Jahrestagung der Deutschen Mathematiker-Vereinigung

Freie und Hansestadt Hamburg

21. bis 25. September 2015

herausgegeben von / edited by
Benedikt Löwe & Hendrik Niehaus

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Grußwort des DMV-Präsidenten

Sehr geehrte Damen und Herren,

es ist mir eine besondere Freude, Sie zur Jahrestagung 2015 der Deutschen Mathematiker-Vereinigung an der Universität Hamburg begrüßen zu können! Freuen Sie sich mit mir auf ein vielfältiges wissenschaftliches Programm mit mathematisch erstklassigen Hauptvorträgen, mit zehn Sektionen und fast vierzig Minisymposien, das den aktuellen Status quo mathematischer Forschung in ihrer ganzen inhaltlichen Breite wiedergeben wird.

Dieses Programm wird ergänzt durch eine Podiumsdiskussion zur Frage der Mathematik-Anforderungen für Studienanfänger in den MINT-Fächern, durch ein Mittagsseminar zur Mathematik in Industrie und Gesellschaft und vieles mehr!

Wenn Sie Mitglied der DMV sind, sollten Sie bitte auch unbedingt zur Mitgliederversammlung kommen. Sollten Sie kein Mitglied der DMV sein, so würde es mich freuen, wenn Sie die Begeisterung über die DMV-Jahrestagung zu einer Mitgliedschaft bewegen würde.

Viel Freude an der Tagung wünscht Ihnen Ihr

Volker Bach
Präsident der Deutschen Mathematiker-Vereinigung

Grußwort des Fachbereichs Mathematik der Universität Hamburg

Liebe Teilnehmerinnen und Teilnehmer,

im Namen des Fachbereichs Mathematik der Universität Hamburg begrüßen wir Sie ganz herzlich in der Freien und Hansestadt Hamburg zur diesjährigen Jahrestagung der *Deutschen Mathematiker-Vereinigung* (DMV). Für unseren Fachbereich ist es eine große Ehre, im Jahr des 125-jährigen Gründungsjubiläums der DMV deren Jahrestagung zum vierten Male nach den Jahren 1901, 1928 und 1979 in Hamburg auszurichten.

Die Freie und Hansestadt Hamburg hat eine vergleichsweise junge Universität, deren Gründung auf das Jahr 1919 datiert. Stand die auf Handel ausgerichtete Hansemetropole der Gründung einer Universität noch im frühen zwanzigsten Jahrhundert skeptisch gegenüber, so schätzte sie doch schon lange vor der Universitätsgründung die Wissenschaften, insbesondere die für die Stadt so wichtige Mathematik. Bereits 1690 wurde mit der "Kunst-Rechnungs-liebenden Societät" in Hamburg eine wissenschaftliche Gesellschaft gegründet, die später in der heutigen *Mathematischen Gesellschaft in Hamburg* aufging—heute eine der ältesten wissenschaftlichen Gesellschaften in Deutschland.

Nach der Gründung der Universität Hamburg entwickelte sich eine lebhafte und forschungsstarke akademische Gemeinschaft in unserem Fach, die durch berühmte Namen wie Emil Artin, Lothar Collatz, Helmut Hasse, Erich Hecke, Erich Kähler, Ernst Witt und anderen vertreten wird.

Wir freuen uns, dass die Hamburger Mathematik nichts von ihrer Anziehungskraft in der deutschen Forschungslandschaft verloren hat, wie die überaus große Zahl der Teilnehmerinnen und Teilnehmer bei dieser Jahrestagung deutlich zeigt.

In diesem Programmheft bieten wir Ihnen sowohl historische Rückblicke und Erinnerungen (zur Geschichte unserer Universität, zu 125 Jahren Geschichte der DMV, zu den drei bisherigen DMV-Jahrestagungen in Hamburg, und zum Hamburger Gymnasialprofessor Hermann Schubert), als auch praktische Informationen für die kommenden fünf Tage und natürlich Zusammenfassungen der fast fünfhundert Vorträge, die auf unserer Tagung gehalten werden.

Wir freuen uns, Sie alle hier begrüßen zu dürfen und wünschen Ihnen eine erfolgreiche Tagung.

Michael Hinze
Leiter des Fachbereichs Mathematik

Benedikt Löwe
Vorsitzender des Programmkomitees

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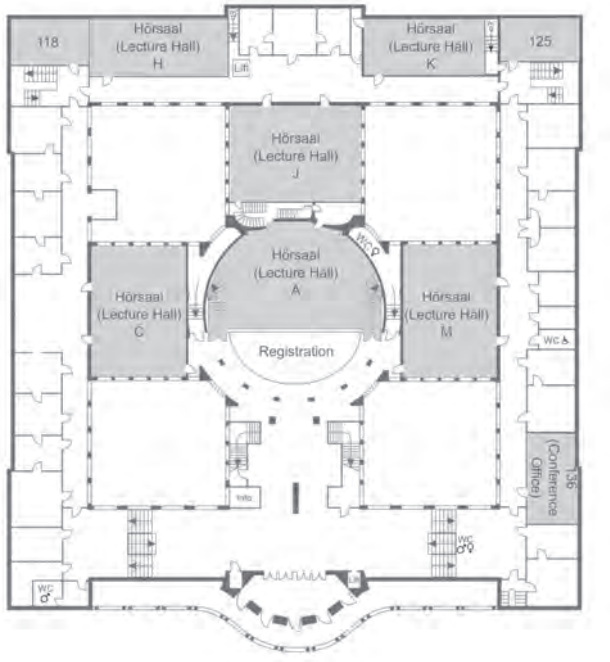
Die DMV-Jahrestagung 2015 in Hamburg

The *DMV-Jahrestagung 2015* is held in the main building of the University of Hamburg located at *Edmund-Siemers-Allee 1*, abbreviated as **ESA1**. This building was donated by the Hamburg merchant Edmund Siemers to the *Hamburgische Wissenschaftliche Stiftung* as part of the prehistory of the University of Hamburg; in this tradition, Dr. Helmut and Hannelore Greve donated to additional buildings in 2002: the west wing (**ESA1W**) and the east wing (**ESA1O**). The entire conference will take place in the historical building ESA1 and its two wings.

The lobby of **ESA1**, spread over two floors, is the central location of the conference: the book exhibit of various publishers can be found in the lobby, our coffee breaks take place in the lobby, the plenary sessions will be in the big lecture hall **ESA1A** (the "*Ernst Cassirer-Hörsaal*") reachable from the lobby with entrances right next to the registration desk which also serves as the information hub (see below). You can find further floorplans of the building and its wings at the back of the programme book.



Our building

ESA1

The **lobby** of **ESA1** stretches over the ground floor and the first floor and is the main location of the book exhibit. You can find *AMS*, *De Gruyter*, *Elsevier*, *Springer Nature*, and *Zentralblatt* on the ground floor and *Cambridge University Press* on the first floor. There are two further exhibits in the lobby of the west wing (**ESA1W**; see below). Furthermore, the catering for coffee breaks, the receptions and the lunch seminar will take place in the lobby.

The conference uses six lecture halls, all located in **ESA1**. The lecture halls are named after Hamburg scientists who suffered under the Nazis. **Hörsaal A** is the *Ernst-Cassirer-Hörsaal* and will be the location of all plenary sessions, including the panel discussion on Tuesday and the *Mittagsseminar* on Thursday. **Hörsaal C** (*Erwin-Panofsky-Hörsaal*) and **Hörsaal M** (*Emil-Artin-Hörsaal*) are reachable directly from the lobby. The general meeting of the DMV will take place in the Emil-Artin-Hörsaal on Thursday. **Hörsaal H** (*Eduard-Heimann-Hörsaal*), **Hörsaal J** (*Magdalene-Schoch-Hörsaal*), and **Hörsaal K** (*Albrecht-Mendelssohn-Bartholdy-Hörsaal*) are all reachable from the corridor that forms a quadrangle around the lobby. In order to find them, please follow the signs.

We will also be using seminar rooms **118** and **125** in **ESA1**; further seminar rooms are in the two wings. Again, in order to find these, please follow the signs.

ESA1W

The **lobby** of the west wing has two more exhibits: the calculator distribution company *Moravia Europe* and an interactive artistic installation entitled "π vs. τ" by Daniel Caleb Thompson. For more information about the art installation, please read Thompsons brief description in the programme book (pp. 23–25).

We are using seven seminar rooms in the west wing: **W120**, **W121**, **W122**, **W220**, **W221**, **W222**, and **W223**. The first digit of the room number indicates the floor, e.g., **W120** is on the first floor and **W221** is on the second floor.

ESA1O

Finally, we are using five more seminar rooms in the east wing, marked with the letter "O" for "Ost" (German for "east"): **O122**, **O124**, **O222**, **O232**, and **O233**. The naming convention is the same as in the west wing, i.e., **O232** is on the second floor.

Our programme

The conference will start with the opening session on Monday, 21 September 2015 in **ESA1A**. However, we have three interesting satellite workshops that will take place on Sunday and Monday in **ESA1C**, **ESA1J**, and **ESA1M** before the conference starts. This means that registration is open from Sunday, 9am onwards. Since we expect a rush to register on Monday afternoon, feel free to make use of the possibility of early registration on Sunday and Monday morning.

Sunday, 20 September 2015

Registration opens at 9am and the three **satellite workshops** *Recent Trends in Stochastic Analysis and Related Topics* (organised by Leif Döring and Alexander Drewitz; **ESA1C**), *Generalized Baire Space* (organised by Giorgio Laguzzi and Wolfgang Wohofsky; **ESA1J**), and *Trends in Proof Theory* (organised by Stefania Centrone; **ESA1M**) start the scientific programme of the conference. All registered participants of the conference are cordially invited to participate in the workshops if they arrive on Sunday or Monday morning.

Monday, 21 September 2015

On Monday, the three satellite workshops will continue until the early afternoon.

Before the conference opening, we shall also start with the **mentoring programme** for the winners of the *DMV-Abiturpreis Mathematik*. Together with Springer, the DMV has been coordinating the *DMV-Abiturpreis Mathematik* for high school students who excel in the subject mathematics since 2008. This year, we invited the 2015 winners of this prize to a mentoring programme at the conference: prize winners could register for the conference for free and are personally guided through the congress by our three mentors, Alexander C. Block, Pascal Gollin and Maria Mohr, doctoral students in mathematics. The mentors will meet with the mentees during a briefing session on Monday and also discuss the experiences of the prize winners during the conference and in e-mail discussions after the conference. The mentoring programme also includes a lunch meeting of the mentees with the *Netzwerkbüro* of the DMV. We hope that the mentoring programme will grant these young talents privileged access to our discipline at an early stage of their career and that it will foster a sustainable love for mathematics in them.

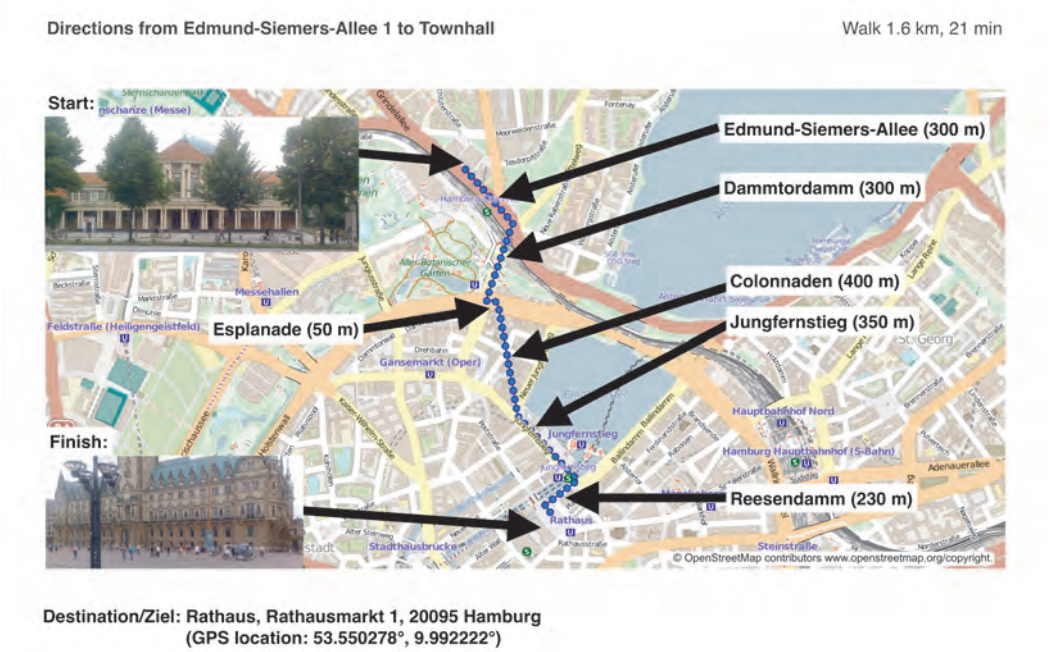
At 4pm, the conference will be opened with an **Opening Ceremony**. The opening will be musically accompanied by the choir *Elbcanto* and feature words of welcome of the president of the *Universität Hamburg* and the president of the *Deutsche Mathematiker-Vereinigung*. The *Deutsche Forschungsgemeinschaft* annually presents the von Kaven Prize for outstanding achievements in mathematics; the prize was donated by Herbert von Kaven (1908–2009). The **von Kaven Prize 2015** will be awarded to Tobias Oertel-Jäger during the opening ceremony of our congress. The laudatio will be given by Günter Ziegler (Berlin).

After the opening ceremony, we have our first keynote lecture by **Alessandra Carbone** (p. 65) on *One-dimensional and three-dimensional protein spaces and protein evolution*.

On Monday evening, Senatorin Katharina Fegebank, the deputy mayor of the city of Hamburg and state minister for science and research invites all participants of the conference to a reception with drinks and nibbles in the city hall of Hamburg ("***Senatsempfang***"). We are very happy that the deputy mayor of Hamburg takes the time to greet the German mathematicians personally. Your conference bag will contain an invitation to this reception which you will need in order to enter city hall: student helpers will check that everyone either has an invitation card or is a registered participant of the conference. If you did not bring your invitation card, you will need some photo identification and a valid registration for the conference.

Carbone's talk will end at 6pm and the reception starts at 7:30pm in City Hall. It will take about 30 to 40 minutes to walk from **ESA1** to City Hall, so it is very important to move soon after Carbone's talk ends. Student helpers will guide the participants on the walk to City Hall. If you have asked for assistance with the transfer to City Hall, please

follow the signs to the bus that was arranged for this. We shall also distribute printed versions of the following map with walking directions to make sure that no one gets lost.



Tuesday, 22 September 2015

In addition to our regular programme, Tuesday is also the **Lehrertag** (*teachers' day*). This is an opportunity for teachers from Hamburg and vicinity to take part in the conference, listen to talks in mathematics education, but also the keynote lectures. The **Lehrertag** is organised under the auspices of Senator Ties Rabe, the state minister for education of the city state of Hamburg. For participating teachers, there will be a special presentation of the project *Panorama der Mathematik* by Andreas Loos and Günter Ziegler in **ESA1M** from 5:45pm to 6:45pm. Of course, the teachers are cordially invited to participate in the panel discussion in the evening (see below).

Tuesday's programme starts at 9am with **Michael Eichmair**'s plenary lecture entitled *Minimal surfaces, isoperimetry, and non-negative scalar curvature in asymptotically flat manifolds* (p. 66) in **ESA1A**. After that, coffee will be served in the lobby of **ESA1** before participants split up in many different parallel sessions for the **mini-symposia**. Note that the seminar rooms for the mini-symposia are spread over the main building **ESA1** and the two wings **ESA1W** and **ESA1O**, and walking from the lobby to the 2nd floor rooms in one of the wings could take up to five minutes. Therefore, please make sure that you familiarise yourself with the location of your mini-symposium and that you start going there soon enough lest you miss the start of your mini-symposium. You find the detailed schedule with information about the locations of the mini-symposia in your conference

material; there are also floor plans of the three building parts at the end of this book. The mini-symposia will start at 10:30am.

Time schedules of the mini-symposia are not necessarily designed to allow participants to switch easily between the mini-symposia. You will notice that many mini-symposia have 30 minute talks, but others have 40 minute talks or 25 minutes talks; some even have 60 minute talks. We ask the chairs of the sessions to make sure that they stick very strictly to the schedule to avoid that people come to the session in order to see a particular talk and then are disappointed due to a shift of the schedule caused by delays. Also from 10:30am to 12:30pm, Carsten Balleier and Frank Kiefer from the *Deutsche Forschungsgemeinschaft* will give a presentation on funding opportunities for mathematicians and answer questions about them in room **O222**.

After the mini-symposia, there is a 90-minute **lunch break** during which you can go to the student restaurant (*Mensa*) or to restaurants in nearby *Grindelallee*; for more detailed instructions, please check the section *Practical Information* (p. 16). Please make sure that you are back by 2pm since the **mini-symposia** will continue immediately after the lunch break with another hour of talks.

From 3pm to 3:15pm, there will be another short **coffee break**; again, coffee will be served in the lobby of the main building. At the end of the break, the **sections** are going to start. As with the mini-symposia before, please familiarize yourself with the location of the section you wish to attend and make sure that you go there early enough to be in the room by 3:15pm. Section talks are in general 20 minutes long, but the section coordinators have selected some of the talks for 40 minute presentations; this will allow switching sections more easily than in the case of the mini-symposia, but keep in mind that there are no breaks between the talks.

The final **coffee break** of the day takes place from 5:15pm to 5:45pm, once more in the lobby of the main building. After the break, the final plenary lecture will be held in **ESA1A**: **Björn Sandstede** will speak about *Turing patterns: past and present* (p. 68).

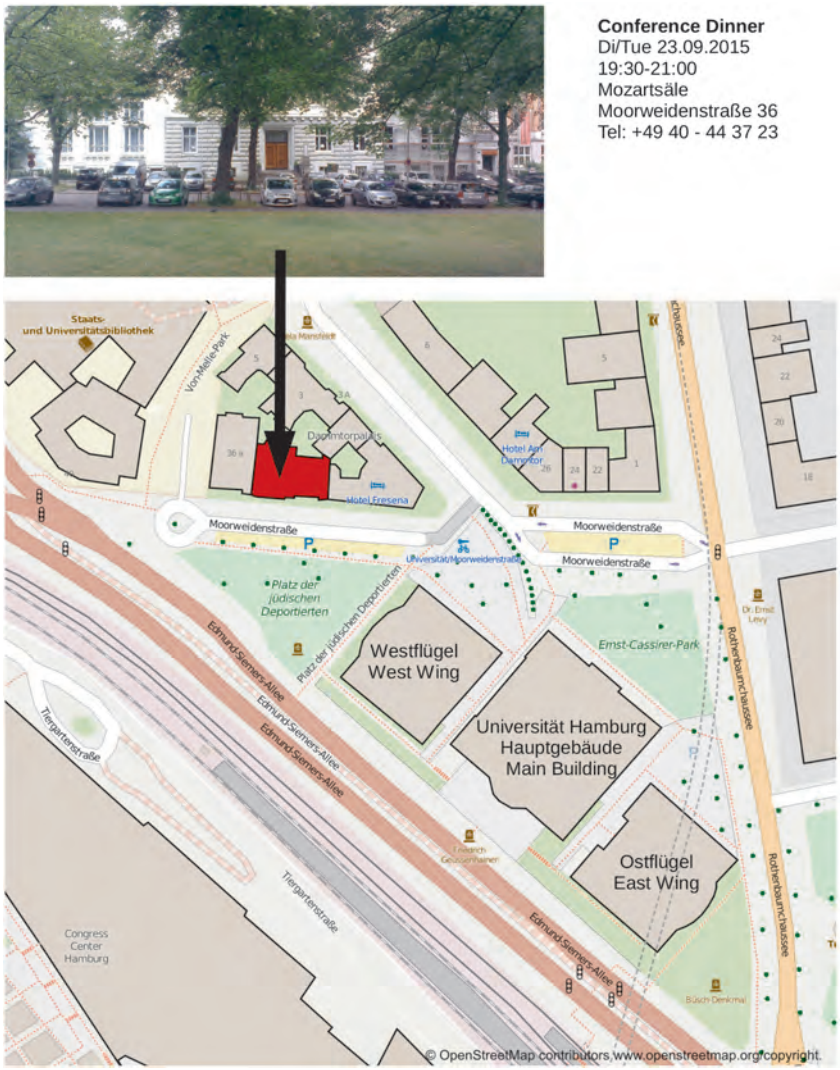
After the lecture, the organisers and the *Springer-Verlag* invite every participant and the academic public for a **drinks reception**. This reception introduces the public **panel discussion** (held in German) entitled *Wie viel Mathematik brauchen Studierende der MINT-Fächer?* concerning the amount of mathematics needed by students in the STEM disciplines. The panel discussion is jointly organised by the organisers of the conference and the *Akademie der Wissenschaften in Hamburg* (p. 10).

The ***DMV-Studierendenkonferenz*** will also start on Tuesday, taking place during the slots of the mini-symposia and sections. The *Studierendenkonferenz* is an annual event organised by the DMV during which the best mathematics graduates from German universities can present their research done as part of a Master's thesis (or in exceptional cases, Bachelor's thesis). The best theses will be awarded prizes, including research stays at the *Deutsches Zentrum für Lehrerbildung Mathematik*, the *Fraunhofer Institute for Industrial Mathematics*, the *Hausdorff Research Institute for Mathematics*, the *Mathematisches Forschungsinstitut Oberwolfach* the *Max-Planck-Institut für Mathematik*, the *Max-Planck-Institut für Mathematik in den Naturwissenschaften*, or the *Rheinisch-Westfälische Technische Hochschule Aachen* and book vouchers from *Springer* and *World Scientific*. The prize winners will be announced in the session on Thursday morning.

Wednesday, 23 September 2015

From 9am to 6:45pm, the programme of Wednesday will be structurally the same as the programme on Tuesday. The day starts with a plenary **Emmy-Noether-Lecture** by **Kathrin Bringmann** entitled *Meromorphic Maass forms* (p. 64) in **ESA1A** at 9am, continues with a **coffee break** in the lobby of the main building and then continues with sessions of the **mini-symposia** (from 10:30am to 12:30pm).

After the 90-minute **lunch break** (where you could go to the student restaurant once more; again, cf. p. 16 for instructions), we reconvene for another session of the **mini-symposia** (from 2pm to 3pm), have a **coffee break**, then two hours of **sections** (3:15pm to 5:15pm), another **coffee break**, and a final plenary lecture by **Simon Thomas** entitled *A descriptive view of infinite dimensional unitary representations* (p. 70).



On Wednesday evening, those of us who have booked the **conference dinner** will dine in the *Mozartsäle der Provinzialloge von Niedersachsen* (Provincial Lodge of Lower Saxony). The Provincial Lodge is located in *Moorweidenstraße* which is the street behind the main building of the university. It will not take more than five minutes to walk from the university to the dinner venue. Dinner will start at 7:30pm; it would be good if you have arrived and taken your seat by 7:15pm. The following map shows the location of the Provincial Lodge; student helpers will also be present to help you find the way.

Thursday, 24 September 2015

The programme on Thursday starts very similar to the past two days. At 9am, **Charles Elliott** opens the day with a plenary talk about *PDEs on evolving domains* in **ESA1A** (p. 67); after a **coffee break**, the participants go into parallel sessions to attend various **mini-symposia** from 10:30am to 12:30pm. (We remind participants that in that session, the *Studierendenkonferenz* will announce its prize winners.)

