjektiv oft mit den Traditionen der deutschen Nation und Mathematik identifizierten, wurden die “jüdischen Mathematiker” auf Grund der politischen Entwicklungen in Weimar nie völlig in die wissenschaftliche Gemeinschaft integriert und schließlich 1933 ausgestoßen. Diese Thesen sollen in dem Vortrag an Beispielen von jüdischen Mathematikern wie Felix Bernstein, Richard Courant, Emil Julius Gumbel, Edmund Landau, Richard von Mises, Johann von Neumann, Emmy Noether, Hans Reichenbach, Arthur Schoenflies und Adolf A. Fraenkel exemplifiziert werden.

Annette Vogt *(Berlin)*
Mathematik und die Mendelssohn-Familie

Im Vortrag werden einige Aspekte der Beziehungen zur Mathematik und zu Mathematikern in der Familie Mendelssohn betrachtet, angefangen mit Moses Mendelssohn, über die Tätigkeiten seiner Söhne bis zu den Ururenkeln. Dank der internationalen Mendelssohn-Forschung liegen seit etwa 15 Jahren detailliertere Kenntnisse vor, auch über andere Familienmitglieder als Moses Mendelssohn und seine Enkel Fanny und Felix. Für den Vortrag wird eine spezielle Perspektive gewählt – die Betrachtung der Beziehungen einiger Enkeltöchter von Moses Mendelssohn zu Mathematikern und die Etablierung einer eigenen Kultur zwischen Salon und Gelehrtentum, d.h. zwischen Musik und Mathematik, zwischen Alltag und akademischer Geschäftigkeit. Aus dieser Innenansicht heraus werden auch Aspekte deutsch-jüdischer Beziehungen sichtbar, von der Aufklärung und einer beginnenden Einbeziehung in Kultur und Wissenschaft bis zur Ausgrenzung, Ausschließung, “Auswanderung” und Ausraubung der Juden während der NS-Zeit.

David Rowe *(Mainz)*
Emmy Noether and the Reception of Einstein’s General Theory of Relativity in Göttingen

Emmy Noether was the daughter of the eminent Jewish algebraic geometer Max Noether, who spent his entire professional career in Erlangen. Although she is rightfully remembered today as the “mother of modern algebra,” her earliest research in Göttingen dealt with differential invariants and the connections between invariant integrals and conservation laws in physics. She undertook this work as part of a concerted research program led by Klein and Hilbert, both of whom were inspired by Einstein’s general theory of relativity. After briefly describing the atmosphere in Göttingen following Einstein’s lectures during the summer of 1915, I will indicate how Noether became the central figure in this Göttingen research program, which culminated in two now famous theorems in the calculus of variations that bear her name.

Ulf Hashagen *(München)*

Antisemitismus und Wissenschaft in der Weimarer Republik: Die verhinderte Karriere des Mathematikers Salomon Bochner an der Universität München

Der Vortrag analysiert anhand einer Fallstudie das Verhältnis von Staat, Antisemitismus und Wissenschaft in der Weimarer Republik. Im Zentrum des Vortrags steht die Frage nach der Rolle von Wissenschaftlern, Universitäten und staatlichen Stellen bei den Ausgrenzungen und Repressionen gegenüber so genannten “ostjüdischen” Wissenschaftlern, die in der Weimarer Republik in einem engen Zusammenhang mit der Einwanderungspolitik sowie mit der Polenpolitik des Deutschen Reiches standen. Die akademische Karriere des Mathematikers Salomon Bochner ist ein besonders krasser Fall dieser allgemeinen Repressionspolitik. Der in Krakau geborene Bochner floh 1914 mit seiner Familie vor der russischen Armee nach Berlin, wo er 1921 bei E. Schmidt promovierte. 1927 wurde er von den an der Universität München wirkenden Mathematikern Carathéodory, Perron und Tietze aufgefordert, sich in München zu habilitieren.

Obwohl Bochner das Habilitationsverfahren glänzend bestand und sich die Mathematiker der Universität München für ihn einsetzten, weigerte sich die bayerische Staatsregierung mehrfach, Bochner als Privatdozent zuzulassen, so dass Bochner bis zu seiner Emigration im Jahr 1933 nur “ausnahmsweise” Vorlesungen halten durfte.