However, on Thursday, there will be no lunch break. Instead, we have a very special event from 12:30pm to 3pm: the ***Mittagsseminar Mathematik in Industrie und Gesellschaft*** (held in German). All participants of the conference are cordially invited to a light snack lunch in the lobby of the main building; after the participants have been provided with sandwiches, three high-profile speakers representing various fields of application of mathematics outside of academia will give short introductory talks, followed by a moderated discussion. This *Mittagsseminar* will take place in **ESA1A**. More information can be found (in German) on p. 12.

After a brief **coffee break** in the lobby of the main building (3pm to 3:15pm), we continue with the final session of the ten **sections** (from 3:15pm to 5:15pm), following by another **coffee break**, and an evening session of presentation in the **mini-symposia** (5:45pm to 6:45pm).

In the evening, the *Deutsche Mathematiker-Vereinigung* asks all of its members to attend the annual general meeting of the DMV (***Mitgliederversammlung***). This meeting will start at 7:15pm in the *Emil-Artin-Hörsaal* (**ESA1M**). Of course, if you are not yet a member of the DMV, please consider joining the DMV: the DMV will be represented at the registration desk and membership application forms can be filled there.

Friday, 25 September 2015

Once more, the final day starts like the others. A keynote lecture by **Jørgen Ellegaard Andersen** on *Topological quantum field theory in low dimensional topology* starts the Friday programme at 9am (p. 63), followed by a **coffee break**, and a two-hour session of the **mini-symposia** (from 10:30am to 12:30pm).

From 12:30pm to 2pm, you have a final **lunch break** (cf. p. 16). At 2pm, participants return for the final session of the **mini-symposia**, before having the final **coffee break** in the lobby of the main building (3pm to 3:15pm). The conference closes with back-to-back plenary lectures by **Karen Vogtmann** on *Cycles in moduli spaces of graphs* (from 3:15pm to 4:15pm; p. 71 and **Herbert Spohn** on *Interacting diffusions in the Kardar-Parisi-Zhang universality class* (from 4:15pm to 5:15pm; p. 69), the winner of the Cantor Medal of the DMV. After Spohn's lecture, the conference will be officially closed and participants will be invited to Braunschweig by the organizers of the *DMV-Jahrestagung 2016*.

Our team, sponsors, and helpers

The **local organising team** at the *Fachbereich Mathematik der Universität Hamburg* consists of Charlotte Becker (née Schulze), Alexander C. Block, Andrea Blunck, Vicente Cortés, Alexander Haupt, Stefan Heitmann, Michael Hinze, Ralf Holtkamp, Nick de Hoog, Philine Kortmann, Ruslan Krenzler, Ulf Kühn, Reiner Lauterbach, Benedikt Löwe (chair), Janja Nahrstaedt, Hendrik Niehaus, Sonja Otten, and Birgit Richter. The organising team was supported by the *DMV-Geschäftsstelle* and the *DMV-Medien- und Netzwerkbüro* as well as the members of the *DMV-Präsidium*; we should like to mention Volker Bach, Etienne Emmrich, Roswitha Jahnke, Moritz Kassmann, and Thomas Vogt in particular. We should like to acknowledge the assistance of the office of the president of the *Universität Hamburg* (in particular, Christian Matheis), the offices of Senatorin Katharina Fegebank (in particular, Timo Langeloh) and Senator Ties Rabe (in particular, Thomas Bressau), the *Akademie der Wissenschaften in Hamburg* (in particular its president, Edwin Kreuzer), the people at *Das Speisekabinett* (in particular, Heiko Knoblauch), our IT group (in particular, Gaja Peters), the administration of the *Universität Hamburg* (in particular, Michael Hinz, Anne Malkowski, and Heiko Mierwaldt), and the *Universität Hamburg Marketing GmbH* (in particular, Xenia Boe and Constanze Weismantel).

The **programme committee**, responsible for the selection of keynote speakers, mini-symposia, and section coordinators consisted of Volker Bach (Braunschweig), Christian Bär (Potsdam), Andrea Blunck (Hamburg), Vicente Cortés (Hamburg), Vagn Lundsgaard Hansen (Kungens Lyngby), Michael Hinze (Hamburg), Ulf Kühn (Hamburg), Reiner Lauterbach (Hamburg), Benedikt Löwe (Amsterdam & Hamburg, chair), and Birgit Richter (Hamburg). We should like to thank the twenty section coordinators for their work in evaluating the submitted section papers and the organisers of the 39 mini-symposia for inviting so many interesting speakers. You can find the names of the section coordinators and organisers of mini-symposia in the corresponding abstracts part of this book, starting on pp. 73 and 131, respectively. Of course, all of the speakers, including keynote speakers, speakers for the *Lehrertag*, speakers at the panel discussion, speakers at the *Mittagsseminar*, speakers at the mini-symposia and sections, provided the most important contribution to the success of the conference; we thank them most gratefully. We appreciate that the *Deutsche Forschungsgemeinschaft* organised the ceremony for the *von Kaven-Preis* as part of the opening of the conference and in particular thank Carsten Balleier and Frank Kiefer for joining us in Hamburg. Renate Tobies very kindly provided two historical papers for this programme book at a rather short notice request. In addition, we cordially thank the five **organisers of satellite workshops**, Stefania Centrone, Leif Döring, Alexander Drewitz, Giorgio Laguzzi, and Wolfgang Wohofsky, and all of their speakers, for their work in arranging and participating in the pre-conference workshops on Sunday and Monday; and Georg Hein for organizing the ***DMV-Studierendenkonferenz*** as part of our conference.

The conference was financially supported by the *Universität Hamburg*, the *Fakultät für Mathematik, Informatik und Naturwissenschaften* of the *Universität Hamburg*, the *Fachbereich Mathematik* of the *Universität Hamburg*, the *Deutsche Forschungsgemeinschaft* (LO 834/12-1), the *Hamburgische Wissenschaftliche Stiftung*, the *Deutsche Vereinigung für Mathematische Logik und für Grundlagenforschung der exakten Wissenschaften*, and *Springer-Verlag*. We should like to thank all financial sponsors without whom the conference would have been impossible.

Since the DMV wants to include students in the activities of their conferences, they coordinated the *DMV-Studierendenstipendien* allowing all students who do not have funding from their own institutions to get their registration fee paid for. The *Studierendenstipendium* was made possible by generous donations of the *Berlin Mathematical School*, the *Sonderforschungsbereich Transregio 154: Mathematische Modellierung, Simulation und Optimierung am Beispiel von Gasnetzwerken*, the *Sonderforschungsbereich 647: Space-Time-Matter, Analytic and Geometric Structures*, the *Humboldt-Universität zu Berlin*, the *Technische Universität Berlin*, and the *Zuse Institute Berlin*. Special thanks are due to Ralf Borndörfer, Jürg Kramer, Gitta Kutyniok, Volker Mehrmann, and Martin Skutella for arranging this grant programme.

Finally, we should like to thank all of our helpers, including the mentors of the mentoring programme for the winners of the *DMV-Abiturpreismathematik* and the student helpers for their assistance.

www.mediaserver.hamburg.de / St. Wallocha

Podiumsdiskussion *Wie viel Mathematik brauchen Studierende der MINT-Fächer?*

Gemeinsame Veranstaltung mit der *Akademie der Wissenschaften in Hamburg*

AKADEMIE DER WISSENSCHAFTEN IN HAMBURG

Lernen für das Leben, oder genauer: Lernen für den Beruf?

MINT steht für „Mathematik, Informatik, Naturwissenschaft und Technik“ und umfasst Fächer wie Biologie, Chemie, Physik, die Geowissenschaften, die Informatik und alle Bereiche der Ingenieurwissenschaft. Als Grundlage der modernen Naturwissenschaften hat Mathematik eine besondere Rolle für diese Fächer, die an der zentralen Rolle der Mathematik in den Studienplänen der Studierenden dieser Fächer deutlich wird.

Aber wie viel und welche Art von Mathematik brauchen Studierende der MINT-Fächer für ihr Leben oder ihren Beruf?

Ohne eine Antwort auf diese Frage ist eine rationale Diskussion über die Frage nach den mathematischen Kenntnissen, die von Studienanfängern der MINT-Fächer gefordert werden, nicht möglich.

Da viele mögliche berufliche Lebensläufe für MINT-Studierende denkbar sind, darf sich die Diskussion nicht an Beispielfällen orientieren, sondern sollte von grundsätzlichen Erwägungen getragen werden. Dabei müssen die zukünftigen Wissenschaftler, deren Erkenntnisse unser Land für wirtschaftlichen Erfolg dringend braucht, ebenso in den Blick genommen werden, wie die Absolventen, die nur wenig Mathematik in ihrem beruflichen Umfeld brauchen werden, und deren Studienerfolg möglicherweise durch zu hohe Anforderungen im Fach Mathematik gefährdet ist.

Dürfen die mathematischen Anforderungen an MINT-Studierende—im Hinblick auf das föderative System und die Autonomie der Bundesländer in der Bundesrepublik Deutschland—vom Bundesland abhängen? Besitzen die Personen, die Entscheidungen über die Mathematikanforderungen treffen, die dazu notwendige Kompetenz? Wie kann man sicherstellen, dass zukünftig in diesen Fragen vernunftgebotene Entscheidungen getroffen werden?

Diese Diskussion muss alle relevanten Parteien einbinden: die Politik, die Schulmathematik, die Hochschulmathematik und die Vertreter der MINT-Fächer.

Im Rahmen der Jahrestagung der *Deutschen Mathematiker-Vereinigung* (DMV) richtet der Fachbereich Mathematik der Universität Hamburg in Kooperation mit der Akademie der Wissenschaften in Hamburg und der gemeinsamen Mathematik-Kommission Übergang Schule-Hochschule der DMV, der *Gesellschaft für Didaktik der Mathematik* (GDM) und des *Deutschen Vereins zur Förderung des mathematischen und naturwissenschaftlichen Unterrichts* (MNU) eine öffentliche Podiumsdiskussion zu diesen Fragen aus, zu dem alle Interessierten ganz herzlich eingeladen sind.

Auf dem Podium diskutieren **Stephan Kabelac**, Professor für Thermodynamik an der Leibniz Universität Hannover und Mitglied der Akademie der Wissenschaften in Hamburg, **Matthias Lippert**, Schulleiter des Röntgen-Gymnasiums Remscheid und Mitglied des Präsidiums der Deutschen Mathematiker-Vereinigung, **Bettina Rösken-Winter**, Professorin für Mathematik und ihre Didaktik an der Humboldt-Universität zu Berlin und Mitglied des Präsidiums der Deutschen Mathematiker-Vereinigung, **Ricki Rosendahl**, Mathematik-Lehrerin am Gymnasium Corveystrasse in Hamburg-Lokstedt und **Monika Seiffert**, Fachreferentin für den Bereich MINT in der Behörde für Schule und Berufsbildung (BSB) der Freien und Hansestadt Hamburg. Die Diskussion wird moderiert von **Reiner Lauterbach**, Professor für Mathematik an der Universität Hamburg und Mitglied der Akademie der Wissenschaften in Hamburg.

Von 19:00 bis 19:30 Uhr laden die Organisatoren der DMV-Jahrestagung und der Springer-Verlag zu einem Empfang im Foyer des Hauptgebäudes der Universität ein; die Podiumsdiskussion beginnt um 19:30 Uhr im *Ernst-Cassirer-Hörsaal* (**ESA1A**).

www.mediaserver.hamburg.de / Christian Spahrbier

Mittagsseminar *Mathematik in Industrie und Gesellschaft*

Zum ersten Mal wird in diesem Jahr die Jahrestagung der Deutschen Mathematiker-Vereinigung um ein Element erweitert, dessen Ziel es ist, die vielfältigen Bezüge der Mathematik zu Gesellschaft, Wirtschaft und Industrie zur Sprache kommen zu lassen. Alle Teilnehmerinnen und Teilnehmer der Jahrestagung sind hierzu herzlich eingeladen.

Lehre und Forschung im Bereich Mathematik finden nicht im luftleeren Raum statt. Auf der einen Seite stehen die Absolventinnen und Absolventen unseres Fachs nach Abschluss des Studiums bzw. der Promotion. Für sie stellt sich die Frage, inwiefern die Ausbildung an Schule, Universität und Fachhochschule für den Erfolg der Jobsuche zielführend ist. Auch für Lehrende ist es interessant zu wissen, welche Tätigkeiten für ihre Studierenden in Frage kommen und bei welchen Herausforderungen Mathematikerinnen und Mathematiker bevorzugt eingesetzt werden. Auf der anderen Seite steht die mathematische Forschung, die häufig von Fragestellungen der angewandten Wissenschaften und von konkreten Problemen der Industrie profitiert. Schlussendlich hat Mathematik eine gesellschaftliche Dimension und dies nicht nur beim Verteilungskampf um Aufmerksamkeit und Ressourcen.

Diese und weitere Fragen wollen wir in Hamburg mit drei hochkarätigen Referenten diskutieren. In Impulsreferaten werden wir zunächst hören, inwieweit Mathematik bei Gefährdungen im Cyberraum helfen kann, welche Rolle sie als ordnende Hand in der Raumfahrt spielt und welche Herausforderungen der Lebensversicherungen auf Mathematikerinnen und Mathematiker warten. Danach wird dann in einer moderierten Podiumsdiskussion auch das Publikum zu Wort kommen. Für alle Teilnehmerinnen und Teilnehmer wird vorab ein Imbiss zur Verfügung gestellt.

Die Referenten sind **Hansjörg Dittus**, Vorstand Raumfahrtforschung und -technologie des Deutschen Zentrums für Luft- und Raumfahrt, **Andreas Könen**, Vizepräsident des Bundesamtes für Sicherheit in der Informationstechnik und **Volker Priebe**, Leiter Produktentwicklung und Aktuariat sowie Verantwortlicher Aktuar der Allianz Lebensversicherung.

Kurz und knapp:

Wo?	**ESA1A**, *Ernst-Cassirer-Hörsaal*	
Wann?	Donnerstag, 24. September 2015	
	12:30 Uhr	Imbiss
	13:00–14:30 Uhr	Impulsreferate der drei Referenten
	14:30–15.00 Uhr	Moderierte Podiumsdiskussion

Ansprechpartner: Stefan Heitmann, Hamburg & Moritz Kassmann, Bielefeld.

Praktische Informationen / Practical Information

Conference Venue / Tagungsort

The DMV annual meeting 2015 will be held at the main building of the University of Hamburg, Edmund-Siemers-Allee 1 (**ESA1**) and its two wings (**ESA1W** and **ESA1O**). The centre of the conference will be the lobby of **ESA1** where you will find book exhibitions and the registration desk, and where the coffee breaks will take place. You will find lecture halls **ESA1A**, **ESA1C**, **ESA1H**, **ESA1J**, **ESA1K** and **ESA1M**, the registration desk and the conference office as well as two additional seminar rooms there. In addition, ground floor and first floor of the main building as well as the ground floor of the west wing will provide space for several international exhibitors and publishers. The east and the west wing of the main building will host some of the mini-symposia and sections. The two wings can be accessed by exiting the main building towards the left or right. Floor plans of the building are provided at the back of this book.

Die DMV-Jahrestagung 2015 wird im Hauptgebäude der Universität Hamburg, Edmund-Siemers-Allee 1 (**ESA1**) und seinen beiden Flügelbauten (**ESA1W** und **ESA1O**), stattfinden. Die zentrale Anlaufstelle für die Jahrestagung werden die ersten beiden Stockwerke des Foyers von **ESA1** sein, wo sich Anmeldung und Verlagsausstellung befinden und wo die Kaffeepausen stattfinden werden. Hier befinden sich auch die Hörsäle **ESA1A**, **ESA1C**, **ESA1H**, **ESA1J**, **ESA1K** und **ESA1M**, sowie das Konferenzbüro und zwei weitere Seminarräume. Im Ost- und Westflügel des Hauptgebäudes werden einige Minisymposien und Sektionen stattfinden. Beide Flügelbauten sind vom Hauptgebäude aus über Seitenausgänge oder über seitliche Stufen am Platz vor dem Haupteingang zugänglich. Grundrisse der Gebäude finden sich auf den letzten Seiten dieses Bandes.

Registration & Information / Anmeldung & Information

You will find the registration desk on the ground floor at the end of the foyer (you cannot miss it if you go towards the *Ernst Cassirer-Hörsaal*, **ESA1A**). When entering the main building and following up the stairs on your right and then turning left, you will find our conference office (room 136). Please register at the the registration desk and collect your conference material. If you have not registered online yet, you can still register in person. However, only cash payments (preferably in exact change) will be accepted. The registration desk and the conference office will be open during the following times:

Sunday:	9:00am to 6:00pm
Monday to Thursday:	8:30am to 7:00pm
Friday:	8:30am to 6:00pm

You can also reach the registration desk by phone via +**49 (40) 42838-4444** / **-6666**. The registration desk staff will be happy to (try and) answer all questions you might have. If you need to print boarding passes or tickets, please contact the registration desk.

Die Anmeldung befindet sich im Erdgeschoss am Ende des Foyers (direkt vor dem *Ernst Cassirer-Hörsaal* **ESA1A**). Wenn Sie direkt durch den Haupteingang in das Foyer gehen und dann rechts den Stufen nach oben folgen, finden Sie linker Hand hinter der ersten Tür unser Konferenzbüro (Raum 136). Wenn Sie sich online angemeldet haben, holen Sie bitte Ihre Konferenzmaterialien bei der Anmeldung ab. Es ist möglich, sich erst bei der Konferenz anzumelden, allerdings können wir in diesem Fall nur Barzahlung (vorzugsweise passend) akzeptieren. Die Anmeldung und das Konferenzbüro sind für Sie zu den folgenden Zeiten geöffnet:

Sonntag:	9:00 Uhr bis 18:00 Uhr
Montag to Donnerstag:	8:30 Uhr bis 19:00 Uhr
Freitag:	8:30 Uhr bis 18:00 Uhr

Sie erreichen die Anmeldung telefonisch unter: +**49 (40) 42838-4444** /**-6666**. Die Anmeldung sollte Ihre Anlaufstelle für Fragen aller Art sein und unsere Mitarbeiter werden sich bemühen, alle Fragen zu beantworten. Wir können Ihnen auch Zugtickets und Bordkarten ausdrucken.

Facilities in the Conference Rooms / Ausstattung der Konferenzräume

All conference rooms have a laptop and a beamer. A student helper will be present in the room to help speakers upload their files to the laptop and assist in the case of problems. The student helper also has a USB stick at hand to help with the transfer of the files. All rooms have at least some (small) board (either black or white); the lecture halls have larger blackboards.

Alle Hörsäle und Seminarräume haben einen Laptop und einen Beamer. In jedem genutzten Raum gibt es eine studentische Hilfskraft, die den Rednern dabei hilft, die Dateien auf dem Laptop zu speichern und im Falle von Problemen zu unterstützen. Die studentische Hilfskraft hat einen USB-Stick, der für die Datenübertragung genutzt werden kann. Alle Räume haben zumindest eine kleine Tafel (Kreidetafel oder Whiteboard); die Hörsäle haben größere Kreidetafeln.

Accessibility / Barrierefreiheit

All conference rooms offer wheelchair access. The registration desk in the foyer of the main building and lecture hall **ESA1A** can be reached via the ramp at the front entrance. Lecture halls **ESA1C**, **ESA1H**, **ESA1J**, **ESA1K** and **ESA1M** can be reached via lift in the back of the main building. Ground-level access to the lifts can be gained on the left and right side of the main building opposite to the wing building entrances. The east and the west wing have lifts in the entrance halls. If you have further questions regarding this point, please do not hesitate to ask our dedicated registration staff.

Alle Hörsäle und Seminarräume können barrierefrei erreicht werden. Die Registrierung und Hörsaal A können über eine Rampe am Vordereingang erreicht werden. Die Hörsäle **ESA1C**, **ESA1H**, **ESA1J**, **ESA1K** und **ESA1M** sind über einen Fahrstuhl, der sich im hinteren Bereich des Gebäudes befindet, zugänglich. Einen ebenerdigen Zugang zum Fahrstuhl finden Sie jeweils auf der linken und rechten Seite des Hauptgebäudes, gegenüber der Eingänge zu den Flügelbauten. In Ost- und Westflügel befindet sich jeweils ein Fahrstuhl neben dem Treppenaufgang in der Eingangshalle. Sollten Sie diesbezüglich weitere Fragen haben, so sprechen Sie unser hilfsbereites Anmeldungspersonal an.

Internet & Social Media / Internet & soziale Medien

Eduroam is available throughout the building, so if you have access to eduroam via your home institution, you will not need any special instructions to access the wireless internet. For those participants who do not have eduroam access, we have guest accounts for the wireless network of the *Universität Hamburg*. Please come to the registration desk to get one of these accounts.

The conference is on Twitter (@DMV2015HH) and on Facebook (DMV2015HH). Please join us by tweeting and posting what happens at the conference.

Die Universität Hamburg verwendet *eduroam*: falls Sie einen *eduroam*-Zugang über Ihre Heimatinstitution haben, können Sie sich wie gewohnt über *eduroam* einloggen. Sollten Sie keinen *eduroam*-Zugang haben, so können Sie sich bei der Anmeldung einen speziellen Zugang für das Gast-Netzwerk der Universität Hamburg abholen.

Die Konferenz ist auf Twitter (@DMV2015HH) und Facebook (DMV2015HH) und wir laden Sie alle ganz herzlich ein, Ihre Erfahrungen auf der Konferenz über Twitter und Facebook zu verbreiten.

Luggage / Gepäckaufbewahrung

You can leave your luggage and coats behind the registration desk counter during opening hours of the registration desk. We should like to stress that the building is a public building and everyone can enter. Please note that we cannot assume any liability for lost property whatsoever.

Während der Tagung haben Sie die Möglichkeit, Gepäck, Jacken und Mäntel hinter der Anmeldung aufzubewahren, solange die Anmeldung besetzt ist. Wir weisen jedoch darauf hin, dass die Garderobe unbewacht ist und dass das Gebäude ein öffentliches Gebäude ist. Wir übernehmen keine Haftung für verlorengegangenes Eigentum oder Wertsachen.

Lunch Breaks / Mittagspausen

The student restaurants ("*Mensa*") will be open from Monday to Friday. They offer various meal types (non-vegetarian, vegetarian and vegan) for prices between € 1.30 and € 6.00 (not including drinks or dessert). The restaurants are located at the main campus reachable within less than ten minutes on foot: exit the main building towards the back passing the west wing and walk along Schlüterstraße. The main student restaurant (*Mensa Studierendenhaus*) is the large building on the left side of the street (7 minute walk). Turning to the left, 100 metres further, you'll find the entrance to the *Mensa Campus* (10 minute walk). The opening times are:

Mensa Studierendenhaus (Von-Melle-Park 2)	Monday to Thursday 11:00am–2:30pm Friday 11:00am–2:00pm
Mensa Campus (Von-Melle-Park 5)	Monday to Thursday 10:00am–3:30pm Friday 10:00am–3:00pm

If you wish to arrange for your own lunch, there is a large variety of restaurants, cafés, snack bars and bakeries within walking distance. Both the east and the west wing host cafés where snacks and cakes are served. The streets of *Grindelallee* and *Grindelhof* offer numerous cheap and mid-range restaurants. Follow the main road in front of the main building to the right and at the first crossroad turn right into *Grindelallee*. Follow *Grindelallee* to pass many restaurants along it and turn right into Grindelhof at the next junction (12 minute walk). If you need any special recommendations, please ask at the information desk. Mid-range and high-end restaurants can be found in the surrounding hotels, such as the *Radisson Blu Hotel* behind *Dammtor* station or the *Grand Elysée Hotel* at *Rothenbaumchaussee* on the other side of the road behind the east wing.

Die Mensen der Universität sind von Montag bis Freitag für Sie geöffnet. Dort gibt es ein breites Angebot an nichtvegetarischen, vegetarischen und veganen Gerichten zwische zwischen € 1,30 und € 6,00 (exklusive Getränke oder Nachtisch). Die Mensen befinden sich auf dem Campus, den Sie zu Fuß in ca. 7 Minuten erreichen, wenn Sie, aus dem Hauptgebäude kommend, rechts um das Gebäude herum gehen und dann der Schlüterstraße folgen, bis Sie auf der linken Seite ein leicht erhöht liegendes großes Gebäude sehen: die Hauptmensa (Mensa Studierendenhaus). Wenn Sie kurz vorher bei der Treppe links abbiegen und 100 Meter weitergehen, erreichen Sie die Mensa Campus. Die Öffnungszeiten der Essensausgabe sind:

Mensa Studierendenhaus (Von-Melle-Park 2)	Montag bis Donnerstag 11 bis 14:30 Uhr Freitag 11 bis 14 Uhr
Mensa Campus (Von-Melle-Park 5)	Montag bis Donnerstag 10 bis 15:30 Uhr Freitag 10 bis 15 Uhr

Die umliegenden Restaurants, Cafés, Imbisse und Bäckereien bieten ebenfalls vielfältige Mittagsangebote. Im Ost- und Westflügel des Hauptgebäudes befinden sich zudem Cafés, die Kuchen und Kleinigkeiten servieren. Viele günstige bis mittelpreisige Restaurants befinden sich in der Grindelallee und am Grindelhof. Folgen Sie der Hauptstraße vor dem Hauptgebäude nach rechts, bis Sie zu einer großen Kreuzung kommen. Biegen Sie rechts in die Grindelallee ein. An der nächsten Kreuzung rechts liegt der Grindelhof (ca. 12 Minuten Fußweg). Im Konferenzbüro oder an der Information helfen wir Ihnen gerne weiter, sollten Sie spezielle Empfehlungen wünschen. Restaurants der höheren Preisklasse sind den umliegenden Hotels angegliedert. Hinter dem Dammtorbahnhof befindet sich das Radisson Blu und hinter dem Ostflügel, auf der gegenüberliegenden Straßenseite der Rothenbaumchaussee, das Grand Elysée.

Coffee and Refreshments / Kaffeepausen

Coffee, tea, water, juice, pastries and fresh fruit will be served throughout the conference. Please find the main buffet in the foyer of the ground floor and another small buffet arrangement on the first floor.

Während der Konferenz servieren wir durchgängig Kaffee, Tee, Wasser, Säfte, Gebäck und frisches Obst im Foyer des Hauptgebäudes (sowohl im Erdgeschoß als auch im ersten Stock).

Taking a break / Erholung

If you feel the need for fresh air, we recommend a walk through *Planten un Blomen*, a lovely public park behind *Dammtor* station: cross the main road in front of **ESA1** and pass under the rail tracks. Then follow the large staircases up to the entrance gates (open 7am to 11pm, no entrance fee). You should calculate a minimum of 20 minutes for a short walk. If you're interested in longer walks, the walking paths around the Alster offer wonderful views and a refreshing surrounding. You will need around 15 minutes to get there. The river Alster (yes, it is a river!) is divided into a small part (*Binnenalster*), within the historical city centre, and a larger part (*Außenalster*) mainly used for sailing, kayaking, and rowing. For a walk around the large part you should schedule at least two

and a half hours. The city centre of Hamburg is within ten to twenty minutes walking distance.

Sollten Sie sich eine kurze Auszeit gönnen wollen, so empfehlen wir einen Spaziergang durch *Planten un Blomen*, eine wunderschöne Parkanlage, die direkt hinter dem Dammtorbahnhof liegt. Überqueren Sie die Edmund-Siemers-Allee und unterqueren Sie die Gleise. Die dahinterliegende Treppe führt auf ein Hochplateau, wo sich der Eingang zu *Planten und Blomen* befindet (täglich geöffnet von 7:00 bis 23:00 Uhr, Eintritt frei). Sie sollten mindestens 20 Minuten für einen kleinen Spaziergang einplanen. Sollten Sie einen größeren Spaziergang wünschen, bieten die Wanderwege rund um die Alster einen wunderbaren Blick auf das Stadtpanorama. Sie benötigen etwa 15 Minuten, um zur Alster zu gelangen. Der Fluss Alster (ja, es handelt sich tatsächlich um einen Fluss!) besteht aus Binnen- und Außenalster. Der kleinere Teil, der Binnenalster, liegt in der historischen Innenstadt. Der größere Teil, die Außenalster, wird vor allem zum Segeln, Paddeln und Rudern genutzt. Für einen Spaziergang um die Außenalster sollten Sie mindestens zweieinhalb Stunden einplanen. Ebenfalls fußläufig zu erreichen ist die Innenstadt (10 bis 20 Minuten, abhängig davon, was man besichtigen möchte).

Emergencies / Im Notfall

If you need an ambulance, call **112**. If you need to call the police, call **110**. The conference office can help out with a list of English-speaking doctors for urgent medical care.

Falls Sie einen Krankenwagen benötigen, wählen Sie **112**. Wenn Sie die Polizei rufen wollen, wählen Sie **110**. Falls Sie dringend einen Arzt benötigen, hilft Ihnen das Konferenzbüro gern weiter.

Public Transport / Öffentlicher Nahverkehr

Hamburg has an excellent public transport system including *S-Bahn* (suburban railway), *U-Bahn* (underground), buses and ferries. The whole public transport system is called *Hamburger Verkehrsverbund* (HVV) and uses a uniform ticket system, no matter which combination of modes of transport you choose (`http://www.hvv.de/en/`)

In buses you buy the ticket either from a machine at the bus stop or from the bus driver. If you don't buy a ticket, you have to show a valid ticket to the bus driver when entering the bus. Only if the buses are very crowded, you are allowed to enter through one of the back doors. For *S-Bahn* and *U-Bahn*, you buy tickets at the machines before entering the platforms.

The fare system in Hamburg is pretty complicated. A single fare *Nahbereich* is €2.10, which is sufficient for all trips within the inner city centre. Most ticket machines will show you the exact ticket pricing after you have entered your destination. When staying in Hamburg throughout the whole conference it might be useful to buy a seven-day ticket at the HVV Service Center at Hamburg central station (*Hauptbahnhof*), at *Dammtor* station or online.

You may also opt for taking a bike from one of the *StadtRAD* stations, which are spread all over the city centre. The first thirty minutes are for free and the maximum per day is €12. You have to register for using *StadtRAD* bicycles either online on `http://stadtrad.hamburg.de` or at the *StadtRAD* terminal. (€5 registration fee, will be turned into €5 cycling credit). Please find a map with all *StadtRAD* stations on the *StadtRAD* webpage.

Hamburg verfügt über ein exzellentes Netz aus S-Bahn, U-Bahn, Bussen und sogar Fähren, alle zusammengefasst im Hamburger Verkehrsverbund (HVV). Weitere Informationen über Verbindungen und Ticketpreise finden Sie unter `http://www.hvv.de`.

In Bussen muss das Ticket beim Busfahrer oder an einem Fahrkartenautomaten an der Haltestelle gekauft werden. Wenn die Busse nicht zu überfüllt sind, muss beim Einstieg ein gültiges Ticket beim Busfahrer vorgezeigt werden. Bei Benutzung der S- oder U-Bahn muss das Ticket gekauft werden, bevor Sie zu den Gleisen gehen.

Hamburgs Ticketsystem ist recht kompliziert. Die meisten Fahrten im Innenstadtbereich sind durch das Ticket „Nahbereich“ für €2,10 abgedeckt. Die meisten Ticketautomaten bieten außerdem die Möglichkeit an, die Zielstation anzugeben, so dass der korrekte Ticketpreis ausgegeben wird. Bei Besuch der gesamten DMV-Jahrestagung kann es sinnvoll sein, ein Wochenticket zu kaufen. Die Wochentickets erhalten Sie in den HVV Service Centern im Hauptbahnhof, im Dammtorbahnhof oder online.

Außerdem haben Sie in Hamburg die Möglichkeit, ein StadtRAD auszuleihen. Das StadtRAD hat Fahrradstationen im gesamten Innenstadtbereich. Um die Stadträder nutzen zu können, müssen Sie sich entweder online unter oder direkt an einem der StadtRADterminals registrieren (€5 Einrichtungsgebühr, die danach in €5 Fahrguthaben umgewandelt werden). Hier finden sie außerdem Informationen über die Standorte der StadtRADstationen. Die erste halbe Stunde Nutzung eines Fahrrads ist kostenfrei. Eine ganztägige Nutzung kostet maximal €12.

Taxi

If you need a taxi, call one of the following taxi services:

Hansa-Taxi:	+49 40 211211
Taxi Hamburg:	+49 40 666666
Das Taxi:	+49 40 221122

If you have a smart phone, you can also download the app `taxi.eu` which allows you to call a taxi via the app and observe how the taxi approaches. `taxi.eu` is not limited to Hamburg, but works in many bigger cities in Germany and Europe (Amsterdam, Berlin, Istanbul, Vienna and many others).

Sollten Sie ein Taxi benötigen, können Sie bei den folgenden Unternehmen ein Taxi bestellen:

Hansa-Taxi:	+49 40 211211
Taxi Hamburg:	+49 40 666666
Das Taxi:	+49 40 221122

Falls Sie ein Smartphone besitzen, können Sie auch die App `taxi.eu` herunterladen, die es Ihnen erlaubt, ein Taxi online zu bestellen und das nahende Taxi auf der Karte zu beobachten. `taxi.eu` ist in Hamburg mit Hansa-Taxi verbunden, und funktioniert in vielen größeren Städten Europas und Deutschlands (z.B. Amsterdam, Berlin, Istanbul oder Wien) mit entsprechenden Anbietern.

Shops / Einkaufsmöglichkeiten

Supermarkets, pharmacies and drugstores can be found along *Grindelallee*. On the left side, within 5 minutes walking distance, you'll find an organic supermarket *Alnatura*. Another supermarket *Edeka* and a drugstore *Budni* are on the right side within 10 minutes walking distance. Keep in mind that shops are generally closed on Sundays in Germany. *Dammtor* train station also offers a small variety of shops and fast food restaurants even late in the evening or on Sunday (mini-supermarket *Brügmann* is open seven days a week from 5am to midnight). Shopping on Sundays and at night is also possible in the *Wandelhalle* of Central Station (*Hauptbahnhof*), where you can find another *Edeka* supermarket and a drugstore *Rossmann* (open seven days a week from 7am to 11pm).

Mehrere Supermärkte, Apotheken und Drogerien finden Sie in der Grindelallee. Hierzu folgen Sie der Edmund-Siemers-Allee vor dem Hauptgebäude nach rechts. An der ersten Kreuzung biegen Sie rechts in die Grindelallee ab. Dort finden Sie auf der linken Straßenseite einen Alnatura-Biosupermarkt (5 Minuten Fußweg). Gehen Sie die Grindelallee weiter hinunter, so finden Sie hinter der nächsten Kreuzung auf der rechten Straßenseite einen Edeka und eine Budni-Drogerie (10 Minuten Fußweg). In Deutschland sind Geschäfte in der Regel am Sonntag geschlossen. Der Dammtorbahnhof bietet diverse Einkaufs- und Essensmöglichkeiten auch spät in der Nacht oder am Sonntag (Delikatessen Brügmann geöffnet von 5:00 bis Mitternacht an jedem Tag der Woche). Weitere Sonntagseinkaufsmöglichkeiten die Wandelhalle im Hauptbahnhof (Edeka und Rossmann geöffnet von 7:00 bis 23:00 an jedem Tag der Woche).

How to get to the conference venue / Wegbeschreibung zum Tagungsort

Dammtor train station is the closest station to the conference venue. Buses M4, M5, 34 and 109, *S-Bahn* S11, S21 and S31 and some trains stop at Dammtor. From there it is only a very short walk to the conference venue; please follow the signs.

Arrival by train (from *Hauptbahnhof*)

Many trains stopping at *Hauptbahnhof* also stop at *Dammtor*. If yours does not, change at *Hauptbahnhof* into the *S-Bahn* S11 (heading towards Altona/Othmarschen/Blankenese), S21 (heading towards Eidelstedt), or S31 (heading towards Altona/Pinneberg). *Dammtor* is the first stop after *Hauptbahnhof*. From there it is only a very short walk to the conference venue; please follow the signs. A taxi from *Hauptbahnhof* will take between five and ten minutes and costs around €7.

Arrival by plane (from Hamburg airport)

Take *S-Bahn* S1 (heading towards Altona/Wedel) to Hamburg Central Station (*Hauptbahnhof*). There, change to *S-Bahn* S11 (heading towards Altona/Othmarschen/ Blankenese), S21 (heading towards Eidelstedt), or S31 (heading towards Altona/Pinneberg) and exit at *Dammtor*. *Dammtor* is the first stop after *Hauptbahnhof*. From there it is only a very short walk to the conference venue; please follow the signs. A taxi from the airport to the conference venue will take approximately half an hour and cost approximately €30.

Dammtor ist der nächstgelegene Bahnhof, an dem die S-Bahnen S11, S21 und S31, Busse M4, M5, 34 und 109 und auch einige Züge halten. Von dort sind es nur noch 2 – 5 Minuten zu Fuß zum Hauptgebäude der Universität Hamburg. Folgen Sie der Beschilderung DMV-Jahrestagung 2015.

Anreise per Bahn (ab Hauptbahnhof)

Überprüfen Sie, ob Ihr Zug auch am Dammtorbahnhof hält. Ansonsten steigen Sie am Hauptbahnhof in die S-Bahn S11 (Richtung Altona/Othmarschen/Blankenese), in die S21 (Richtung Eidelstedt) oder in die S31 (Richtung Altona/Pinneberg) um. Nach einer Station erreichen Sie den Dammtorbahnhof. Von hier sind es nur noch ein kurzer Fußweg; bitte folgen Sie der Beschilderung. Ein Taxi vom Hauptbahnhof zum Hauptgebäude benötigt ungefähr fünf bis zehn Minuten und kostet ca. €7.

Anreise mit dem Flugzeug (ab Flughafen Hamburg)

Um vom Flughafen mit den öffentlichen Verkehrsmitteln zum Hauptgebäude der Universität Hamburg zu gelangen, nehmen Sie die S-Bahn S1 (Richtung Altona/Wedel) und steigen am Hauptbahnhof in die S-Bahn S11 (Richtung Altona/Othmarschen/Blankenese), in die S21 (Richtung Eidelstedt) oder in die S31 (Richtung Altona/Pinneberg) um. Nach einer Station erreichen Sie den Dammtorbahnhof. Von hier sind es nur noch ein kurzer Fußweg; bitte folgen Sie der Beschilderung. Ein Taxi vom Flughafen braucht etwa eine halbe Stunde und kostet ungefähr €30.

Universität Hamburg, Ref. 22

τ vs. π
An art intervention at the crossroads of mathematics and culture

Daniel Caleb Thompson

Background

The number π is defined as the ratio between the circumference of a circle and its diameter and is known to be both irrational and transcendental. It is arguably the only transcendental number that is known to many non-mathematicians and has a great deal of popular appeal. Non-specialists are fascinated by memorizing and calculating digits of π and the 14th of March ("3/14" in American date notation) is celebrated as "π day" by some.

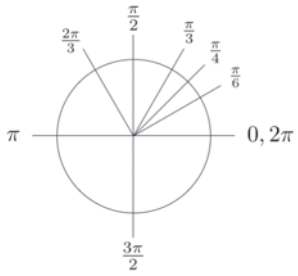
For several years there has been an underground movement spearheaded by Bob Palais, Michael Hartl, Peter Harremoës, Joseph Lindenberg and other people who claim that the ratio between the circumference of a circle and its radius is a more natural number that deserves the popular appeal that π is enjoying. This number, the ratio between the circumference and its radius, is called τ, and clearly, $\tau = 2\pi$.

τ?

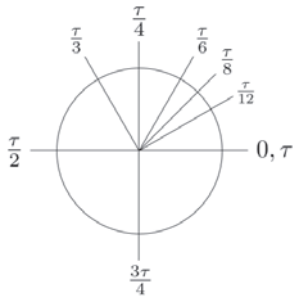
One of the primary arguments made by the "tau-ists" for this paradigm change is based upon the classical definition of a circle: A circle is an Euclidean shape composed of the collection of all points on a plane that are equidistant from a central point. The distance of the points from the centre is the *radius* of the circle. In practice, e.g., when measuring the size of a plumbing pipe, the diameter of the pipe is a value easier to measure with traditional tools like calipers, and the radius is usually determined by measuring the diameter and dividing by 2. However, in pure mathematics, their relation is reversed: the radius is the basic value and the diameter is derived from it by multiplying by 2. This is discussed by Hartl in a discussion about the values of angles in a circle measured in radians,[1] as seen in the diagrams on the next page.

What is immediately obvious is that τ-radians more intuitively and more simply describe a circle's radians. Just think about it: Why is $\frac{1}{4}$ of a circle $\frac{\pi}{2}$ and $\frac{3}{4}$ of a circle $\frac{3}{2}\pi$? Isn't it more obvious to respectively use $\frac{\tau}{4}$ and $\frac{3}{4}\tau$?

[1] Cf. *The Tau Manifesto* by Michael Hartl on `http://tauday.com`.



Some special angles, in "π-radians".



Some special angles, in "τ-radians".

Intervention

In the lobby of the west wing of the main building of the *Universität Hamburg*, a voting machine will be installed during the conference. This machine is composed of a computer, a laser-printer, a large monitor, two buttons and one coin slot. Two algorithms calculate sequential decimal digits of π or τ. As soon as the next digit's value has been calculated, it is registered in a private synchronized block-chain as a proof-of-work so that the algorithms can operate in perpetuity, even after an electricity black-out or device failure. Then the value is shown on the screen.

The installation as a sketch.

The viewer may elect to press one of the two buttons. The system places a vote for either π or τ—depending upon which button has been pressed. The vote is then registered on the screen above the respective panes for π or τ and increases the relative value of that circle-constant's blockchain.

If the participant inserts a coin and then presses a button —e.g., for τ—the system will print the screen-half showing the currently displayed τ value on heavyweight acid-free A3 paper that was previously signed and numbered by the artist. This certificate is a unique proof of ownership of that decimal position in the τ blockchain. The participant may take the print home with them. Unclaimed digits may be printed by the artist and offered for sale.

Note: If a digit is the same as the digit that came before it, a "Feynman" badge will appear. This badge will also show how often the digit has been repeated. "Feynman" badges multiply the market value of that blockchain member by its face value.

Algorithms

The computer in the intervention applies a multi-threaded processor-based variation of Simon Plouffe's and Fabrice Bellard's algorithm in C to produce decimal versions of individual digits of π or τ (available on `http://bellard.org`).

This value is then md5sum'd together with the exact decimal position similar to this bash command (as in the above model certificate) and subsequently qr-encoded:

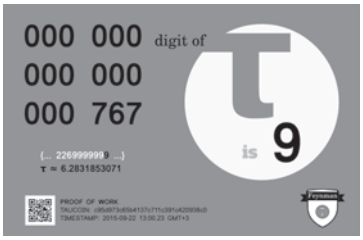
```
$ echo "TAU 767 9" | md5sum | cut -d" " -f1 > "TAU_767.block"
$ cat "TAU_767.block" | qrencode - -o TAU_767.png
```

This is the proof of work that is required for a picoin / taucoin. Analyses of the results and source code will be made available under an open-source license at

`https://denjello.github.io/taupi`.

Discussion

To be clear, the author is not suggesting we suddenly overturn centuries of practice and switch from π to τ. The intervention is intended to be an entertaining way of enabling discussion about the issue. The question which of the two constants is more natural is a matter of convention, not of mathematical substance. A mathematically informed discussion about this conventional decision can be compared to discussions in the past that led to events like switching from the imperial to metric standards of measurement or the Gregorian calendar reform. As opposed to discussions about standards of measurement or calendars, there is no official governing body responsible for the choice of mathematical constants.



A model certificate.

Since $\tau = 2\pi$, all equations involving π can easily be converted to equations involving τ and vice versa. Mathematical operations come at a processing cost, and simplifying equations is in everyone's best interest. Part of the concrete mathematical background of this intervention is to discover which of two similar algorithms is faster: the one calculating the individual digits of π or the one calculating the individual digits of τ. Faster algorithms are just better.

By using the notion of blockchain computation as "work", the intervention takes the noble step of challenging infinity and assigning real value to the constituent digits of the artist's favorite shape: a full circle.

Daniel Caleb Thompson was born in Waukesha, WI, United States of America. He holds a BFA from Cardinal Stritch University in Milwaukee (2000) and a Fine Arts *Diplom* from Bauhaus-Universität Weimar (2004). At Bauhaus he was a member of the artistic staff from 2010 to 2011 in the Department of Aesthetics under Dr. Olaf Weber. Since 2012, he has been active in the working group for Arts Curating in Hamburg's *Gängeviertel*.

www.mediaserver.hamburg.de / Christian Spahrbier

Geschichte der Universität Hamburg

Eine junge Universität. Die Universität Hamburg gehört zu den jüngeren deutschen Universitäten. Ihre Errichtung dokumentiert sich nicht in einem landesherrlichen Stiftungsbrief, sondern im nüchternen *Amtsblatt* der Freien und Hansestadt Hamburg vom 1. April 1919.

Wurzeln der Universität in der Stadt. Die Wurzeln der Universität reichen jedoch bis in das beginnende 17. Jahrhundert zurück. 1613 wurde in Hamburg das *Akademische Gymnasium* gegründet. Es war als Zwischenstufe zwischen Schule und Universität gedacht: In zwei Semestern sollten hier allgemeinbildende Vorlesungen gehört werden, ehe sich die Absolventen Spezialstudien zuwandten.

Das erste Vorlesungsgebäude. Aus Mangel an Zuhörern musste diese Einrichtung 1883 geschlossen werden; es blieb jedoch ein 1895 neugeordnetes „Allgemeines Vorlesungswesen". Hierfür stiftete der Kaufmann Edmund Siemers das 1911 eingeweihte Vorlesungsgebäude an der später nach ihm benannten Allee. ***Der Forschung, der Lehre, der Bildung*** gewidmet, dient es heute als *Hauptgebäude* der Universität.

Das Vorlesungswesen blüht. Neben öffentlichen Vorlesungen für Laien gab es auch Fortbildungskurse für bestimmte Berufskreise, so für Kandidaten der Theologie, für Verwaltungsbeamte, Zollbeamte, praktische ärzte, Kaufleute, Pharmazeuten und Lehrer. Für die Bedeutung dieses *Vorlesungswesens* sprechen einige Zahlen: Im Wintersemester 1913/14 wurden 300 Kurse von 207 Dozenten abgehalten. 4300 Vorlesungsverzeichnisse wurden in diesem Semester verkauft.