Die Art und Weise des Zusammenwirkens der verschiedenen staatlichen Stellen bei der Nichtzulassung von Bochner zum Privatdozenten wirft auch die Frage auf, ob das sog. “Gesetz zur Wiederherstellung des Berufsbeamtentums” von 1933 tatsächlich den Beginn der Vertreibung jüdischer Wissenschaftler aus Deutschland “markiert” oder ob es nicht schon in der Weimarer Republik (in einzelnen Fällen) einen staatlich sanktionierten und bürokratisch organisierten Antisemitismus gab.

Symposium mit Podiumsdiskussion

Neue Perspektiven der Lehrerausbildung in der Mathematik und den Naturwissenschaften

Eine Veranstaltung der Deutsche Telekom Stiftung in Kooperation mit der Deutschen Mathematiker-Vereinigung im Rahmen der Jahrestagung 2006.

Veranstaltungsort: Universität Bonn, Alfred-Philippson-Hörsaal des Geographischen Instituts, Meckenheimer Allee 166

Veranstaltungszeit: Dienstag, 19. September 2006, 15:30 – ca. 19:00 Uhr

Teilnehmer: Lehrer, Studenten, Schüler, Eltern, Vertreter der Bildungsadministration, Vertreter der Universität

Kosten: Keine

Anmeldung: Im Rahmen der Anmeldung zur DMV-Tagung *oder* an

Deutsche Telekom Stiftung
Herrn Manfred Mudlagk
Graurheindorfer Str. 153
53117 Bonn
Tel. 0228.181.92019
`manfred.mudlagk@telekom.de`

Bitte beachten Sie in diesem Zusammenhang auch das Programm des Minisymposiums 28, welches sich auch mit diesem Thema beschäftigt.

Vorläufiges Programm der Podiumsdiskussion

15:30 - 15:35 Uhr	**Dr. Klaus Kinkel**, Vorsitzender Deutsche Telekom Stiftung Begrüßung und Einführung
15:35 - 16:00 Uhr	**Prof. Dr. Lisa Hefendehl-Hebeker** (*Uni Duisburg-Essen*) Impulsreferat: “Perspektiven der Lehrerausbildung im Fach Mathematik”
16:00 - 16:30 Uhr	**Prof. Dr. Albrecht Beutelspacher** (*Uni Gießen*) **Prof. Dr. Rainer Danckwerts** (*Uni Siegen*) Vorstellung des Stiftungsprojekts “Mathematik Neu Denken” – ein Projekt zur Neuorientierung der universitären Lehrerausbildung im Fach Mathematik für das gymnasiale Lehramt
16:30 - 17:00 Uhr	**Prof. Dr. Andreas Müller** (*Uni Koblenz-Landau)* Vorstellung des Projekts LENA – ein Programm zur Verbesserung der Lehrerausbildung in den Naturwissenschaften
17:00 - 18:00 Uhr	Podiumsdiskussion – Neue Perspektiven der Lehrerausbildung im Fach Mathematik Moderation: **Dr. Ekkehard Winter** Geschäftsführer Deutsche Telekom Stiftung, **Prof. Dr. Albrecht Beutelspacher** Projektleiter “Mathematik Neu Denken”, Leiter Mathematikum Gießen; **Prof. Dr. Rainer Danckwerts** Projektleiter “Mathematik Neu Denken”, Uni Siegen; **Prof. Dr. Michael Neubrand** Mitglied des wissenschaftlichen PISA Konsortiums, Uni Oldenburg; **OStD Dr. Sjuts** Studienseminar Leer; **Staatssekretär Winfried Willems** Kultusministerium Sachsen-Anhalt
18:00 - 19:00 Uhr	Empfang in der Universität Bonn, Geographisches Institut (s. S. 20, Meckenheimer Allee 166, nahe Nr. 4)

Vortragsauszüge

Lisa Hefendehl-Hebeker *(Duisburg-Essen)*
Perspektiven der Lehrerausbildung im Fach Mathematik

Ein von der KMK in Auftrag gegebener Bericht kommt zu dem Ergebnis, dass die Lehramtsausbildung in Deutschland strukturell zwar ein hohes Maß an Fachlichkeit aufweist, dass die beteiligten Fächer dieser Aufgabe und ihren spezifischen Anforderungen alles in allem aber zu wenig Aufmerksamkeit schenken.