Weitere wissenschaftliche Institute entstehen. Im 19. Jahrhundert hatten sich neben dem Akademischen Gymnasium zahlreiche wissenschaftliche Institute entwickelt, so der Botanische Garten (1821), die Sternwarte (1833), das Chemische Staatslaboratorium (1878), das Physikalische Staatslaboratorium (1885), das Laboratorium für Warenkunde (1885), das Institut für Schiffs- und Tropenkrankheiten (1900).

Das Professorenkonvent. Die Direktoren dieser *Wissenschaftlichen Anstalten* wurden nach Schließung des Akademischen Gymnasiums verpflichtet, die öffentlichen Vorlesungen fortzuführen. Sie bildeten 1892 gemeinsam mit den für das allgemeine Vorlesungswesen berufenen Dozenten einen *Professorenkonvent*.

***Hamburgische Wissenschaftliche Stiftung* und *Kolonialinstitut* werden gegründet.** Die Gründung der *Hamburgischen Wissenschaftlichen Stiftung* im Jahre 1907 und des Kolonialinstituts im Jahre 1908 waren zwei wichtige weitere Stationen auf dem Wege zu einer Universität.

Die Stiftung machte sich die Anwerbung von Gelehrten und die Unterstützung von Forschungsreisen und wissenschaftlichen Publikationen zur Aufgabe. Das Institut bereitete angehende Kolonialbeamte auf ihre spätere Arbeit im Ausland vor. Die *Zentralstelle* des Kolonialinstituts war als Dokumentations- und Informationszentrum für Fragen der gesamten überseeischen Welt tätig; ihr Nachfolger wurde das Hamburgische Welt-Wirtschafts-Archiv.

Gründerväter. Obwohl Werner von Melle sich als Senator und später als Bürgermeister den Zusammenschluss dieser Einrichtungen zu einer Universität Anfang des 20. Jahrhunderts zur Lebensaufgabe gemacht hatte, scheiterte dieser Plan in der nach Klassenwahlrecht zusammengesetzten Bürgerschaft.

Hamburg ist Handelsmetropole. Dort überwogen die Stimmen, die Hamburg auf seine dominierende Rolle als Handelsmetropole beschränkt wissen wollten und sowohl die Kosten einer Universität als auch die gesellschaftlichen Ansprüche ihrer Professoren scheuten.

Durch Einzelinitiative wurden gleich nach dem Ersten Weltkrieg für die zurückkehrenden Kriegsteilnehmer „Universitätskurse“ eingerichtet.

Gründung der „Hamburgischen Universität“ 1919. Erst die demokratisch gewählte Bürgerschaft beschloss mit ihrer neuen Mehrheit in einer ihrer ersten Sitzungen die Gründung einer „Hamburgischen Universität“. Sie wurde am 10. Mai 1919 in der Hamburger Musikhalle feierlich eröffnet. Werner von Melle wurde 1921 mit der einmaligen Würde eines *rector magnificus honoris causa* ausgezeichnet.

Blüte in der Weimarer Republik. In der Weimarer Republik erwarb sich die junge Universität durch herausragende Gelehrte in einer Reihe von Disziplinen schnell auch internationalen Rang. Die enge Verbindung zu Einrichtungen wie Aby Warburgs *Kulturwissenschaftlicher Bibliothek* oder Albrecht Mendelssohn Bartholdys *Institut für Auswärtige Politik* begründete neue Formen und Inhalte auch disziplinübergreifender Zusammenarbeit.

Verluste in der NS-Zeit. Die nationalsozialistische Diktatur zerstörte diese kurze Blüte, vor allem durch die erzwungenen Entlassungen von etwa fünfzig Wissenschaftlerinnen und Wissenschaftlern, unter ihnen die bedeutendsten Gelehrten der Universität.

An einige von ihnen, etwa den Psychologen William Stern, den Philosophen Ernst Cassirer und den Physiko-Chemiker Otto Stern, errinnern heute Büsten und Gedenktafeln ebenso wie an die studentischen Mitglieder des Hamburger Zweiges der „Weißen Rose“, die für ihren Widerstand gegen das Unrechtsregime ihr Leben lassen mußten.

Bildung der Fakultäten. Zunächst waren vier Fakultäten geschaffen: Rechts- und Staatswissenschaften, Medizin, Philosophie, Naturwissenschaften. Die Voraussetzungen für die Errichtung der Medizinischen Fakultät waren in dem gut ausgestatteten Krankenhaus in Eppendorf gegeben, das sich in der Zeit der großen Cholera-Epidemie Ende des 19. Jahrhunderts auch außerhalb Hamburgs einen hohen Ruf erworben hatte.

Seit 1945 „Universität Hamburg“. Die Zahl der Fakultäten der im November 1945 als „Universität Hamburg“ wiedereröffneten Hochschule erhöhte sich 1954 auf sechs, und zwar durch Neugründung einer Evangelisch-Theologischen Fakultät und durch Abtrennung der Wirtschafts- und Sozialwissenschaften von der Rechtswissenschaftlichen Fakultät.

1969 Ausbau der akademischen Selbstverwaltung. Am 25. April 1969 verabschiedete die Bürgerschaft der Freien und Hansestadt Hamburg ein neues Universitätsgesetz. Sichtbarsten Ausdruck fand die darin niedergelegte Reform einerseits im Ausbau der akademischen Selbstverwaltung, der Mitbestimmung aller Universitätsmitglieder auf ihren drei Ebenen (Konzil und Senat, Fachbereichsräte, Institutsräte), andererseits in der Schaffung einer kontinuierlichen Zentralinstanz, des Präsidenten, der in einem ausbalancierten System die Autonomie der Universität in Wissenschaft und Forschung nach außen und die Belange des Staates, der die Universität finanziell unterhält und die Rechtsaufsicht ausübt, nach innen vertritt.

Fachbereiche lösen Fakultäten ab. Die alten sechs Fakultäten wurden 1969 in 15 Fachbereiche aufgeteilt. Im Laufe der Jahre erhöhte sich die Zahl der Fachbereiche auf 19. Durch die Zusammenlegung der beiden rechtswissenschaftlichen Fachbereich im Sommersemester 1998 verfügt die Universität nun über 18 Fachbereiche. Hinzu kommen sieben sogenannte senatsunmittelbare Einrichtungen, acht fachübergreifende Studieneinrichtungen und vier Hochschulübergreifende Studiengänge.

Absolute Mehrheit für Professoren. Am 1. Januar 1979 wurde das Universitätsgesetz von 1969 durch das Hamburgische Hochschulgesetz abgelöst, welches das Landesrecht an das Hochschulrahmengesetz anpasst. In allen Selbstverwaltungsgremien, die über Lehre, Forschung oder Berufung entscheiden, verfügen Professoren nunmehr—anders als vorher—über die absolute Mehrheit.

Entwicklung der Studierendenzahlen. 1919 studierten 1729 Studenten an der Universität. Anfang der fünfziger Jahre war die Zahl auf rund 6000, 1960 auf 12.600 und 1970 auf 19.200 angestiegen. Zurzeit sind rund 40.000 Studierende—unter ihnen ca. 4800 ausländische—eingeschrieben.

Bauliche Entwicklung des Campus. Ende der fünfziger bis Mitte der sechziger Jahre erfolgte der Ausbau des Campus im Von-Melle-Park nahe der Außenalster im Herzen der Stadt. Eine Reihe weiterer großer Gebäude im Campus-Bereich erhielt die Universität in den Jahren 1974 und 1975, so das „Geomatikum“ für die Fachbereiche Mathematik und Geowissenschaften, das mit seinen 22 Stockwerken alle Häuser des Stadtteils Hamburg-Eimsbüttel überragt.

Im Herbst 1998 wurde der vom Ehepaar Hannelore und Dr. Helmut Greve gestiftete „Flügel West“ am Hauptgebäude der Universität an der Edmund-Siemers-Allee bezogen.

Einrichtungen der Universität sind über die gesamte Stadt verteilt. Weitere Einrichtungen der Universität befinden sich in anderen Stadtteilen; das Universitätsklinikum in

Eppendorf, der neue Botanische Garten und das Institut für Allgemeine Botanik in Flottbek, das Institut für Hydrobiologie und Fischereiwissenschaft in Altona in der Nähe von Hafen und Elbe, die Sternwarte in Bergedorf und einige Physikalische Institute in Bahrenfeld, wo auch das weltbekannte Deutsche Elektronensynchrotron (DESY) arbeitet. Seit 1994 ist die Informatik in Stellingen zusammengefasst („Informatikum“).

Seit Anfang der achtziger Jahre befasst sich die Universität Hamburg in vielfältiger Form verstärkt auch mit ihrer eigenen Geschichte. Hierzu sind von ihren Mitgliedern zahlreiche Veröffentlichungen erschienen, vornehmlich in der von der Universität herausgegebenen Reihe „Hamburger Beiträge zur Wissenschaftsgeschichte“ im Dietrich Reimer Verlag (Berlin und Hamburg).

Diese Bemühungen haben seit 1993 in der „Hamburger Bibliothek für Universitätsgeschichte“ im Fachbereich Geschichtswissenschaft ihren Mittelpunkt gefunden.

Dieser Text wurde vom Referat Kommunikation und Öffentlichkeitsarbeit der Universität Hamburg verfaßt und findet sich auf der Webseite der Universität. Ausführlichere Informationen finden sich in Rainer Nicolaysen, *„Frei soll die Lehre sein und frei das Lernen“. Zur Geschichte der Universität Hamburg*. DOBU-Verlag, Hamburg 2008. Der Text wird mit Genehmigung der Universität Hamburg in diesem Programmbuch abgedruckt.

125 Jahre DMV

Renate Tobies

Dem Wunsch des DMV-Präsidiums, zum 125jährigen Jubiläum unserer Vereinigung „einen kurzen historischen Artikel“ beizutragen, komme ich gern nach, wenngleich einige Beiträge zur Geschichte der *Deutschen Mathematiker-Vereinigung* (DMV) bereits vorliegen.[2] Vor fünf Jahren präsentierte Gert Schubring (2010) eine Zusammenfassung von Ergebnissen jüngerer Forschungen. Ich möchte hier einiges aus persönlicher Sicht und auf der Basis eigener Untersuchungen hinzufügen. Der Blick soll auf die Zeit des 100jährigen Jubiläums sowie die Phase der Gründungsgeschichte und ersten Jahre gerichtet werden. Die DMV wurde am 18. September 1890 in Bremen gegründet, im Rahmen der dort tagenden Gesellschaft Deutscher Naturforscher und Ärzte (GDNÄ). Einhundert Jahre später fand die Jahresversammlung der DMV erneut in Bremen statt, jetzt als von den Naturforschern getrennte Fachgesellschaft (vgl. Tobies, 1996).

[2] Zu Publikationen zur Geschichte der DMV siehe: `http://dmv.mathematik.de/index.php/88-dmv/geschichte/493-publikationen-zur-geschichte-der-dmv`.

Zum Jahr 1990

Das Jahr des hundertjährigen Gründungsjubiläums 1990 war nicht nur für die Mathematiker und Mathematikerinnen, sondern für ganz Deutschland ein besonderes Ereignis. Aus Leipzig kommend, war ich in der Lage, die Zeit hautnah mitzuerleben. Im Sommersemester 1990 weilte ich zu einem Studienaufenthalt an der Universität Kaiserslautern und an der damaligen TH Darmstadt, initiiert durch Helmut Neunzert (*1936), den Begründer der Technomathematik in Deutschland, und unterstützt durch Jürgen Lehn (1941–2008) und Josef Hoschek (1935–2002). Am 6. Juni 1990 hörte ich im Darmstädter Mathematischen Kolloquium einen Vortrag von Rolf Klötzler (*1931), Professor an der Universität Leipzig, mit den Forschungsschwerpunkten Variationsrechnung und Optimierung. Klötzler übte von 1981 bis 1990 den Vorsitz der 1962 nach dem Mauerbau gegründeten Mathematischen Gesellschaft der DDR (MGDDR) aus. Als der Leipziger Mathematikhistoriker Hans Wußing (1927–2011) im Jahre 1975 eine Fachsektion Geschichte der Mathematik innerhalb dieser Gesellschaft etablierte, war ich dieser beigetreten. Klötzler präsentierte bei seinem Darmstädter Vortrag nicht nur mathematische Ergebnisse, sondern warb zugleich für das Zusammenführen der MGDDR mit der DMV. Der Numeriker Willi Törnig (*1930), seit 1972 Professor in Darmstadt, fungierte zu diesem Zeitpunkt als Präsident der DMV und bereitete die Jahrestagung in Bremen vor.

Plakat von Karl Heinrich Hofmann zum Vortrag *Zur Lagrangeschen Multiplikatorenregel bei mehrdimensionalen Steuerungsproblemen* von Rolf Klötzler am 6. Juni 1990 an der Technischen Hochschule Darmstadt

Mit der Bremer Jubiläumstagung 1990 konnten nicht nur die Mitglieder der beiden deutschen Gesellschaften vereint werden; d.h. die MGDDR wurde formal aufgelöst; und die Mitglieder beider Gesellschaften wurden in der DMV vereint. Die in der MGDDR bestehenden Fachsektionen, darunter diejenige für Geschichte der Mathematik, blieben im Rahmen der DMV bestehen.

Die DMV und die Frauen

Auf der Jahresversammlung 1990 in Bremen gab es einen weiteren Höhepunkt in der 100jährigen Geschichte unserer Vereinigung: erstmals wurde mit Ina Kersten, Algebraikerin und wissenschaftliche Enkelin Emmy Noethers, eine Mathematikerin in das DMV-Präsidium gewählt (Präsidentin 1995–97). Emmy Noether (1882–1935) war der DMV im Jahre 1909 beigetreten, nachdem sie ein Jahr zuvor mit *summa cum laude* promoviert worden war. Auch danach wurden weitere promovierte Mathematikerinnen Mitglied der DMV, vornehmlich angeregt durch ihre Doktorväter. Auffallend war dies bei August Gutzmer (1860–1924), der in der Nachfolge des Felix-Klein-Schülers Walther Dyck (1856–1934; ab 1901: von Dyck) Schriftführer im DMV-Vorstand wurde: vierzehn der Doktor-Schüler und drei der Doktor-Schülerinnen von Gutzmer traten der DMV bei, so z. B. die erste Hallische Mathematik-Promovendin Frieda Nugel, verh. Hahn (1884–1966), die vom Jahr der Promotion 1912 bis 1929 der DMV angehörte (Tobies, 2003).

Vor Emmy Noether gehörten der DMV ebenfalls bereits einige weibliche Mitglieder an; allerdings waren es nur Ausländerinnen, da deutsche Frauen damals die Hochschulreife nur auf Sonderwegen erreichen konnten. Es seien hervorgehoben:

Die erste Britin Charlotte Angas Scott (1858–1931), die 1885 unter Arthur Cayley (1821–1895) den Doktortitel erworben hatte und im selben Jahr *Head of the Mathematical Department* des *Women's College* Bryn Mawr in den Vereinigten Staaten geworden war. Sie trat 1898 der DMV bei, unter der Präsidentschaft Felix Kleins (1849–1925)—der nicht nur frühen Kontakt zu Cayley besaß, sondern in Göttingen bereits 1895 zwei Frauen promoviert hatte. Scott hatte zu den Gründungsmitgliedern der *American Mathematical Society* gehört, die 1894 aus der *New York Mathematical Society* (gegründet 1888) entstanden war. Sie publizierte in den Mathematischen Annalen (algebraische Geometrie) und sandte einige ihrer Schülerinnen zum Zusatzstudium nach Göttingen. So schrieb sie zum Beispiel am 19. März 1897 an Klein: "I am expecting to send two of my best students to Göttingen next year, to both of them have been awarded College Fellowships, and they are both very desirous of obtaining a year's study under your direction, if this is agreeable to you." (zitiert in Tobies, 1999).

Die erste in Mathematik promovierte US-Amerikanerin Winifred Edgerton Merrill (1862–1951) wurde 1904 DMV-Mitglied (Toepell, 1991, S. 254). Sie hatte 1886 an der Columbia University den Doktortitel mit der Dissertation "Multiple Integrals and Their Geometrical Interpretation of Cartesian Geometry, in Trilinears and Triplanars, in Tangentials, in Quaternions, and in Modern Geometry; Their Analytical Interpretations in the Theory of Equations, Using Determinants, Invariants and Covariants as Instruments in the Investigation" erworben. Sie lehrte an verschiedenen Orten und gründete eine eigene *girls' school*.

Die Russin Nadjeschda von Gernet (1877–1943), die 1901 bei David Hilbert (1862–1943) in Göttingen mit dem Thema „Untersuchung zur Variationsrechnung. Ueber eine neue Methode in der Variationsrechnung" promovierte, trat im selben Jahr der DMV bei. Hilbert hatte 1900 die Präsidentschaft übernommen. Von Gernet wurde Dozentin in St. Petersburg (Leningrad) und weilte auch nach der Promotion zu Studienaufenthalten in Göttingen, wo Frauen in Mathematik—im Unterschied zur Universität Berlin—bereits gefördert wurden, als sie sich noch nicht regulär immatrikulieren durften.

Felix Kleins Einfluss

Felix Klein gehörte neun Jahre lang dem DMV-Vorstand an (1896–1898, 1903–1905, 1907–1909) und war dreimal Präsident (1897, 1903, 1908). Er war damit in den Anfangsjahren am einflussreichsten, abgesehen von Georg Cantors (1845–1918) Wirken von 1890 bis 1893.

Bereits als 21jähriger, frisch unter Alfred Clebsch (1833–1872) in Göttingen habilitiert, hatte Klein Clebschs Initiative, alle (deutschen) Mathematiker zu regelmäßigen Versammlungen zusammenzuführen, aufgegriffen. Kleins jugendlicher Anspruch, möglichst selbst in allen mathematischen Gebieten zu arbeiten und alle Mathematiker und mathematische Richtungen zu einen, spiegelt sich gut in den Briefen an Sophus Lie (1842–1899) wider. Er arbeitete—im Austausch mit Lie—nicht nur mathematisch energisch weiter, z. B. zehn Publikationen 1871, sondern kreierte auch mit Adolph Mayer (1839–1908) und Max Noether (1844–1921) „ein Comité behufs Abhaltung einer Mathematikerversammlung" (Tobies &

Rowe, 1990, S. 59). Dieses Comité wurde um Ludwig Kiepert (1846–1934), Carl Ohrtmann (1839–1885) und Emil Lampe (1840–1908) erweitert, um Repräsentanten der Berliner Schule (Kiepert als Weierstraß-Schüler), des Crelle-Journals (Lampe als „Corrector“ dort) und des 1869 gegründeten Referatejournals Jahrbuch über die Fortschritte der Mathematik zu beteiligen. Für Sophus Lie erläuterte Klein am 1. April 1872:

> Seit 8 Tagen bin ich mit Kiepert zusammen hier [in Berlin, R. T.], und stehe in möglichst regem Verkehr mit den vielen hiesigen Mathematikern. Es ist leider nur so gar nicht möglich, den Leuten von unseren Sachen zu erzählen, weil alle Anknüpfungspuncte fehlen. Um so energischer betreibe ich eine Art gesellschaftliche Einigung einmal der hiesigen, dann überhaupt der deutschen Mathematiker (durch eine periodisch wiederkehrende Versammlung); hat man dies, so wird es leichter sein, den allgemeinen wissenschaftlichen Standpunct in dem uns wünschenswerth scheinenden Sinne zu heben. Ich befriedige gleichzeitig dadurch ein bei mir immer vorhandenes Bedürfniß nach socialer Thätigkeit, welches mich nicht zufrieden läßt, wenn ich mich nur abstract mit der reinen Wissenschaft beschäftige.[3]

Es ist inzwischen hinreichend bekannt, dass die von den Naturforschern losgelöste Versammlungsidee (Ostern 1873 in Göttingen mit 52 Teilnehmern; Nachfolgeversammlung 1875 abgesagt) nicht den erwarteten Effekt gebracht hatte und dass eine lange zweite Phase gefolgt war, die Zusammenkünfte im Rahmen der GDNÄ anzustreben (vgl. Tobies, 1991, § 1).

Die Frage des organisatorischen Anbindens an die GDNÄ

Als die Naturforscherversammlung 1877 in München tagte, war Klein Professor an der dortigen TH und fungierte als Vorsitzender des „Redactions-Comités“. Er plante das Programm langfristig, lud viele persönlich ein. Der Einladung folgten u.a. Sophus Lie und Luigi Cremona (1830–1903). Ähnlich gelungen war die Naturforscherversammlung 1886 in Berlin, wo Klein begeistert an Max Noether schrieb, „... doch in Zukunft solche Zusammenkünfte eifriger [zu] benutzen ...; vielleicht dass dann der Plan der nach 1873 missglückte, schließlich doch noch zum Gelingen kommt...“ (Tobies, 1998, S. 136).

Georg Cantor, der Ende der 1880er Jahre das Heft in die Hand genommen hatte, trat dezidiert für eine separate Vereinigung nach Vorbild der *Société mathématique de France* ein (Gispert, 1991). Klein, der offiziell im Hintergrund blieb, plädierte hartnäckig und auf den bisherigen Erfahrungen beruhend für das Anbinden an die GDNÄ. Obgleich diese Ansicht von der Mehrzahl der Kleinschen Verbündeten an Cantor herangetragen wurde, war dieser zunächst nicht zu überzeugen. Die auf die DMV-Gründungsgeschichte bezogenen Briefe an Cantor liegen im Universitätsarchiv Freiburg, wurden für (Tobies, 1998) erstmals ausgewertet. Da Ulf Hashagen bei seinen Darlegungen zur Gründungsgeschichte mit Blick auf Dyck (Hashagen, 2003, S. 403–437) wohl Weierstraß' Einfluss übersah, sei noch einmal besonders hervorgehoben, dass Cantor seine Ansicht erst dann änderte, nachdem sich Karl Weierstraß (1815–1897) kurz vor der Bremer Zusammenkunft zu Wort gemeldet hatte. Im Brief vom 6. September 1890 an Cantor nahm Weierstraß Bezug auf die gescheiterten separaten Versammlungen der 1870er Jahre und leitete ab: “Auch hieraus ziehe ich den

[3] Die Briefe Felix Kleins an Sophus Lie liegen im Nachlass von Sophus Lie, Nationalbibliothek Oslo.

Schluß, daß der Gründung einer ganz selbständigen mathematischen Gesellschaft für ganz Deutschland Hindernisse entgegenstehen müssen, die in der Natur der Sache begründet sind." (zitiert in Tobies, 1998, S. 141).

Und weiter schlug Weierstraß im selben Brief an Cantor vor:

> Ich meine, es müssten möglichst viele Mathematiker bewogen werden, der von nun an in fester Organisation fungirenden Vereinigung der Naturforscher beizutreten und in derselben eine selbständige mathematische Section mit besonderen Statuten einzurichten. Ich möchte glauben, dass sich als dann alljährlich doch so viele Mathematiker zusammenfinden werden, dass die Section in Thätigkeit treten könnte, zumals wenn auch außerordentliche Theilnehmer zugelassen würden. Es müsste aber jedes Mal ein Vorstand gewählt werden, der die nächste Versammlung gehörig vorbereitet—vielleicht ein länger fungirender. Da die meisten Mathematiker sich doch auch für physikalische Dinge interessiren, so müsste sich ein Anschluß der mathematischen Vereinigung an die der Naturforscher um so mehr empfehlen. (zitiert in Tobies, 1998, S. 141)

Dass Cantor nun überzeugt war, dokumentiert der zweite im DMV-Nachlass liegende Weierstraß-Brief vom 14. September 1890:

> Es freut mich aufrichtig, daß Sie mit dem von mir in meinem Briefe gemachten Vorschlag, im Anschluß an die Naturforscher-Vereinigung eine [...] mathematische Section mit einem Stamm beständiger Mitglieder zu bilden, einverstanden sind (zitiert in Tobies, 1998, S. 141).

Somit stimmten Klein und Weierstraß in ihren Intentionen überein; ihre Vorschläge, die Organisation betreffend, wurden in Bremen realisiert. Auch Kleins personelle Vorschläge für eine abgeglichene Zusammensetzung des Vorstands wurden weitgehend umgesetzt.

Inhaltliche Aufgaben der DMV

Der (erste) Weierstraß-Schüler Leo Königsberger (1837–1921) hatte am 9. Juni 1890 an Cantor geschrieben: „Mir scheinen lediglich die Ideen von Klein, und zwar desshalb weil sie noch ganz allgemeiner Natur sind, die richtigen zu sein ..." (zitiert in Tobies, 1998, S. 139). Kleins Wunsch bestand vor allem darin, das zunehmende mathematische Wissen zusammenzufassen und breiteren Kreisen verfügbar zu präsentieren. Dazu gehörte die Sorge um das Referate-Journal Jahrbuch über die Fortschritte der Mathematik, da es nach allgemeiner Ansicht zu wenig rasch herauskam (vgl. auch Siegmund-Schultze, 1993). Dazu gehörte ebenfalls das Engagement für „ausführliche Referate über gemeinsam interessierende Gebiete der Mathematik", was schließlich in das Großprojekt Encyklopädie der mathematischen Wissenschaften mit Einschluss ihrer Anwendungen mündete (vgl. Tobies, 1994). In die ersten DMV-Statuten flossen beide Aufgaben ein.

Gert Schubring meinte, dass "wir noch zu wenig darüber wissen, wie und wodurch die DMV doch zu einer durchsetzungskräftigen Fachgesellschaft wurde", denn nach Cantors Rücktritt vom Vorsitz 1893, nach Georg Frobenius' (1849–1917) Nichtannahme der Wahl zum Vorsitzenden und Dycks Niederlegung des Schriftführer-Postens habe der Zusammenbruch gedroht (Schubring, 2010, S. 106). Ich sehe darin, dass die DMV ihren Aufgabenkreis 1893 auf die Fragen des mathematischen Unterrichts und die Ausbildung von Lehramtskandidaten erweiterte, einen wichtigen objektiven Schub:

> Wenn auch der nächste und vornehmste Zweck der Jahresversammlungen der Deutschen Mathematiker-Vereinigung die Besprechung rein wissenschaftlicher Fragen ist, so erscheint es doch naturgemäß, auch Fragen des mathematischen Unterrichts in den Bereich der Discussion zu ziehen, weil die Gesellschaft in ihrer Vereinigung von Lehrern der Mathematik an Hoch- und Mittelschulen ein hervorragendes Interesse an solchen Einrichtungen nimmt, welche die Ausbildung der Lehramtscandidaten betreffen (Bericht, 1894, S. 5).

Neue Prüfungsordnungen für Lehramtskandidaten und die Reform des Mathematikunterrichts bildeten wichtige Diskussionsgegenstände der nachfolgenden Jahresversammlungen—wobei sich Kleins Rolle nicht nur im zeitgenössischen Ausdruck „Kleinsche Unterrichtsreform", in seiner Mitgliedschaft im Comité de Patronage der ersten internationalen Zeitschrift für Mathematikunterricht *L'Enseignement mathématique* (1899)—neben H. Poincaré, E. Picard, L. Cremona, G. Greenhill u.a.—, und seiner Wahl zum ersten Präsidenten der IMUK spiegelte.

Das Nichtscheitern, sondern Vorankommen der DMV seit Mitte der 1890er Jahre beruhte zudem auf dem Engagement von Mathematikern des ehemaligen Clebsch-Kreises bzw. mit Göttingen Verbundener: Paul Gordan, Alexander von Brill[4], Heinrich Weber, Felix Klein, Aurel Voss, Max Noether, David Hilbert übernahmen seit 1894 nacheinander den Vorsitz. Klein koordinierte mit dem Schriftführer August Gutzmer—wie zuvor mit Dyck—die Aufgaben (vgl. Tobies, 1988).

Mitgliedschaft

Die Zahl der Mitglieder wuchs in den Anfangsjahren von 205 (1891) über 498 (1901) bis 769 (1913). Der Anteil ausländischer Mitglieder erhöhte sich von 7,8% (1891) auf 30,1% (1901) und betrug 1913 39%. Das Kümmern nicht nur um Mathematiker an Universitäten und Hochschulen, sondern auch um (wissenschaftlich tätige) Lehrer an höheren Schulen gehörte zu den konzeptionellen Überlegungen der DMV von Beginn an. Im Unterschied etwa zur *Société mathématique de France* (vgl. Gispert & Tobies, 1996) lag der Anteil von Lehrern in den ersten Jahren regelmäßig um ca. 20%. Hermann C. H. Schubert (1848–1911), der in den *Mathematischen Annalen* publizierte, als Gymnasiallehrer in Hildesheim u.a. die Hurwitz-Brüder gefördert und Adolf Hurwitz 1877 zum Studium zu Felix Klein geschickt hatte, wurde—gemäß Kleins Vorschlag—als Repräsentant für diese Gruppe in den ersten DMV-Vorstand aufgenommen (vgl. Tobies, 2015).

Koordinierungsfunktion

Mit den Jahresversammlungen, deren Inhalt in den Jahresberichten wiedergegeben wurde, übte die DMV eine Koordinierungsfunktion aus. Das erste Jahrzehnt war erfolgreich. Es ist charakteristisch, dass Felix Klein ein neues Programm entwarf, aufgezeichnet zu Silvester 1899 (vgl. Tobies, 2000). Der Jahresbericht sollte dem zunehmend internationalen Charakter der DMV entsprechen und auch die vielfältigen Diskussionen um die mathematische Lehre u.a. berücksichtigen. Dazu entstanden die Mitteilungen als Anhang zum Jahresbericht. Gutzmer wechselte 1901 von der Position des Schriftführers in die Position des

[4]Vorsitz 1895. Die deutsche Wikipedia-Seite *Deutsche Mathematiker-Vereinigung* enthält für 1895/96 falsche bzw. fehlende Angaben (Stand: August 2015).

Herausgebers des Jahresberichts, der ab Band 11 neben wissenschaftlichen Abhandlungen enthalten sollte:

1. Mitteilungen über nationale und internationale mathematische Zusammenkünfte;
2. akademische Reden;
3. Beiträge zu Fragen des mathematischen Hochschulunterrichts;
4. Personalnachrichten und Berichte über die Tätigkeit von Akademien, Gesellschaften und Vereinen (von Dyck et al., 1902).

Nach zehnjährigem Bestehen war die DMV auf den Weg gebracht. Weiterhin existierende Differenzen zwischen mathematischen Schulen, Querelen von weniger an organisatorischen Fragen Interessierten sowie tiefe politische Einschnitte konnten letztlich den Weg nicht aufhalten.

Bibliographische Angaben finden sich im „Gemeinsamen Literaturverzeichnis“ auf S. 59.

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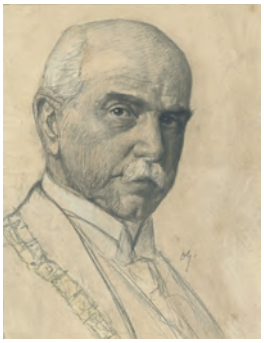
Die ersten beiden Hamburger DMV-Jahresversammlungen 1901 und 1928

Benedikt Löwe

Die erste Versammlung der Deutschen Mathematiker-Vereinigung (DMV) in Hamburg fand im Jahre 1901 statt. Heutzutage wird eine DMV-Jahrestagung (wie auch die diesjährige in Hamburg) stets von einem universitären Mathematik-Fachbereich ausgerichtet. Vor diesem Hintergrund erscheint es, zumindest, wenn man mit der frühen Geschichte der DMV nicht vertraut ist, vielleicht überraschend, daß die Versammlung im Jahre 1901 viele Jahre vor der Gründung der Universität Hamburg (1919) bereits in der Hansestadt stattgefunden hat.

Die DMV-Jahresversammlungen innerhalb der *Gesellschaft deutscher Naturforscher und Ärzte*

Die Deutsche Mathematiker-Vereinigung hatte sich im ausgehenden neunzehnten Jahrhundert aus der *Gesellschaft deutscher Naturforscher und Ärzte* herausgelöst (Tobies, 1991). Obschon einer der Beweggründe für diese Loslösung die Kritik an den Versammlungen dieser Gesellschaft gewesen war,[1] war der Versuch, separate Mathematiktagungen abzuhalten, als gescheitert empfunden worden: die lange vorbereitete Göttinger Tagung im Jahre 1873 war von nur 52, mehrheitlich jüngeren Personen besucht worden (Tobies, 1991, § 1). Daher fanden die Versammlungen der 1890 gegründeten Deutschen Mathematiker-Vereinigung bis auf eine Ausnahme bis zum Ersten Weltkrieg als Teil der *Versammlungen deutscher Naturforscher und Ärzte* statt und somit blieben letztere „das Gremium, in welchem sich Mathematiker im nationalen Rahmen trafen“ (Tobies, 1991, S. 37f).



Walther von Dyck (1856–1934), ca. 1906, mit der Rektorenkette der Technischen Hochschule München, Radierung von Otto Graf, Foto: Deutsches Museum.

Nach dem Ersten Weltkrieg wechselte die Gesellschaft deutscher Naturforscher und Ärzte von einem jährlichen auf einen zweijährlichen Rhythmus und versammelte sich jeweils nur in den geradzahligen Jahren. Dies erlaubte den Fachgesellschaften, in den jeweils ungeradzahligen Jahren eigene Tagungen abzuhalten.

[1] Alexander Brill (1842–1935, ab 1897: von Brill) benannte in seinem Bericht von 1873 die „Übelstände“ dieser Versammlungen: „nicht zur Sache gehörige Festlichkeiten, ausführliche Vorträge über spezielle Themata etc.“ (zitiert nach Tobies, 1991, S. 31).

Wiederum mit einer Ausnahme fanden die Versammlungen der Deutschen Mathematiker-Vereinigung bis zum Zweiten Weltkrieg in den ungeradzahligen Jahren und ab 1931 in allen Jahren zusammen mit dem Physikertag statt (Physikalische Blätter, 1962).[2]

Zwischen der Gründung der DMV und dem Ersten Weltkrieg war es nicht selbstverständlich, dass die DMV grundsätzlich der Gesellschaft deutscher Naturforscher und Ärzte folgte. Als der Ausbruch der Cholera in Hamburg im August 1892 die für September geplante Versammlung deutscher Naturforscher und Ärzte in Nürnberg in Frage stellte, plädierte Walther Dyck dafür,

> die [DMV-]Versammlung trotzdem abzuhalten, da es sich um 'keine großen Menschenmengen' handeln würde ... [Georg] Cantor [der damalige DMV-Vorsitzende, 1845–1918] hatte daraufhin an Dyck geschrieben, daß man die Versammlung der DMV trotzdem abhalten solle. ... [D]ie Naturforscherversammlung wurde dann tatsächlich abgesagt. ... Cantor versicherte am 31. August den Züricher Mathematikern, daß die Versammlung der DMV stattfinden würde. (Hashagen, 2003, S. 423).

Letztendlich wurde auch die DMV-Versammlung in Nürnberg im Jahre 1892 entgegen Cantors Versicherung von Dyck abgesagt.[3] Dyck hatte hierbei selbst viel zu verlieren: er hatte seit 1891 eine Ausstellung mathematischer Modelle für die Nürnberger Versammlung geplant, die nun ebenfalls ausfallen würde.

> Dyck machte dann den Vorschlag, die Versammlung der DMV zusammen mit der Ausstellung nächstes Jahr in München abzuhalten ... Im Vorstand der mathematischen Vereinigung einigte man sich noch im Herbst 1892 relativ rasch darauf, Dycks Vorschlag zu folgen und die nächste Versammlung der DMV ... getrennt von der Naturforscherversammlung im September in München abzuhalten. (Hashagen, 2003, S. 425)

Auch Anfang des zwanzigsten Jahrhunderts empfand die DMV immer noch die Freiheit, sich von der Versammlung deutscher Naturforscher und Ärzte zu lösen. In Vorbereitung der Hamburger Versammlung 1901 findet man den folgenden Bericht von der Aachener Versammlung:

> Nach den zu Aachen gefaßten Beschlüssen wird die nächste Jahresversammlung im September 1901 zu Hamburg stattfinden, und zwar, wie üblich, in Gemeinschaft mit der Abteilung für Mathematik und Astronomie der Versammlung Deutscher Naturfoscher und Ärzte. (Bericht, 1901, S. 6)

[2] Die Ausnahme war das Jahr 1923, in dem der Physikertag in Bonn, die Versammlung der DMV aber in Marburg stattfand. Gericke (1972, S. 9) zitiert aus der *Zeitschrift für Angewandte Mathematik und Mechanik* (Band 3:4, August 1923):

> Die Versammlung ist um einige Tage verschoben worden, um nach Möglichkeit Kollision mit dem am 16. September beginnenden Physikertag in Bonn zu vermeiden. Leider ist eine gemeinschaftliche Tagung in diesem Jahre nicht zustande gekommen, da die Physiker meinten, an dem ursprünglich in Aussicht genommenen Bonn festhalten zu müssen, was den Mathematikern aus praktischen Gründen untunlich erschien.

und kommentiert dies mit: „Der Grund für diese Schwierigkeiten war die Besetzung des Ruhrgebietes."

[3] Purkert & Ilgauds (1987, S. 126) nehmen an, daß diese Entscheidung Dycks der Grund für Cantors Rücktritt als DMV-Vorsitzender gewesen sei. Vgl. auch (Schubring, 2010, S. 105).

Dieser Bericht betont sowohl die Üblichkeit der gemeinsamen Tagung als auch die Tatsache, dass in jedem Einzelfall die DMV beschliessen mußte, ob sie gemeinschaftlich mit den deutschen Naturforschern und Ärzten tagen wollte. Im Sommer 1901 gab es den Plan, die Versammlung deutscher Naturforscher und Ärzte im Jahre 1902 in Posen (heute Poznán) abzuhalten. Dies veranlaßte den damaligen DMV-Schriftführer August Gutzmer (s. S. 44) dazu, an den DMV-Vorstand zu schreiben:

> So viel bis jetzt schon sich übersehen läßt, wird die Naturforscher-Versammlung im nächsten Jahre (1902) in Posen stattfinden. Da diese Stadt gar zu excentrisch gelegen ist, da ferner 1902 das dem internationalen Congresse von 1904 [ICM 1904 in Heidelberg; B.L.] zu Grunde zu legende Programm beraten werden soll, wobei die Anwesenheit möglichst zahlreicher Fachgenossen erwünscht ist, so ist angeregt worden, daß die Vereinigung im nächsten Jahre eventuell nicht mit der Naturforscher-Versammlung tagen möge. Auch ist bereits Jena als Versammlungsort genannt worden. Ohne damit schon andere Vorschläge, die vielleicht zweckmäßiger sind, abschneiden zu wollen, möchte ich nur sagen, daß wir Jenenser eventuell gern bereit sein werden, uns in den Dienst der Versammlung zu stellen; wir werden die Fachgenossen herzlich willkommen heißen. Allerdings werden sie fürlieb nehmen müssen mit den kleinen Verhältnissen, die hier obwalten; wer mit großen Erwartungen herkommt, wird enttäuscht sein. (7. Juli 1901; E4/11 000077v)[4]

In einem Schreiben vom 20. September 1901 (vermutlich an Gutzmer) betont von Dyck seinen Wunsch, daß Jena der Versammlungsort für 1902 werden soll, „falls Posen für die Naturforscherversammlung gewählt wird“ (E4/11 000069). Die Naturforscherversammlung 1902 fand dann allerdings in Karlsbad statt und die Mathematiker folgten den Naturforschern.[5]

Die von Brill in seinem Bericht aus dem Jahre 1873 genannten „Übelstände“ der Naturforscherversammlung (s. Fußnote 1) blieben Kritikpunkte der Mathematiker. Die Versammlungen deutscher Naturforscher und Ärzte waren riesige Veranstaltungen, in denen die soziale Komponente eine große Rolle spielte. Z.B. hatte bereits die Hamburger Naturforscherversammlung im Jahre 1876 „1873 auswärtige und 1355 hiesige Teilnehmer ..., darunter 1334 Damen“ (Regierungsrat Maass, 1928, S. 8f); in den zwanziger Jahren des zwanzigsten Jahrhunderts waren diese Zahlen auf weit über zehntausend Teilnehmer angewachsen.

Brills „nicht zur Sache gehörige Festlichkeiten“ nehmen einen beträchlichen Teil des Programms der Versammlungen ein: Z. B. organisierte im Jahre 1901 das *Comité zur Veranstaltung ärztlicher Studienreisen in Bade- und Kurorte* eine elftägige Reise nach Sylt, Wyk, Helgoland, Wangerooge, Spiekeroog, Norderney, Juist, Borkum und Cuxhaven auf einem Salondampfer im Anschluss an die Naturforscherversammlung zum Preise von 100 Mark in Vollpension an:

[4] Alle zitierten Originaldokumente stammen aus dem Archiv der Deutschen Mathematiker-Vereinigung, welches sich im Universitätsarchiv Freiburg befindet (Bestand E0004); die Dokumente zur Versammlung 1901 stammen aus der Akte E4/11, die Dokumente zur Versammlung 1928 aus der Akte E4/31. Wir danken dem Universitätsarchiv Freiburg für die Möglichkeit der Nutzung dieser Unterlagen. S. auch (Remmert, 1999).

[5] Wir bemerken, daß die sehr erfolgreiche Vorgängerjahrestagung unserer Hamburger Tagung im Jahre 2014 in Poznán, gemeinschaftlich organisiert mit der *Polskie Towarzystwo Matematyczne*, stattfand.

> In Rücksicht auf die grosse Bedeutung, welche die Kenntnis der klimatologischen, balneo-therapeutischen, physikalisch-diätetischen Heilmethoden in den letzten Jahren gewonnen hat, muss es als besonders wünschenswert erachtet werden, dass den praktischen Aerzten, Sanitätsoffizieren, und Studierenden der Medicin mit Aufwendung geringer pekuniärer Opfer die Möglichkeit gegeben wird, die Bade- und Kurorte der deutschen Lande aus eigener Anschauung kennen zu lernen. (Einladung, 1901, S. 39)

Bei der Versammlung im Jahre 1928 war ein *Damenausschuß* von 35 Ehegattinen von Naturforschern und Ärzten für das sogenannte *Damenprogramm* (heutzutage: *Sozialprogramm*) zuständig. Man kann vermuten, daß damals (wie auch heute im Rahmen des sozialen Programms von Fachtagungen) nicht nur die Begleitpersonen, sondern auch viele reguläre Tagungsteilnehmer das Sozialprogramm den Vorträgen vorzogen. Im folgenden zitieren wir aus (Regierungsrat Maass, 1928, S. 150ff) den Überblick über das Sozialprogramm für einen repräsentativen Tag (in diesem Fall Montag, der 17. September 1928):

9¼ Uhr Rundfahrt um die Alster und durch die Stadt ... mit anschließender Hafenrundfahrt und Dampferbesichtigung. ...

9¼ Uhr Rundfahrt um die Alster, Besichtigung neuer Wohnungsbauten, evtl. Besichtigung der Schiffsbautechnischen Versuchsanstalt, Besichtigung des Ohlsdorfer Friedhofes. ...

10 Uhr Besichtigung und Führung durch die Museen, Kunsthalle, Staats- und Universitätsbibliothek, Rathaus und Kirchen.

10½ Uhr Gang durch die Stadt, Botanischer Garten, Museum für Hamburgische Geschichte, Bismarckdenkmal, Michaeliskirche mit Turm. ...

13¾ Uhr Fahrt nach Aumühle-Friedrichsruh mit Besuch des Mausoleums des Fürsten Bismarck und Besichtigung des Sterbezimmers. ...

15 Uhr Fahrt zum Flugplatz Fuhlsbüttel und zurück. ... Flugvorführungen; Rundflüge zu ermäßigten Preisen. ...

15 Uhr Abfahrt nach Hagenbeck's Tierpark. ...

15 Uhr Abfahrt von St.-Pauli-Landungsbrücken mit Dampfer „Jan Molsen"; Fahrt elbabwärts und zurück. ... Kaffeetafel an Bord. ...

15½ Uhr Abfahrt von St.-Pauli-Landungsbrücken mit Dampfer „Kehrwieder" zum Tee auf Dampfer „Hamburg". (Die Teilnehmerzahl ist auf 350 Personen beschränkt. Weiße Sonderkarten!) ...

17 Uhr Besichtigung des Instituts für Schiffs- und Tropenkrankheiten, unter Führung des Direktors Prof. Dr. Nocht. ...

19½ Uhr Orgelkonzert (Prof. Alfred Sittard) in der großen St. Michaeliskirche ... [Vincent Lübeck, Heinrich Scheidemann, Joh. Seb. Bach, Max Reger, Franz Liszt, Georg Fr. Händel].

19½ Uhr Philharmonisches Konzert (Kapellmeister Eugen Pabst) in der Musikhalle ... [Haydn, Mozart, Beethoven].

Man sieht, dass Teilnehmer den ganzen Tag am Programm teilnehmen konnten, ohne auch nur an einem einzigen wissenschaftlichen Vortrag teilzunehmen. Zusätzlich zum vom Damenausschuß organisierten Sozialprogramm finden sich vier Seiten mit Einladungen akademischer Verbände und Vereinigungen (z. B. der Akademische Turnbund, der Verband alter Corpsstudenten, die Deutsche Wehrschaft, die Vereinigung Alter Sängerschafter und der Wingolfsbund) zu Feiern, geselligem Beisammensein und Tanz (Regierungsrat Maass, 1928, S. 169ff) sowie vierzehn Seiten ausstellender Firmen (Regierungsrat Maass, 1928, S. 174–187).

Im Kontrast fanden in den zwanziger Jahren in den jeweils ungeradzahligen Jahren die Versammlungen der Mathematiker und Physiker im deutlich kleineren Rahmen und an bescheideneren Orten (1921 Jena, 1923 Marburg, 1925 Danzig, 1927 Bad Kissingen) statt.[6] Die Marburger Tagung (wie oben erwähnt, die einzige ohne die Physiker) hatte „über hundert Mitglieder“ (Gericke, 1972, S. 9).