Demgegenüber möchte der Vortrag speziell für das Fach Mathematik entfalten, warum das Lehramtsstudium eine aktuelle Gestaltungsaufgabe von hoher Dringlichkeit ist und an welchen notwendigen Kompetenzen für Lehrkräfte es sinnvoll ausgerichtet werden müsste. In die Ausführungen sollen möglichst auch Ergebnisse des Minisymposiums vom Vortage aufgenommen werden.

Albrecht Beutelspacher *(Gießen)*, **Rainer Danckwerts** *(Siegen)*
Vorstellung des Stiftungsprojekts “Mathematik Neu Denken” – ein Projekt zur Neuorientierung der universitären Lehrerausbildung im Fach Mathematik für das gymnasiale Lehramt

Mit dem Projekt “Mathematik Neu Denken” fördert die Deutsche Telekom Stiftung ein Forschungs- und Entwicklungsvorhaben zur Neuorientierung der Gymnasiallehrer-Ausbildung im Fach Mathematik. Ziel ist es, die Qualifikation der Pädagogen und damit langfristig auch die Qualität des Mathematik-Unterrichts zu verbessern. Partner des Projekts sind die mathematischen Fakultäten der Universitäten in Gießen und Siegen, die spezielle Veranstaltungen im Grundstudium für Studierende mit Berufsziel Mathematiklehrer anbieten. Die wissenschaftliche Leitung des Projekts liegt bei Prof. Albrecht Beutelspacher (Gießen) und Prof. Rainer Danckwerts (Siegen). Beide engagieren sich seit langem für einen Paradigmenwechsel im Umgang mit der Mathematik. Nach ihrer Auffassung werden die Studierenden traditionell so mit der Mathematik konfrontiert, dass für viele der Zusammenhang mit dem Berufsziel Lehrer nicht sichtbar ist. Um dieses Defizit zu beseitigen, befürworten Beutelspacher und Danckwerts eine grundsätzlich neue Vorbereitung künftiger Lehrerinnen und Lehrer, die sie mit dem Stiftungsprojekt umsetzen.

Andreas Müller *(Koblenz-Landau)*

Vorstellung des Projekts LENA – ein Programm zur Verbesserung der Lehrerausbildung in den Naturwissenschaften

Ziel des vorgestellten Programms, “LeNa” –Lehrerbildung in den Naturwissenschaften– ist es, eine möglichst kohärente Lehrerbildung zu verwirklichen. Kohärenz bezeichnet dabei zum ersten innere Kohärenz des Lehramtsstudiums. Dieser sind die zentralen Maßnahmen von “LeNa” gewidmet, mit folgenden Teilzielen:

- verbesserte Abstimmung von Fachwissenschaften, Fachdidaktik und Bildungswissenschaften,
- verbesserte Abstimmung mit der schulpraktischen Ausbildung und allgemein der drei Phasen der Lehramtsausbildung untereinander,
- verstärkte Kohärenz von Lehre und Forschung, d.h. eine verstärkte Forschungsorientierung des Lehramtsstudiums.

Kohärenz meint aber auch äußere Kohärenz mit wichtigen anderen Entwicklungen im Bildungswesen, mit welchen die Lehrerbildung eng zusammenhängt, vor allem in den Bereichen Schule und Unterricht. Diesen Aspekten sind flankierende Maßnahmen des Programms gewidmet.

Sonntagstreff Wissenschaft

Uni Bonn im Deutschen Museum Bonn

Anlässlich der Jahrestagung der Deutschen Mathematiker-Vereinigung in Bonn veranstaltet die Mathematisch-Naturwissenschaftliche Fakultät am Sonntag, dem 17. September 2006, einen Treff mit Schwerpunkt Mathematik.