Auf der Versammlung in Bad Kissingen regte Otto Toeplitz (1881–1940) an, der Naturforschergesellschaft die Abtrennung der Mathematiker anzudrohen. In einem Brief vom 22. September 1927 verdeutlichte Toeplitz seine Kritikpunkte:

> Ein nach meiner Auffassung übermässiger und ausgesprochen geschäftsmässiger Ehrgeiz der Oberbürgermeister vieler deutscher Grossstädte verleitete in den letzten Jahren die [Gesellschaft deutscher Naturforscher und Ärzte] vielfach dazu, grosse Städte aufzusuchen und den Versammlungen mit monströsen Besuchsziffern, die nur von grossen Städten noch gefasst werden können, einen besonderen Glanz zu verleihen. Dieser Glanz, der in Düsseldorf einen Beitrag von 25M und ein elendes Unterkommen der meisten von uns zur Folge hatte, hat nichts mit dem inneren Wert der Versammlungen zu tun. Wenn diese in kleinen Universitätsstädten, in Badeorten u. dgl. stattfinden, so kommen vielleicht statt 12000 nur 3000 Gelehrte—so wars in Nauheim [1920], in Innsbruck [1924], aber diese 3000 sind eben die wirklichen Wissenschaftler, auf die es ankommt.
>
> Mein Antrag bezweckt, dass die Naturf.-Ges. zu ihrer alten schlichten Einfachheit und Sachlichkeit zurückkehrt und die persönliche wiss. Bezugnahme als die vornehmste Aufgabe der Congresse ansieht, hinter der alles andere zurücktreten muss. (E4/31 055r)

Die von diesem Brief ausgelöste Diskussion im Vorstand ist nicht in den Archiven der DMV enthalten, aber am 9. September 1928 (also nur eine Woche vor Beginn der Hamburger Versammlung) wurde ein Brief der DMV an die Gesellschaft deutscher Naturforscher und Ärzte aufgesetzt, der sich eng am Wortlaut des Briefes von Toeplitz orientierte:[7]

> Die Deutsche Mathematikervereinigung hat durch Jahrzehnte hindurch regelmäßig ihre Jahresversammlung zugleich mit der Gesellschaft deutscher Naturforscher und Ärzte abgehalten und dafür gesorgt, dass die erste Abteilung dieser Gesellschaft sich würdig in das Ganze einfügte. Es erfüllt die Deutsche Mathematikervereinigung aber mit besonderer Besorgnis, dass die Massenveranstal-

[6] Vgl. (Heineke, 1972, S. 385f): „Die Naturforscher und Ärzte tagten weiter in großen Städten; die kleine Physiker-Vereinigung bevorzugte kleine Badeorte, bis auch die wachsende DPG von der Intimität kleiner Orte Abschied nehmen mußte.“

[7] Aus den Archiven ist nicht ersichtlich, ob dieser Brief tatsächlich abgeschickt wurde.

tungen auf diesen Kongressen in den letzten Jahren zunehmen und den eigentlichen Zweck wenigstens unserer Mathematikertagung zu ersticken drohen. So führt das Drängen nach grossen Besuchsziffern und nach finanziellen Überschüssen dazu, dass die Tagungen in Grossstädten stattfinden und dass drückende Beitragssummen erhoben werden müssen, dass die Mehrzahl der Teilnehmer gleichwohl in elender, unwürdiger Weise untergebracht werden. Dazu behindert der grosse Tam-tam des Halbpopulären und die Entfernungen einer Grossstadt, die persönliche Bezugnahme der Einzelnen und den erspriesslichen Verlauf der wissenschaftlichen Fachsitzungen, sowie auch die wirklich wissenschaftlich ergiebige Zusammenarbeit der einzelnen Abteilungen. ... Die DMV hat sich nun schweren Herzens entschlossen, 1928 der Gesellschaft Deutscher Naturforscher und Ärzte nach Hamburg zu folgen. Sie muss befürchten, dass in künftigen ähnlichen Fällen, diejenigen, welche unsere Tagung von der Gesellschaft loszulösen wünschen, die Mehrheit erhalten. (E4/31 052–054)

Hamburg 1901: 22. bis 28. September 1901

August Gutzmer (1860–1924), Schriftführer der DMV im Jahre 1901; Foto von Gustav Kerp (1908), abgedruckt mit Genehmigung der Städtischen Museen Jena

Während der Hamburger Versammlung 1901 war Walther von Dyck (1856–1934) der Vorsitzende der DMV. Das wichtigste Thema dieser Versammlung war die Neuordnung des Jahresberichts der DMV (s. auch Remmert & Schneider, 2010, S. 106–108). Tobies (2000) berichtet, daß sich Alfred Ackermann-Teubner (1857–1941) seit 1899 um eine Neuordnung der Mathematik-Zeitschriften in Deutschland kümmern wollte; er hatte im Jahre 1900 einen Vorschlag für die Umgestaltung des *Jahresberichts* an den damaligen DMV-Vorsitzenden David Hilbert (1862–1943) geschickt. Auf Betreiben Felix Kleins (1849–1925) hatte man sich darauf geeinigt, die Details auf der Hamburger Versammlung im September 1901 zu besprechen.

Von Dyck war verhindert und wurde von Hilbert, seinem Vorgänger als DMV-Vorsitzender, vertreten:[8]

> Nun macht mir ... die Reichsschulkommission einen Strich durch die Hamburger Pläne. Die Sitzungen derselben ... finden in Eisenach vom 24.^{n} Sept an statt (d. i. Dienstag). (Brief von v. Dyck vermutlich an Gutzmer, 1860–1924; E4/11 000070)

Bei der Sitzung wurde August Gutzmer zum Herausgeber des *Jahresberichts* gewählt (Gutzmer, 1909, S. 17); der Vorstand beschreibt die neuen Aufgaben des *Jahresberichtes* in (von Dyck et al., 1902). In einem Schreiben vom 6. November 1901 an den Vorstand bietet Gutzmer das Amt des Herausgebers demjenigen an, der sich bereiterklärte, Schriftführer der DMV zu werden:

> Es wird nun vor allem nötig sein, daß wir einen Schriftführer cooptiren. Die bisher in Betracht gezogenen Persönlichkeiten haben abgelehnt. Es scheint hier eine große Schwierigkeit vorzuliegen, und ich habe deshalb in Hamburg bei meiner Wahl zum Herausgeber der Jahresberichte sogleich erklärt, daß ich es im

[8] Vgl. (Bericht, 1902, S. 4 & 8).

Deutsche Mathematiker-Vereinigung.

Im August 1901.

Der Vorstand der „Deutschen Mathematiker-Vereinigung“ ladet hierdurch die Mitglieder zur Teilnahme an der vom 22. bis 28. September d. J. zu Hamburg stattfindenden Jahresversammlung ein, welche in Gemeinschaft mit den Sitzungen der 1. Abteilung der Naturforscher-Versammlung abgehalten werden wird.

Bisher sind für die wissenschaftlichen Verhandlungen folgende Vorträge angemeldet worden:

1. **Adler** (Prag): Sphärische Abbildung der Flächen und ihre Anwendung in der darstellenden Geometrie.
2. **Charlier** (Lund): Die astronomische Erklärung einer Eiszeit.
3. **Eberhard** (Halle a. S.): Ein Beitrag zur Theorie der Gleichungen.
4. **Ebert** (Kiel): Über eine Frage aus der Himmelsmechanik.
5. **Engel** (Leipzig): Die höheren Differentialquotienten.
6. **Folie** (Grivegnée): Über die Oppolzer'schen Formeln der Nutation.
7. **Halm** (Edinburgh): Über die Beziehungen des Erdmagnetismus zu seismologischen Vorgängen und ihre Bedeutung für die messende und theoretische Astronomie.
8. **Hilbert** (Göttingen): Über einige neuere mathematische Dissertationen.
9. **Klein** (Göttingen), **Meyer** (Königsberg), **Wiechert** (Göttingen): Berichterstattung über den Stand der „Encyklopädie der mathematischen Wissenschaften“.
10. **Kowalewski** (Leipzig): Referat über die Theorien von Sophus Lie.
11. **von Lilienthal** (Münster): Die Geometrie der Bewegung in ihrer Anwendung auf die Differentialgeometrie.
12. **Marcuse** (Berlin): Über die neuere Entwicklung der geographischen Ortsbestimmung.
13. **Meyer** (Königsberg i. Pr.): Die Ausdehnung des Henrici'schen und Ivory'schen Satzes auf Flächen beliebiger Ordnung.
14. **Schilling** (Göttingen): Neue kinematische Modelle zur Verzahnungstheorie und ihre Beziehung zur Theorie der Berührungstransformationen.
15. **Schoute** (Groningen): Über die Beweglichkeit eines Nullsystems N_{n-1} im R_n.
16. **Schubert** (Hamburg): Über die Constantenzahl der n-dimensionalen Verallgemeinerung des Polyeders.
17. **Stäckel** (Kiel): Referat über die Entwicklung des Unterrichtsbetriebes in der angewandten Mathematik an den deutschen Universitäten.
18. **Study** (Greifswald): Ein neuer Zweig der Geometrie.
19. **Torka** (Berlin): Über eine neue Bewegungsgeometrie.
20. **Zermelo** (Göttingen): Über ein geometrisches Maximumsproblem.
21. ——— ———: Zur Theorie der kürzesten Linien.

Die angemeldeten Vorträge werden, wie üblich, teils in den Fachsitzungen, teils in gemeinschaftlichen Sitzungen mehrerer Abteilungen gehalten werden. Für die gemeinsamen Sitzungen ist Dienstag Nachmittag ins Auge gefasst worden. Um im Hinblick auf die für die Fachsitzungen verbleibende knappe Zeit von vornherein zweckmäfsige Dispositionen treffen zu können, bitten wir, allfällige weitere Vorträge und Mitteilungen möglichst bis zum 12. September bei dem unterzeichneten Schriftführer anmelden zu wollen. Auch bitten wir, die beiliegende Postkarte auszufüllen und vor der Versammlung an die aufgedruckte Adresse gelangen zu lassen. Die allgemeine Tagesordnung und Zeiteinteilung der Naturforscher-Versammlung dürfen wir als bekannt voraussetzen; es sei nur noch bemerkt, dafs die Fachsitzungen bereits am Montag Nachmittag 1½ Uhr nach Bildung und Eröffnung der Abteilung im Johanneum, Hörsaal A, beginnen werden.

Die Geschäftssitzung der Vereinigung wird voraussichtlich am Donnerstag der Versammlungswoche stattfinden. In dieser wird der Vorstand auf Grund mehrjähriger Erwägungen und Verhandlungen mit einer grofsen Zahl von Mitgliedern und mit der Teubnerschen Verlagsbuchhandlung den Antrag stellen, den bisherigen Jahresbericht in ein in Monatsheften auszugebendes Organ umzugestalten, welches neben dem bisherigen Inhalte noch besonders Mitteilungen aktuellen Interesses enthalten soll. Es wird dann ein ständiger Redakteur zu wählen sein, und es wird ferner mit Rücksicht auf die umfangreichen und stetig zunehmenden Geschäfte das Amt des Schriftführers durch Einrichtung einer Kassenstelle zu entlasten sein. Die Firma B. G. Teubner hat sich in dankenswerter Weise bereit erklärt, die Kassengeschäfte zu übernehmen.

Demgemäfs wird der Vorstand der Versammlung die folgenden Anträge vorlegen:

1. Umwandlung des Jahresberichtes in ein monatlich erscheinendes Organ, dessen Programm auf der Versammlung näher erläutert und festgestellt werden soll;
2. Wahl eines ständigen Herausgebers des Jahresberichtes, welcher zugleich dem Vorstande angehört;
3. Wahl eines besonderen Schriftführers, der im bisherigen Turnus in den Vorstand eintritt bezw. aus demselben ausscheidet;
4. Wahl der Verlagsbuchhandlung B. G. Teubner in Leipzig zur Kassenstelle der Vereinigung.

Es würde hiernach der Vorstand aus den sechs gewählten Mitgliedern und dem ständigen Herausgeber der Jahresberichte bestehen; für die Wahl der ersteren verbleibt es bei den bisherigen Bestimmungen.

Mögen die wissenschaftlichen und geschäftlichen Verhandlungen in Hamburg das Band, welches die Mitglieder der Vereinigung umschlingt, enger knüpfen, zum Wohle des Ganzen, zur Befriedigung des Einzelnen!

Für den Vorstand der Deutschen Mathematiker-Vereinigung

W. von Dyck
München, Hildegardstr. 1½
d. Z. Vorsitzender.

A. Gutzmer
Jena, Schaefferstr. 4
d. Z. Schriftführer.

> Interesse der Vereinigung für erwünscht hielte, wenn das Amt des Schriftführers und Herausgebers in einer Hand lägen, und daß ich daher jeden Augenblick die Redaction niederlege, sobald der neue Schriftführer die Bedingung stellt, daß er die Redaction gleichzeitig führen wolle. Vielleicht entschließt sich dann der eine oder andere leichter zur Uebernahme des Schriftführeramtes. (E4/11 000067)

Dieses Angebot wurde nicht angenommen: als Adolf Krazer (1858–1926) bei der Karlsbader Versammlung im Jahre 1902 zu Gutzmers Nachfolger als Schriftführer der DMV gewählt wurde, blieb Gutzmer der Herausgeber des *Jahresberichts*; er sollte dies bis zu seinem Tode im Jahre 1924 bleiben; bis 1921 alleinverantwortlich, ab 1922 gemeinsam mit Ludwig Bieberbach (1886–1982).

Die Einladung zur Naturforscher-Versammlung (Einladung, 1901) wurde am 1. Juli 1901 gedruckt und enthält 14 Vorträge in der 1. Abteilung (Mathematik, Astronomie und Geodäsie); die Auflistung dieser Vorträge endet mit dem Vermerk „Die vervollständigte Vortragsliste versendet die Deutsche Mathematiker-Vereinigung Ende August an ihre Mitglieder“, der sich in keiner anderen Abteilung findet. Am 7. Juli 1901 schickt Gutzmer einen Entwurf für die Einladung zur Versammlung der DMV an den DMV-Vorstand und bemerkt „es sind zur Zeit schon 16 Vorträge angemeldet“ (E4/11 000077r). Die Einladung an die Mitglieder enthält bereits 21 Vorträge, wurde im August 1901, also etwa einen Monat vor der Versammlung verschickt, und forderte die Mitglieder auf, „allfällige weitere Vorträge und Mitteilungen möglichst bis zum 12. September beim unterzeichnenden Schriftführer einreichen zu wollen“ (E4/11 000074; s. S. 45 & 46; abgedruckt mit Genehmigung des Universitätsarchivs Freiburg). Die endgültige Zusammenstellung des Programms erfolgte also sehr kurzfristig (weniger als zwei Wochen vor der Versammlung) und anscheinend kurzfristiger als in anderen Abteilungen. Ein Überblick über den wissenschaftlichen Inhalt der Versammlung wurde im *Jahresbericht* veröffentlicht (Bericht, 1902).

Auf der Hamburger Versammlung war der Hamburger Gymnasialprofessor Hermann Schubert (1848–1911) der Gelehrtenschule des Johanneums der sogenannte *Einführende* der *Abteilung 1: Mathematik, Astronomie und Geodäsie* der Gesellschaft deutscher Naturforscher und Ärzte (zu Schubert, vgl. Tobies, 2015); Gutzmer und Schubert wurden für drei Jahre in den wissenschaftlichen Ausschuß der Gesellschaft gewählt (Bericht, 1902, S. 9). Die auf der Hamburger Versammlung von den Biologen verabschiedeten sogenannten „Hamburger Thesen“ zum Biologieunterricht leiteten einen Prozeß ein, der dann bei der Breslauer Tagung 1904 zur Einsetzung der *Breslauer Unterrichtskommission* der Gesellschaft deutscher Naturforscher und Ärzte, deren Vorsitz Gutzmer übernahm (Schimmack, 1907, S. 4–6).

Hamburg 1928: 16. bis 22. September 1928

In der DMV war das Jahr 1928 durch die Auseinandersetzung um den 8. internationalen Mathematikerkongreß in Bologna, der nur wenige Tage vor der Hamburger Versammlung deutscher Naturforscher und Ärzte stattfand (3.–10. September 1928), und den darauf kulminierenden berühmten *Annalenstreit* geprägt. Der Streit zwischen Hilbert und L. E. J. Brouwer (1881–1966) hatte sowohl grundlagentheoretische (*Intuitionismus* vs. *Formalismus* in der sogenannten *Grundlagenkrise der Mathematik*) als auch politische Hintergründe. Bereits im Jahre 1925 gab es einen Streit im Herausgebergremium der *Mathematischen*

Annalen um politische Selektion von Autoren (Schappacher & Kneser, 1990, S. 55); nach dem internationalen Mathematikerkongreß in Bologna flammte dieser Streit wieder auf. Nach dem Ersten Weltkrieg waren die deutschen Mathematiker von der Mitgliedschaft in der *International Mathematical Union* (IMU) ausgeschlossen gewesen; zunehmende Kritik an dieser Regelung führte dazu, dass man sie für den Kongreß in Bologna 1928 aufhob (Lehto, 1998, §§ 2.2 & 2.3). Mathematiker wie Bieberbach und Brouwer lehnten

> die Teilnahme von Deutschen ab ..., weil eine Beteiligung des durch seine Boykottpolitik gegen die deutsche Wissenschaft bekannten *Conseil International de Recherche* an der Organisation des Kongresses vermutet wurde, und weil das Rahmenprogramm des Kongresses insbesondere einen Ausflug in das „befreite Südtirol“ vorsah, der als anti-deutscher Affront gewertet wurde. (Schappacher & Kneser, 1990, S. 55)

Hilbert leitete die deutsche Delegation nach Bologna und sorgte sich nach dem Kongreß darum, daß Brouwer aus dem Herausgebergremium der *Mathematischen Annalen* entfernt wurde.[9]

Erhard Schmidt (1876–1959); Foto: Konrad Jacobs; mit Genehmigung des Bildarchivs des Mathematischen Forschungsinstituts Oberwolfach.

Das Archiv der DMV im Freiburger Universitätsarchiv enthält somit auch kaum Dokumente zur Hamburger Jahresversammlung aus dem Jahre 1928, sondern hauptsächlich Material zu Bologna und den *Mathematischen Annalen*. Lediglich drei Briefe (E4/31 067, 070 & 072 von Leopold Vietoris, Fritz Rehbock und Hellmuth Kneser) liegen vor: die Vortragenden waren von Bieberbach aufgefordert worden, ihre Vortragszusammenfassungen für den Versammlungsbericht (Bericht, 1929) einzureichen. Die drei Briefe betreffen diese Einreichungen und administrative Angelegenheiten.[10] Der Vorsitzende der DMV im Jahre 1928 war Erhard Schmidt, der Schriftführer war Bieberbach.

Die Vorträge, die auf der Versammlung in Hamburg gehalten wurden, sind mit Zusammenfassungen im *Jahresbericht* veröffentlicht (Bericht, 1929). Um den Teilnehmenden der Jahrestagung im Jahre 2015 einen Eindruck von dieser Versammlung des Jahres 1928 zu geben, listen wir im Folgenden die Vorträge aus dem Programm der Naturforscherversammlung (Regierungsrat Maass, 1928) in alphabetischer Reihenfolge auf:

Bergmann (Berlin) *Über unendliche Hermitesche Formen, mit Anwendungen auf die Abbildung durch Paare von Funktionen von zwei komplexen Veränderlichen.*

Brauer (Berlin) *Über die Approximation algebraischer Zahlen durch algebraische.*

Brauer (Königsberg i. Pr.) *Über Systeme hypercomplexer Zahlen.*

Cremer (Leipzig) *Über das Zentrumproblem.*

Fenchel (Berlin) *Krümmung und Windung geschlossener Kurven.*

[9] Vgl. Schappacher & Kneser (1990, S. 54–56), Mehrtens (1987, S. 211–217), Hashagen (2003, S. 601) und van Dalen (1990).

[10] Vietoris (E4/31 067, 6. Oktober 1928) informiert die DMV, daß er zum ordentlichen Professor an der Wiener Technischen Hochschule berufen wurde; Rehbock (E4/31 070, 31. Oktober 1928) informiert die DMV, daß er nunmehr „Assistent bei Herrn Professor Doetsch“ in Stuttgart ist; und Kneser (E4/31 072, 3. November 1928) informiert die DMV über den Tod von W. Windau.

Graf (Karlsruhe) *Über geodätische Vierecksnetze inhaltsgleicher Felder.*

Jacob (Berlin) *Beitrag zu den Fundamentalsätzen der Wahrscheinlichkeitsrechnung.*

Haack (Stuttgart) *Affine Differentialgeometrie der Strahlensysteme.*

Haentzschel (Berlin) *Über ein kubisches diophantisches Problem.*

Hagge (Kiel) *Die Grundlagen der Brocard'schen Geometrie des Dreiecks und die Erweiterung auf das Vieleck.*

Hamburger (Köln) *Zur Theorie der sphärischen Abbildung im Großen.*

Hammerstein (Berlin) *Über nichtlineare Integralgleichungen und die damit zusammenhängenden Randwertaufgaben.*

Hertz (Göttingen) *Axiomensysteme für allgemeine Satzsysteme.*

Herzberger (Jena) *Über die Eigenschaften erster Ordnung längs einem Strahl im allgemeinen Strahlensystem.*

Hopf (Berlin) *Ein Beitrag zur Theorie der elliptische Differentialgleichungen.*

Kamke (Tübingen) *Zur Theorie der Differentialgleichungen.*

Kleinschrod (München) *Über das Wesen von Zeit und Zahl und ihr Verhältnis zur Eigengesetzlichkeit des Lebens.*

Kneser (Greifswald) *Geschlossene Flächen in dreidimensionalen Mannigfaltigkeiten.*

Korn (Berlin) *Mathematische Probleme, die in der Wellenmechanik auftreten.*

Koschmieder (Brünn) *Über die C-Summierbarkeit gewisser Verallgemeinerungen der Laplaceschen Reihe.*

Leuse (München) *Über die konforme Abbildung durch die Funktion $W = 1/T(2)$.*

Löbell (Cannstatt) *Eigenschaften der geodätischen Linien in Clifford-Klein'schen Flächen.*

Mayrhofer (Hamburg) *Über Kurvensysteme.*

Mühlendyck (Berlin) *Kinematische Einteilung der reellen analytischen Somenmannigfaltigkeiten.*

Neder (Münster) *Über die Grundlagen der Arithmetik.*

von Neumann (Berlin) *Allgemeine Eigenwerttheorie hermiteische-symmetrischer Funktionaloperatoren.*

Rehbock (Berlin) *Eine Abbildung des R_3 auf nichteuklidische ebene Bewegungen.*

Reinhardt (Greifswald) *Über die Zerlegung der Euklidischen Ebene in kongruente Bereiche.*

Rembs (Berlin) *Eine Verbiegung der Vollkugel.*

Sauer (München) *Eine geometrische Ableitung der Codazzischen Gleichungen und des Bonnet-Gauß'schen Satzes.*

Schmidt (Jena) *Neue Verallgemeinerung der Legendreschen Funktionen.*

Scholz (Berlin) *Anwendung der Klassenkörpertheorie auf die Konstruktion von Körpern mit vorgeschriebener Gruppe.*

Süß (Greifswald) *Relative Differentialgeometrie und Minkowski's Theorie von Volumen und Oberfläche.*

Thomsen (Hamburg) *Referat über differentialgeometrische Untersuchungen zur Kugelgeometrie.*

Vietoris (Innsbruck) *Zum Homöomorphieproblem der kombinatorischen Topologie.*

Die Jahresversammlung 1928 sollte die vorletzte gewesen sein, die gemeinsam mit den Naturforschern und Ärzten stattfand. Die letzte gemeinsame Versammlung fand im September 1930 in Königsberg statt. Zu dieser Gelegenheit wurde David Hilbert zum Ehrenbürger seiner Geburtsstadt Königsberg gemacht und hielt seine berühmte Radioansprache, die mit dem Motto „Wir müssen wissen; wir werden wissen!" endete (Reid, 1996, § XXII).

> However, lives do not always end on great lines. At almost the same time that Hilbert was making his speech at Königsberg, a piece of work was being brought to a conclusion which was to deal a death blow to the specific epistemological objective of the final programme of Hilbert's career. On November 17, 1930, the *Monatshefte für Mathematik und Physik* received for publication a paper by a 25-year-old mathematical logician named Kurt Gödel. (Reid, 1996, S. 197)

Bibliographische Angaben finden sich im „Gemeinsamen Literaturverzeichnis" auf S. 59.

Benedikt Löwe ist Professor für Mathematische Logik und interdisziplinäre Anwendungen der Logik an der Universität Hamburg und der Vorsitzende des Programmkomitees der diesjährigen DMV-Jahrestagung. Zusätzlich zu seiner Tätigkeit in Hamburg lehrt und forscht er am *Institute for Logic, Language and Computation* der *Universiteit van Amsterdam*. Er dankt Rainer Nicolaysen und Renate Tobies für Kommentare zu einer früheren Version des Artikels.

Hermann Schubert, die DMV und Hamburg

Renate Tobies

Hermann Cäsar Hannibal Schubert (1848–1911) gehörte der Deutschen Mathematiker-Vereinigung seit der Gründung bis zu seinem Tode (am 20. Juli 1911 in Hamburg) an. Schubert war ein bedeutender algebraischer Geometer: Friedrich Hirzebruch (1927–2012) widmete Schuberts Kalkül der abzählenden Geometrie noch 2010 zwei Vorträge, in Edinburgh und Bonn gehalten, zum Thema „125 years of the Schubert Calculus“. Schubert hatte 1874 eine Goldmedaille der Dänischen Akademie für die Lösung einer Preisaufgabe erhalten, die Hieronymus G. Zeuthen (1839–1920) gestellt hatte. Schubert gehörte auch der *Société mathématique de France* an und wurde Ehrenmitglied der *Koninklijke Nederlandse Akademie van Wetenschappen* (vgl. Burau, 2008; Burau & Renschuch, 1993).

Schubert publizierte in verschiedenen Zeitschriften. Als besonders wichtiger Mitarbeiter wurde er bei den *Mathematischen Annalen* geschätzt. Er publizierte hier fünfzehn seiner Arbeiten (Tobies & Rowe, 1990, S. 39). Clebsch hatte die Annalen zunächst vor allem als Organ für seine Schule der algebraischen Geometrie gegründet. Schubert erhielt für seine aktive Mitarbeit regelmäßig ein Freiexemplar der *Mathematischen Annalen* seit Beginn der 1880er Jahre—neben Brill, Lie, Lüroth, Scheibner, Stolz, Sturm, Voss, Zeuthen (vgl. Tobies & Rowe, 1990, S. 117).

Gelehrtenschule des Johanneums, auf dem Hamburger Domplatz, erbaut um 1840, Lithografie um 1840

Früh in den Kreis der Clebsch-Schüler eingebunden, engagierte sich Schubert bereits im Comité, welches die 1873 in Göttingen stattfindende Mathematiker-Versammlung vorbereitet hatte und „die gesamte deutsche Mathematik ohne Unterschied der Richtungen“ vereinen wollte (Bericht, 1873, S. 315). Schubert war nach seiner Promotion (1870 in Halle) Gymnasiallehrer in Hildesheim geworden. Welche Rolle herausragende, forschende Gymnasiallehrer für den mathematischen Nachwuchs spielen können, zeigt das Beispiel der Hurwitz-Brüder, die hier von Schubert gefördert wurden (vgl. jüngst Steuding & Oswald, 2014).

Als Schubert im Jahre 1876 als Gymnasialprofessor an das Johanneum nach Hamburg wechselte, engagierte er sich in der hiesigen mathematischen Gesellschaft. Zwar wurde die Universität mit mathematischen Lehrstühlen erst 1919 gegründet, jedoch existierte seit 1690 die *Hamburger Mathematische Gesellschaft* (gegründet als „Kunstrechnung liebende

Societät“, seit 1790 „Gesellschaft zur Verbreitung der mathematischen Wissenschaften in Hamburg“; 1877 „Mathematische Gesellschaft in Hamburg“), die allgemein anerkannt als erste fachspezifische mathematische Gesellschaft im internationalen Rahmen gilt. Sie gab Lehr- und Handbücher, Tabellenwerke und eine Zeitschrift (Mitteilungen seit 1872) heraus. Hermann Schubert übernahm hier eine führende Position und publizierte auch Ergebnisse in den Mitteilungen.

Als das Unternehmen Deutsche Mathematiker-Vereinigung definitive Gestalt annahm und die Bremer Naturforscherversammlung 1890 vorbereitet wurde, gehörte Hermann Schubert zu denjenigen, die Felix Klein für ein in Bremen zu wählendes Comité empfahl. Klein schrieb am 15. Juni 1890 an Paul Gordan (1837–1912):

> Bremen läßt sich jetzt so an, daß ich befürworte
>
> 1) Möglichst zahlreichen Besuch seitens unserer Freunde, womöglich so, dass seitens derselben jetzt schon Vorträge angemeldet werden...
> 2) Später Wahl eines 4gliedrigen Comités aus den in Bremen anwesenden Herren, welche die nächstjährige math. Section zweckmäßig vorbereiten sollen. Ich beantrage 2 norddeutsche und 2 süddeutsche Mitglieder, also etwa einerseits G. Cantor und (wenn Kronecker nicht zu haben sein sollte) Schubert, andererseits Dyck und Königsberger, oder wenn K. nicht kommt, wie ich fast glaube, Lüroth ... (erstmals zitiert in Tobies & Rowe, 1990, S. 23).

In ähnlicher Weise hatte Klein dazu am 12. Juni 1890 schon an Georg Cantor geschrieben (E4/1 40; zitiert in Tobies & Volkert, 1998, S. 142f.).[1] Schubert selbst stand zu diesem Zeitpunkt bereits mit Cantor in Kontakt, der ebenfalls die Teilnahme von Gymnasiallehrern befürwortete und ihn besonders informiert hatte. In einem Brief vom 8. Mai 1890, den Schubert an Cantor schrieb, lesen wir:

> Selbstverständlich bin ich mit allem nicht bloß einverstanden, sondern ich sehe endlich einen Lieblingswunsch erfüllt, den ich, seitdem wir die 1873er Göttinger Versammlung veranstalteten, immerzu gehegt habe. Aber die Mathematiker, mit denen ich gelegentlich bei meinen Reisen sprach, bissen nicht initiatif [sic!] genug an. Ich werde also nach Bremen kommen, und mich ganz der Mathematiker-Versammlung widmen. Wir Nichtuniversitäts-Mathematiker fühlen noch mehr, als die Univ.-Math., das Bedürfnis nach persönlicher Anregung (E4/1 48, zitiert in Tobies & Volkert, 1998, S. 148).

Schubert unterbreitete detaillierte Vorschläge, welche Gymnasiallehrer einzuladen seien und welche nicht. An der Tagung in Bremen, meinte er, könnten ausnahmsweise die an höheren Schulen tätigen studierten Mathematiklehrer teilnehmen, „auch wenn sie nicht produktiv sind oder waren“. Ansonsten plädierte er dafür, Gymnasiallehrer nur dann einzuladen, wenn sie nach der Dissertation auch weiterhin mathematisch produktiv tätig gewesen sind.[2]

[1] Die zitierten Originaldokumente stammen aus dem Archiv der Deutschen Mathematiker-Vereinigung, welches sich im Universitätsarchiv Freiburg befindet; Akte E4/1 ist das Korrespondenzbuch „Vereinigung deutscher Mathematiker“ 1873, 1889–1895; vgl. (Remmert, 1999, S. 15).

[2] Schuberts Briefe an Cantor sind ausführlich zitiert in (Tobies & Volkert, 1998, S. 119f & 148); Originale befinden sich im Freiburger Universitätsarchiv; s. Fußnote 1.

Schubert wurde in Bremen in das Comité gewählt und gehörte dem Vorstand der DMV bis zum Jahre 1893 an. Als sich die Gesellschaft deutscher Naturforscher und Ärzte (GDNÄ) für Hamburg als Versammlungsort 1901 entschied, wurde Schubert Organisator der mathematisch-astronomischen Abteilung dieser Gesellschaft. Dass er als Organisator dieser Abteilung zunächst kaum Kontakt mit dem aktuellen DMV-Vorstand (Vorsitz Walther Dyck) gesucht hatte, geht aus einem Brief hervor, den August Gutzmer am 12. März 1901 an Felix Klein richtete:

> Die Erweiterung der Jahresberichte wird jetzt im Vorstande erörtert, nachdem ich über den Plan eine ausführliche Mitteilung gemacht habe. Vielleicht kommt diese Angelegenheit auch auf der Leipziger Conferenz zur Sprache, die ja allerdings eigentlich der Vorbereitung der Hamburger Versammlung gewidmet ist. Mit dieser Versammlung liegt es anscheinend schlimmer denn je: Schubert hat sich nur den Namen des gegenwärtigen Vorsitzenden geben lassen, im übrigen meines Wissens von der Vereinigung nicht Notiz genommen. Vermutlich ladet die Abteilung von sich aus (ohne Vereinigung) ein; dann werden wir natürlich sogleich von uns aus einladen müssen (zitiert in Tobies, 1988, S. 43).

Die Hamburger Tagung verlief offensichtlich gut, wenn auch die Naturforscher und Ärzte insgesamt gewaltige Festlichkeiten mitorganisierten.[3] Hermann Schubert fungierte als erster Einführender der erwähnten mathematisch-astronomischen Abteilung (Bericht, 1902, S. 4). Außerdem hielt er einen Vortrag aus seinem Forschungsfeld „Über die Konstantenzahl der n-dimensionalen Verallgemeinerung des Polyeders“, der im Jahresbericht der DMV abgedruckt wurde (Schubert, 1902). Das in Hamburg verabschiedete neue Programm des Jahresberichts spiegelte sich im Inhalt dieses Bandes 11 bereits deutlich.

Hermann Schubert wurde—neben August Gutzmer—in Hamburg für drei Jahre (bis Ende 1904) in den wissenschaftlichen Ausschuss der GDNÄ gewählt (Bericht, 1902, S. 9). Schubert blieb aktiv, publizierte weiterhin auch im Jahresbericht der DMV und gehörte zum Ausschuss, der am 20. April 1903 in Heidelberg erstmals zusammentrat, um den III. Internationalen Mathematiker-Kongress vorzubereiten. Er war als einer der Einführenden für die *Section VI (Mathematische) Pädagogik*, gemeinsam mit Peter Treutlein (1845–1912), vorgesehen (Krazer, 1905, S. 3–5).

Bibliographische Angaben finden sich im „Gemeinsamen Literaturverzeichnis“ auf S. 59.

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[3] Vgl. Löwe (2015).

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Einige Erinnerungen an die DMV-Jahrestagung 1979 in Hamburg

Ernst Bönecke

Die Hamburger Mathematiker waren sehr erfreut, als die Deutsche Mathematiker-Vereinigung beschloss, die Jahrestagung 1979 in Hamburg abzuhalten, insbesondere, da Hamburg im Jahr zuvor bei der Zuteilung des *Internationalen Mathematikerkongresses* (ICM) der Internationalen Mathematischen Union (IMU) für 1982 leer ausgegangen war. Seit 1904 hatte kein ICM mehr in Deutschland stattgefunden. Es hatte 1978 in Helsinki eine Entscheidung gegeben, bei der Hamburg in der letzten Runde gegen Warschau ausgeschieden war. Mit dem ICM 1998 in Berlin fand dann nach einer weiteren, erfolglosen, Bewerbung von München wieder ein ICM in Deutschland statt.

In Vorbereitung auf die Jahrestagung berief der Fachbereich eine örtliche Tagungsleitung, bestehend aus Walter Benz, Ernst Bönecke, Helmut Brückner, Helmut Müller, und Oswald Riemenschneider. Wir waren stolz darauf, die Tagung in unserem Dienstgebäude durchführen zu können, dem Geomatikum, das wir erst vier Jahre zuvor (gemeinsam mit dem Fachbereich Geowissenschaften) bezogen hatten, und das neben sechs Hörsälen zahlreiche kleinere Übungsräume bietet. Das Geomatikum steht auch heute noch, aber die Fassade bröckelt, und rundherum werden neue Institutsgebäude für die Universität gebaut, so dass man sich zur Zeit den Zugang zum Gebäude zwischen Bauzäunen suchen muss. Da sind die Hörsäle im Uni-Hauptgebäude an der Edmund-Siemers-Allee für die jetzige Tagung die bessere Wahl. Dort belegt der *Emil-Artin-Hörsaal* (in dem z.B. in diesem Jahre die Mitgliederversammlung der DMV stattfinden wird) mit einer zu seinen Lebzeiten entstandenen Maske von Artin den Stolz der Universität Hamburg auf ihren berühmten Mathematiker.

Totenmaske von Emil Artin (im Besitz von Oswald Riemenschneider)

Als Organisatoren hatten wir einige Vorschläge für die Hauptvortragenden gemacht, mussten aber schnell feststellen, dass das Präsidium der DMV schon genaue eigene Vorstellungen hatte. So blieben wir hauptsächlich mit der praktischen Durchführung der Tagung beschäftigt. Man erinnere sich, dass wir damals noch kaum auf die Hilfe von Computern zurückgreifen konnten. Für die Eingänge der Tagungsgebühren führten wir handgeschriebene Listen—bei über 300 Teilnehmern zeitraubend.

Wie auch dieses Jahr hatte die DMV schon im Jahre 1979 vorgeschlagen, die geographische Lage Hamburgs zu nutzen, um die Beziehungen zu den skandinavischen Mathematikern zu intensivieren, etwa dadurch, dass die dänischen Mathematiker ihre Jahrestagung

in Hamburg durchführen. Dazu kam es zwar nicht, aber unter den eingeladenen Hauptvortragenden waren zwei aus Schweden und einer aus Norwegen.

Die mathematischen Vorträge fanden nach dem klassischen Muster statt: Morgens zwei bis drei Hauptvorträge von eingeladenen Sprechern, nachmittags sechzig 20-minütige Sektionsvorträge in zwei parallelen Sektionen. Daneben wurden im Rahmen der Jahrestagung erstmalig zwei *Arbeitsgemeinschaften* durchgeführt: vier zweistündige Vorlesungen, eine über „Algebraische Theorie der quadratischen Formen“ (M. Knebusch & W. Scharlau) und eine über „Konvexität in der komplexen Analysis“ (K. Diederich & I. Lieb). Diese wurden in der neuen Serie „DMV-Seminare“ veröffentlicht, später dann, getrennt von der DMV-Tagung, als „Oberwolfach-Seminare“, weitergeführt und letztlich durch die „Mini-Symposien“ ersetzt. Am Freitag nachmittag gab es zusätzlich ein Kolloquium über Fragen der Lehrerausbildung, finanziert durch das Institut für Lehrerfortbildung.

Finanziert wurde die Tagung durch die Tagungsgebühren (20 DM für Mitglieder), durch Spenden aus der Hamburger Wirtschaft und einen Beitrag des Hamburger Senats. Wir hatten nicht viele Kosten. Die Buchung der Unterkünfte erledigte für uns die Hamburger Fremdenverkehrszentrale. Das Rahmenprogramm bestand aus einem kleinen Senatsempfang im Rathaus, einer Stadtrundfahrt, einer Schifffahrt ins Alte Land und zum Schulauer Fährhaus, einer Werftbesichtigung, einem Opernbesuch und einer Besichtigung des Deutschen Elektronen-Synchrotrons in Bahrenfeld. Außerdem hatten wir Vorschläge für Wanderungen an Alster und Elbe aufgeschrieben—das Echo dafür war gering, da es während der Tagung meistens regnete. So bekamen die Teilnehmer einen realistischen Eindruck vom Leben in Hamburg. Hoffen wir, dass sich in diesem Jahr der Herbst von einer besseren Seite zeigt!

Hauptvortragende.

Montag, 17.9.1979, 10:15–11:15. M. Knebusch (Regensburg), *Signaturen, reelle Stellen und reduzierte quadratische Formen.*

Montag, 17.9.1979, 11:30–12:30. K. Diederich (Wuppertal), *Konvexität in der komplexen Analysis: neuere Ergebnisse.*

Dienstag, 18.9.1979, 9:00–10:00. H. Amann (Kiel), *Funktionalanalysis und nichtlineare Differentialgleichungen.*

Dienstag, 18.9.1979, 10:15-11:15. H.-O. Kreiss (Uppsala), *Numerical methods for hyperbolic partial differential equations.*

Dienstag, 18.9.1979, 11:30–12:30. V. Baumann (Bochum), *Stand und Möglichkeit einer Weiterentwicklung der mathematischen Statistik.*

Mittwoch, 19.9.1979, 9:00–10:00. J. Elstrodt (Münster), *Die Selbergsche Spurformel für kompakte Riemannsche Flächen.*

Mittwoch, 19.9.1979, 10:30-11:30. J. W. S. Cassels (Cambridge), *Rationale quadratische Formen.*

Donnerstag, 20.9.1979, 9:00–10:00. H. H. Schaefer (Tübingen), *Ordnungsstrukturen in der Operatorentheorie.*

Donnerstag, 20.9.1979, 10:30–11:30. L. Gårding (Lund), *Microlocal analysis of distributions.*

Freitag, 21.9.1979, 9:00-10:00. E. Vogt (Berlin), *Blätterungen, deren Blätter alle kompakt sind.*

Freitag, 21.9.1979, 10:15–11:15. J. F. Fenstad (Oslo), *Non-standard methods in stochastic analysis and mathematical physics.*

Freitag, 21.9.1979, 11:30–12:30. D. T. Whiteside (Cambridge), *Isaac Newton: Dynamic Mathematician.*

Sektionsvorträge in alphabetischer Reihenfolge der Vortragenden: D. Abts (Aachen), *Abbildungseigenschaften holomorpher Fredholmabbildungen in komplexen Banachräumen.* B. Anger (Erlangen), *Fortsetzung von Linearformen mit strikter Majorisierung auf lokalkompakten Kegeln.* W. Balser (Ulm), *Darstellung von Lösungen meromorpher Differentialgleichungen als Laplace-Integrale.* G. Becker (Göttingen), *Optimale Beobachtungsschemata für eine Familie von Zählprozessen.* G. Boese (München), *Einschließung sämtlicher Nullstellen von Partialbruchsummen und Exponentialpolynomen durch Kreisbogenpolygonbereiche bzw. durch Polygonbereiche.* H. Brandenburg (Berlin), *Charakterisierungen entwickelbarer topologischer Räume.* A. Brandis (Heidelberg), *Verlagerungstheorie endlicher Gruppen.* R. Braun (Tübingen), *Ein Gelfand-Naimark-Theorem für* C^**-Tripel.* H. Brunotte (Essen), *Metrische Kennzeichnung von Erzeugenden für Einheitengruppen vom Rang 1 oder 2 in algebraischen Zahlkörpern.* P. Bundschuh (Köln), *Zwei Resultate über transzendente Zahlen.* V. Dembinski (Düsseldorf), *Austrittskerne und Quasilinksstetigkeit von standard Markow-Prozessen.* M. Denker (Göttingen), *Über das Gesetz vom iterierten Logarithmus und eine Anwendung.* R. Felix (München), *Über Distributionen, die unter einer unitären Gruppenoperation invariant sind.* K.-J. Förster (Braunschweig), B. Mahr (Berlin), *Über die polynomiale Äquivalenz zwichen dem Graph-Isomorphie-Problem und dem Cliquen-Problem für spezielle Graphenklassen.* W. Freeden (Aachen), *Über gewichtete Gitterpunktsummen in Kreisbereichen.* G. Freiling (Duisburg), *Mehrpunkt-Eigenwertprobleme.* T. Hanschke (Freiburg), *Berechnung von Grenzwahrscheinlichkeiten bei Competitionprozessen mit Hilfe des Jacobi-Perron-Algorithmus.* E. Hartmann (Darmstadt), *Minkowski-Ebenen über Permutationsgruppen.* N. C. Heldermann (Berlin), *Über eine systematische Verallgemeinerung der Metrisierbarkeit topologischer Strukturen.* R. W. Henrichs (München), *Extremalpunkte, Seiten und Zerlegung nichtseparabler* C^**-Algebren.* E. Heppner (Frankfurt a.M.), *Über die Anzahl der natürlichen Zahlen* $n \leq x$*, für die jede Gruppe der Ordnung* n *auflösbar ist.* G. Hetzer (Aachen), *Ein Existenzsatz für das periodische Randwertproblem bei gewöhnlichen, semidissipativen Differentialgleichungen in einem Hilbertraum.* U. Höhle (Wuppertal), *Minkowskifunktionale von L-unscharfen Teilmengen.* M. Hortmann (Kaiserslautern), *Globale holomorphe Kerne zur Lösung der Cauchy-Riemannschen Differentialgleichungen.* A. Janssen (Dortmund), *Ein verallgemeinertes Reinheitsgesetz für das abzählbare Faltungsprodukt diskreter Wahrscheinlichkeitsmaße.* G. Jung (Tübingen), *Negation in der geometrischen Logik.* V. Kasten (Hannover), *Die Koeffizientenkörper der im Einheitskreis schlichten Trinome.* N. Kiesow (Bochum), *Einbettung differenzierbarer und reell-analytischer Räume in Mannigfaltigkeiten minimaler Dimension.* F. Kirchheimer (Freiburg), *Explizite Präsentation gewisser Hilbertscher Modulgruppen durch Erzeugende und Relationen.* H.-J. Klemmt

(Clausthal), *Asymptotische Entwicklungen für kanonische Weierstraßprodukte und Riemanns Überlegungen zur Nullstellenanzahl der Zetafunktion.* E. Knobloch (Berlin), *Einfluß der Symbolik und des Formalismus auf die Entwicklung des mathematischen Denkens.* W. Kratz (Ulm), *Ein Algorithmus zur Berechnung von simultanen diophantischen Approximationen in Dimension* $n = 2^M$. E. Kremer (Hamburg), *Lokale Bahadur-Effizienz linearer Vorzeichen-Rangtests.* R. Laue (Aachen), *Untergruppen linearer Gruppen.* G. Leha (Erlangen), *Gibbs-Darstellungen bedingter Wahrscheinlichkeiten.* H. Lindinger (München), *Das totale Differential von Matrixfunktionen.* U. Moller-Funk (Freiburg), *Benachbartheit, asymptotische Normalität und Limestrennschärfen von Testfolgen.* V. Müller-Horrig (Frankfurt a.M.), *Fredholmspektren verbundener Operatoren.* A. Oberschelp, G. Todt (Kiel), *Zur Definition geordenter Paare.* F. Pukelsheim (Freiburg), *Charakterisierungen* c*-optimaler stetiger Versuchspläne.* A. Reich (Göttingen), *Werteverteilung von Zetafunktionen.* N. Reidel (München), *Spektraltheorie in geordneten Vektorräumen.* P. Rentrop (München), *Ein Algorithmus zur Berechnung des Exponentialsplines.* G. Richter (Bielefeld), *Die varietale Hülle eines Funktors.* U. Rösler (Göttingen), *Nicht-negative harmonische Funktionen für eine Klasse von Diffusionen.* L. Rüschendorf (Aachen), *Verteilungskonvergenz gewichteter empirischer Prozesse.* G. Schiffels (Bielefeld), *Zur Fortsetzung von Ringtopologien auf Quotientenringe.* G. Schmieder (Hannover), *Über den Zusammenhang zwischen lokaler und globaler Schlichtheit bei Trinomen im Einheitskreis.* R. Schöneberg (Aachen), *Zeros of m-accretive Operators in Banach Spaces.* V. Schulze (Berlin), *Potenzreste.* E. Sperner jr. (Bayreuth), *Nichtlineare elliptische Differentialgleichungen in singulären Gebieten.* W. Stork (Frankfurt a.M.), *Lipschitz-stetige Störungen selbst-adjungierter Fredholm-Operatoren.* E. M. Schröder (Hamburg), *Kennzeichnung der affin-metrischen Geometrien.* H. Weber (Konstanz), *Die atomare Struktur schwach s-beschränkter Inhalte.* H. J. Weinert (Clausthal), *Über links, rechts, und zweiseitig kürzbare Elemente von Halbgruppen.* E.-A. Weiss (Erlangen), *Endliche-additive Maße in der Mathematischen Wirtschaftstheorie.* W. Wiesław (Bielefeld), *Idealtopologien auf Ringen.* K. E. Wolff (Giessen), *Punkt-stabile Inzidenzstrukturen mit höchstens 3 Eigenwerten.* P. Zahn (Darmstadt), *Ein argumentativer Weg zur Wohlordnung.* L. Zsidó (Münster), *Zusammenhang zwischen Automorphismengruppen und Faktorisation.*

Ernst Bönecke war bis zu seiner Pensionierung im Jahre 2009 am Fachbereich Mathematik der Universität Hamburg als akademischer Oberrat tätig. Dieser Artikel ist in Zusammenarbeit mit Oswald Riemenschneider entstanden.