Programm

11:00 Uhr **Prof. Dr. Ingo Lieb** *(Mathematisches Institut der Uni Bonn)*

Eröffnung und Begrüßung

11:10 Uhr **Prof. Dr. Ulrich Charpa** *(Leo-Baeck-Institut London)*

Juden und moderne Wissenschaft in Deutschland

Die Rolle von Juden in der Wissenschaftsentwicklung in Deutschland während des ersten Drittels des 20. Jahrhunderts ist ein beispielloses wissenschaftshistorisches Phänomen. Es stellt uns vor grundsätzliche Fragen wie die nach den Ursachen des wissenschaftlichen Erfolges und Mißerfolges von Personengruppen, wirft aber auch spezielle begriffliche Probleme wie die der Kategorisierung von Forschern als 'jüdisch' auf. Es werden in beiden Hinsichten einige bereits eingeführte wie auch neue Überlegungen mitgeteilt.

12:00 Uhr **Dr. Dietrich "Piano" Paul**

PISA, Bach, Pythagoras I

Der Mathematiker, Musiker, Kabarettist und Niederbayer Paul greift ein Phänomen unserer Zeit auf, das uns alle via Schule, Studium und beruflicher Karriere noch lange auf Trab halten wird: Die verbreitete Neigung, neueste Technik gerne zu nutzen, aber Mathematik und Naturwissenschaften in Schule und Öffentlichkeit möglichst an den Rand zu drängen.

12:45 Uhr *Mittagspause*

13:45 Uhr **Dr. Dietrich “Piano” Paul**

PISA, Bach, Pythagoras II

14:45 Uhr **Prof. Dr. Rolf Krause**

(Institut für Angewandte Mathematik, Uni Bonn)

Von Osteoklasten und Mathematikern
– Zur Simulation biomechanischer Prozesse

Biomechanische Vorgänge haben in den letzten Jahren zunehmend Aufmerksamkeit in Forschung und Anwendung erfahren. Ihre Modellierung und Simulation erfordert die Entwicklung geeigneter mathematischer Modelle ebenso wie deren effiziente numerische Lösung. Knochenheilung etwa wird durch das Zusammenspiel mechanischer Größen wie Spannungen und Kräfte und zellulärer Vorgänge wesentlich beeinflusst. Die Bestimmung von Kräften und Momenten, die in den Gelenken wirken, verlangt es, komplizierte Materialien wie Knorpel und mechanische Vorgänge wie Kontakt zu modellieren. Wir diskutieren die Schwierigkeiten, die bei der Simulation dieser Vorgänge auftreten, anhand von ausgewählten Beispielen und skizzieren Ansätze zu ihrer effizienten numerischen Lösung.

15:45 Uhr **Prof. Dr. Don Zagier**

(Max-Planck-Institut für Mathematik, Bonn)

Ramanujans Mock-Thetafunktionen
– eine romantische Geschichte in der Mathematik

Srinivasa Ramanujan schrieb 1913 einen berühmt gewordenen Brief aus der indischen Provinz an den englischen Mathematiker G.H. Hardy, in dem er über kaum glaubbare Resultate seiner zahlentheoretischen Forschungen berichtete. Hardy lud ihn nach England ein, wo er vier Jahre blieb und mit Hardy auf das Engste und Erfolgreichste zusammen arbeitete. Kurz vor seinem frühen Tod schrieb Ramanujan einen letzten Brief aus Indien an Hardy. Er sprach darin von “Mock-Thetafunktionen”, deren Sinn Hardy und allen anderen Mathematikern bis vor wenigen Jahren allerdings völlig verborgen blieb. Erst 2002 hat ein junger Doktorand das Geheimnis gelüftet.

Liste der Vortragenden

Zukunftsenergie Bildung.

Bildung ist das zentrale Thema für die erfolgreiche Gestaltung unserer Zukunft. Die Deutsche Telekom Stiftung hat sich zum Ziel gesetzt, an der Verbesserung des Bildungssystems in den Bereichen Mathematik, Naturwissenschaften und Technik mitzuwirken. Wir halten dies für eine unverzichtbare Voraussetzung dafür, dass Deutschland ein starker Technologiestandort bleibt.

Entlang der Bildungskette arbeiten wir mit engagierten Kindergärten, Schulen und Hochschulen zusammen. Die Übergänge zwischen den einzelnen Bildungsstufen sind uns ein besonderes Anliegen. So ermöglichen wir zum Beispiel im Projekt „Schüler-Universitäten“ begabten und leistungsbereiten Schülerinnen und Schülern parallel zum Unterricht ein Frühstudium in mathematisch-naturwissenschaftlich-technischen Fächern.
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