Gemeinsames Literaturverzeichnis

Bericht (1873). Bericht über die Mathematiker-Versammlung zu Göttingen am 16., 17. und 18. April 1873. *Zeitschrift für mathematischen und naturwissenschaftlichen Unterricht*, 4:313–316.

Bericht (1894). Bericht über die Jahresversammlung zu München, 5.–9. September 1893. *Jahresbericht der Deutschen Mathematiker-Vereinigung*, 3:3–7.

Bericht (1901). Bericht über die Jahresversammlung zu Aachen am 16. bis 23. September 1900. *Jahresbericht der Deutschen Mathematiker-Vereinigung*, 9:3–8.

Bericht (1902). Bericht über die Jahresversammlung zu Hamburg am 22. bis 28. September 1901. *Jahresbericht der Deutschen Mathematiker-Vereinigung*, 11:4–8.

Bericht (1929). Bericht über die Jahresversammlung in Hamburg, 16.–23. September 1928. *Jahresbericht der Deutschen Mathematiker-Vereinigung*, 38:1–50.

Burau, W. (2008). Schubert, Hermann Cäsar Hannibal. In: Gillispie, C. C., Holmes, F. L., & Koertge, N. (Hrsgg.), *Complete Dictionary of Scientific Biography*. Charles Scribner's Sons, Detroit.

Burau, W. & Renschuch, B. (1993). Ergänzungen zur Biographie von Hermann Schubert. *Mitteilungen der Mathematischen Gesellschaft in Hamburg*, 13:63–65.

Einladung (1901). *Einladung zur 73. Versammlung Deutscher Naturforscher und Aerzte in Hamburg. 22. bis 28. September 1901.* Lütcke & Wulff, Hamburg.

Gericke, H. (1972). *50 Jahre GAMM. Im Auftrag und unter Mitwirkung des Fachausschusses für die Geschichte der GAMM*, Band 105 der Reihe *Veröffentlichungen des Forschungsinstituts des Deutschen Museums für die Geschichte der Naturwissenschaften und der Technik, Reihe A: Kleine Mitteilungen.* Springer, Berlin.

Gispert, H. (1991). *La France mathématique: la Société mathématique de France, 1870-1914*, Band 34 der Reihe *Cahiers d'histoire & de philosophie des sciences, nouvelle série.* Société mathématique de France, Paris.

Gispert, H. & Tobies, R. (1996). A comparative study of the French and German Mathematical Societies before 1914. In: Goldstein, C., Gray, J., & Ritter, J. (Hrsgg.), *Europe mathématique. Histoires, Mythes, Identités*, Librairie européenne des idées, S. 409–430. Editions de la Maison des sciences de l'homme, Paris.

Gutzmer, A. (1909). Geschichte der Deutschen Mathematiker-Vereinigung. Im Auftrage des Vorstandes für den III. Internationalen Mathematiker-Kongreß zu Heidelberg im August 1904. *Jahresbericht der Deutschen Mathematiker-Vereinigung*, 10(1):1–18.

Hashagen, U. (2003). *Walther von Dyck (1856–1834). Mathematik, Technik und Wissenschaftsorganisation an der TH München*, Band 47 der Reihe *Boethius. Texte und Abhandlungen zur Geschichte der Mathematik und der Naturwissenschaften*. Franz Steiner Verlag, Stuttgart.

Heineke, W. (1972). Europas Physiker in Wiesbaden. *Physikalische Blätter*, 28(9):385–387.

Krazer, A. (Hrsg.) (1905). *Verhandlungen des dritten internationalen Mathematiker-Kongresses in Heidelberg vom 8. bis 13. August 1904*. Teubner, Leipzig.

Lehto, O. (1998). *Mathematics without borders. A history of the International Mathematical Union*. Springer, New York.

Löwe, B. (2015). Die ersten beiden Hamburger DMV-Jahresversammlungen 1901 und 1928. In: Löwe, B. & Niehaus, H. (Hrsgg.), *Jahrestagung der Deutschen Mathematiker-Vereinigung, Freie und Hansestadt Hamburg, 21. bis 25. September 2015*, S. 39–50. Verein zur Ausrichtung von Tagungen am Fachbereich Mathematik der Universität Hamburg, Hamburg.

Mehrtens, H. (1987). Ludwig Bieberbach und die ‚Deutsche Mathematik'. In: Phillips, E. R. (Hrsg.), *Studies in the History of Mathematics*, Band 26 der Reihe *MAA Studies in Mathematics*, S. 195–241. Mathematical Association of America, Washington D.C.

Physikalische Blätter (1962). Tagungen der Naturforscher und Physiker. Neuordnung bei den physikalischen Gesellschaften/Fraunhofer-Gesellschaft. *Physikalische Blätter*, 18(9):423–426.

Purkert, W. & Ilgauds, H. J. (1987). *Georg Cantor: 1845–1918*, Band 1 der Reihe *Vita Mathematica*. Birkhäuser, Basel.

Regierungsrat Maass (Hrsg.) (1928). *90. Versammlung deutscher Naturforscher und Ärzte. Hamburg / 16.-22. September 1928. Versammlungshandbuch*. Chr. Adolff, Altona-Ottensen.

Reid, C. (1996). *Hilbert*. Springer, New York.

Remmert, V. R. (1999). *Bestand E 0004, Deutsche Mathematiker-Vereinigung, 1889–1987*, Band 2 der Reihe *Findbücher aus dem Universitätsarchiv Freiburg*. Universitätsarchiv der Albert-Ludwigs-Universität, Freiburg.

Remmert, V. R. & Schneider, U. (2010). *Eine Disziplin und ihre Verleger. Disziplinenkultur und Publikationswesen der Mathematik in Deutschland, 1871–1949*. Mainzer historische Kulturwissenschaften. transcript Verlag, Bielefeld.

Schappacher, N. & Kneser, M. (1990). Fachverband—Institut—Staat. In: Fischer, G., Hirzebruch, F., Scharlau, W., & Törnig, W. (Hrsgg.), *Ein Jahrhundert Mathematik 1890–1990. Festschrift zum Jubiläum der DMV*, Band 6 der Reihe *Dokumente zur Geschichte der Mathematik*, S. 1–82. Friedrich Vieweg & Sohn, Braunschweig.

Schimmack, R. (Hrsg.) (1907). *F. Klein, Vorträge über den mathematischen Unterricht an den höheren Schulen, Teil 1: Von der Organisation des mathematischen Unterrichts*. Teubner, Leipzig.

Schubert, H. (1902). Über die Konstantenzahl der n-dimensionalen Verallgemeinerung des Polyeders. *Jahresbericht der Deutschen Mathematiker-Vereinigung*, 11:217–222.

Schubring, G. (2010). 120 Jahre Deutsche Mathematiker-Vereinigung. Neue Ergebnisse zu ihrer Geschichte. *Mitteilungen der Deutschen Mathematiker-Vereinigung*, 18:103–108.

Siegmund-Schultze, R. (1993). *Mathematische Berichterstattung in Hitlerdeutschland. Der Niedergang des ‚Jahrbuchs über die Fortschritte der Mathematik'.* Vandenhoeck & Ruprecht, Göttingen.

Steuding, J. J. & Oswald, N. M. R. (2014). Complex continued fractions—Early work of the brothers Adolf and Julius Hurwitz. *Archive for History of Exact Sciences*, 68:499–528.

Tobies, R. (1988). Zu den Bestrebungen von August Gutzmer, die Anwendungen der Mathematik zu fördern. In: Jena, D. (Hrsg.), *Wissenschaft und Erfahrung*, Band 5 der Reihe *Alma Mater Jenensis. Studien zur Hochschul- und Wissenschaftsgeschichte*, S. 31–50. Friedrich-Schiller-Universität Jena, Jena.

Tobies, R. (1991). Warum wurde die Deutsche Mathematiker-Vereinigung innerhalb der Gesellschaft deutscher Naturforscher und Ärzte gegründet? Mathematiker-Briefe zur Gründungsgeschichte der DMV. *Jahresbericht der Deutschen Mathematiker-Vereinigung*, 93:30–47.

Tobies, R. (1994). Mathematik als Bestandteil der Kultur-—Zur Geschichte des Unternehmens ‚Encyklopädie der mathematischen Wissenschaften mit Einschluss ihrer Anwendungen'. *Mitteilungen der Österreichischen Gesellschaft für Wissenschaftsgeschichte*, 14:1–90.

Tobies, R. (1996). Physikalische Gesellschaft und Deutsche Mathematiker-Vereinigung. In: Hoffmann, D., Bevilacqua, F., & Stuewer, R. H. (Hrsgg.), *The emergence of modern physics: Proceedings of a conference commemorating a century of physics, Berlin, 22–24 March 1995*, Collana di storia della scienza: Serie gialla, S. 479–494. Università degli studi di Pavia, Pavia.

Tobies, R. (1998). Die Suche der Mathematiker nach Wegen für die wissenschaftliche Kommunikation im nationalen Rahmen. In: Tobies, R. & Volkert, K. (Hrsgg.), *Mathematik auf den Versammlungen der Gesellschaft Deutscher Naturforscher und Ärzte, 1843–1890*, Band 7 der Reihe *Schriftenreihe zur Geschichte der Versammlungen Deutscher Naturforscher und Ärzte*, S. 125–157. Wissenschaftliche Verlagsgesellschaft, Stuttgart.

Tobies, R. (1999). Felix Klein und David Hilbert als Förderer von Frauen in der Mathematik. *Prague Studies in the History of Science and Technology*, 3:69–101.

Tobies, R. (2000). „allen Parteien in der Mathematik offen sein". Die Entstehung der DMV-Mitteilungen. *Mitteilungen der Deutschen Mathematiker-Vereinigung*, 8(1):43–48.

Tobies, R. (2003). *Mathematik-Promovierende an der Universität Halle im Vergleich mit Promovierenden an anderen Orten, 1907 bis 1945*, Band 01-2003 der Reihe *Reports on Didactics and History of Mathematics.* Martin-Luther-Universität Halle-Wittenberg, Halle.

Tobies, R. (2015). Hermann Schubert, die DMV und Hamburg. In: Löwe, B. & Niehaus, H. (Hrsgg.), *Jahrestagung der Deutschen Mathematiker-Vereinigung, Freie und Hansestadt Hamburg, 21. bis 25. September 2015*, S. 51–53. Verein zur Ausrichtung von Tagungen am Fachbereich Mathematik der Universität Hamburg, Hamburg.

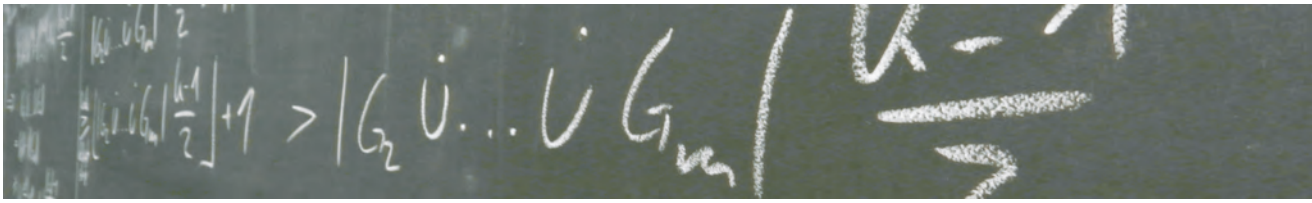
Tobies, R. & Rowe, D. E. (1990). *Korrespondenz Felix Klein–Adolph Mayer. Auswahl aus den Jahren 1871 bis 1907*, Band 14 der Reihe *Teubner-Archiv zur Mathematik*. Teubner, Leipzig.

Tobies, R. & Volkert, K. (Hrsgg.) (1998). *Mathematik auf den Versammlungen der Gesellschaft Deutscher Naturforscher und Ärzte, 1843–1890*, Band 7 der Reihe *Schriftenreihe zur Geschichte der Versammlungen Deutscher Naturforscher und Ärzte*. Wissenschaftliche Verlagsgesellschaft, Stuttgart.

Toepell, M. (1991). *Mitgliederverzeichnis der Deutschen Mathematiker-Vereinigung 1890-1990*. Institut für Geschichte der Naturwissenschaften, München.

van Dalen, D. (1990). The war of the frogs and the mice, or the crisis of the *Mathematische Annalen*. *Mathematical Intelligencer*, 12(4):17–31.

von Dyck, W., Gutzmer, A., Hilbert, D., Mehmke, R., Meyer, F., Minkowski, H., & Weber, H. (1902). Über die neuen Aufgaben des Jahresberichts der Deutschen Mathematiker-Vereinigung. *Jahresbericht der Deutschen Mathematiker-Vereinigung*, 11:1–3.



Hauptvortragende / Keynote Speakers

Topological quantum field theory in low dimensional topology

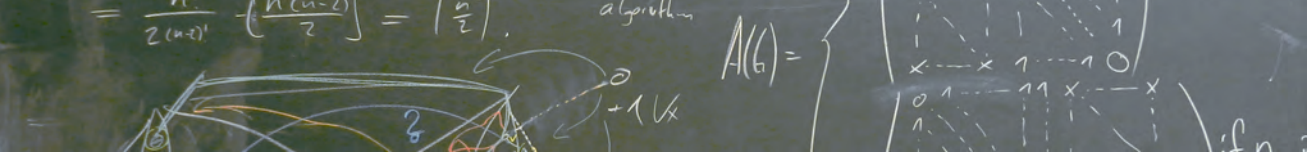
Jørgen Ellegaard Andersen
Aarhus University, Denmark

In physics, Quantum Field Theory (QFT) has been very successful in describing fundamental particle physics. Mathematically, these quantum field theories still possess enormous challenges. So far there are no mathematical definitions of these theories. These QFT's have however analogous theories, which are considerably simpler and which can be defined mathematically. Among these are the so-called Topological Quantum Field Theories (TQFT) which are purely topological in nature as indicated by their name. For TQFT's, the only non-trivial evolution happens when the space itself, on which the theories are considered, undergoes topological changes. This is atypical for general states of a proper physical QFT, however for the ground states of QFT, this is in general the physical expectation.

From a mathematical point of view, these theories are very exciting, since they can be mathematically defined, thus studied mathematically and one can in certain cases prove many of the physics predicted properties. Further, one can use these theories to provide new topological invariants and they give rise to representations of the symmetry groups of the underlying topological spaces, thus they become interesting from a purely mathematical point of view as well.

This has been particularly successful in low dimensional topology and there has been a very interesting interplay between topology on the one hand and properties of TQFT's on the other. This has lead to further insight into the influence of the global topology of space time on the possible ground states for general QFT's. In particular, as a somewhat unexpected by-product, new efficient TQFT models for quantum computers has in this way been identified.

In this talk we shall review some of these TQFT's, discuss how they are linked to low dimensional topology and on the way touch on their applications towards quantum computing.



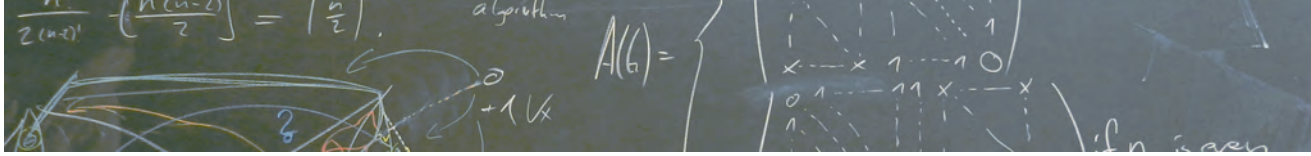
Meromorphic Maass forms

Kathrin Bringmann
Universität Köln, Germany

Seit 2008 gibt es bei den Jahrestagungen der Deutschen Mathematiker-Vereinigung eine *Emmy Noether-Vorlesung*. Für diese herausgehobenen Plenarvorträge werden jeweils exzellente Mathematikerinnen aus Deutschland ausgewählt, deren wissenschaftliches Werk damit besonders gewürdigt wird; sie präsentieren im Vortrag ihre aktuelle Forschung. Die Emmy Noether-Vorlesung 2015 wird von Katrin Bringmann gehalten.

Classical modular forms are holomorphic functions that are meromorphic at the cusps and satisfy nice modular symmetries. Harmonic Maass forms are real-analytic generalizations thereof in that instead of being holomorphic they are annihilated by the weight k Laplace operator. These functions generalize Maass waveforms, which are of weight 0 and decay in the cusps. Recently there has been an active interest in harmonic Maass forms, as their holomorphic parts (so-called mock modular forms) naturally occur in various areas of mathematics and physics. The probably most famous example of mock modular forms are given by Ramanujan's mock theta function which he introduced in his last letter to Hardy shortly before he died.

In this talk I instead consider Maass forms which are also allowed to have poles in the upper half plane and give various applications of such functions including Hardy-Ramanujan type formulas for meromorphic modular forms. All this is joint work with Ben Kane.

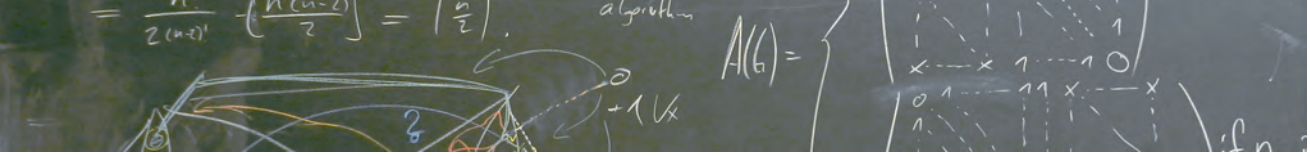


One-dimensional and three-dimensional protein spaces and protein evolution

Alessandra Carbone
Université Pierre et Marie Curie, France

In computational biology, a fundamental question is the extraction of evolutionary information from DNA sequences. We consider protein sequences here and we shall describe how a precise mapping between the one-dimensional representation of a protein (its sequence) and its three-dimensional representation (its structure) revealed important biological information on protein-protein binding sites and on mechanical and allosteric properties of proteins. Coupled with a reductionist physical model of molecular interaction, this mapping has been fundamental for discriminating protein partners, and considerably advancing on the problem of a computational reconstruction of a protein-protein interaction (PPI) network.

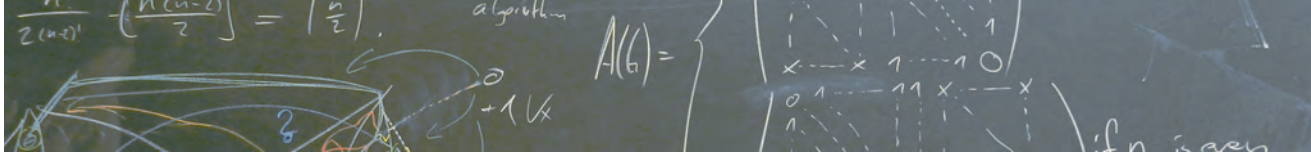
We recall that PPI are at the heart of the molecular processes governing life and constitute an increasingly important target for drug design. Given their importance, it is vital to determine which protein interactions have functional relevance and to characterize the protein competition inherent to crowded environments. Suitable mathematical approaches appear necessary to properly address these questions.



Minimal surfaces, isoperimetry, and non-negative scalar curvature in asymptotically flat manifolds

Michael Eichmair
Universität Wien, Austria

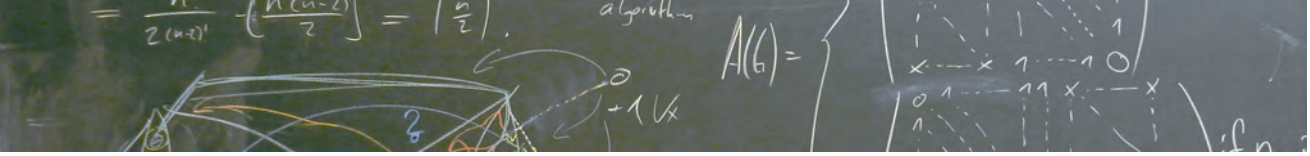
It is a classical observation that a small geodesic ball at a point of positive scalar curvature contains more volume than a round ball in Euclidean space that has the same surface area. In this talk, I shall describe several global effects of non-negative scalar curvature on the large-scale isoperimetric structure of asymptotically flat manifolds, including seminal contributions by H. Bray, G. Huisken, J. Qing, R. Schoen, G. Tian, and S.-T. Yau. I shall then discuss consequences of these phenomena for the space-times evolving from such manifolds according to the Einstein equations. My presentation will include recent joint work with S. Brendle, A. Carlotto, O. Chodosh, and J. Metzger.



PDEs on evolving domains

Charles M. Elliott
University of Warwick, England

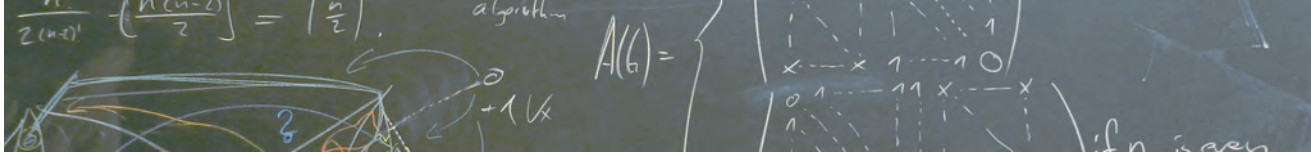
Mathematical models in many applications across the physical and life sciences involve partial differential equations on complex evolving domains. Often the domain is unknown leading to free boundary problems. I shall discuss the variational formulation of parabolic equations posed on evolving surfaces. These surface PDEs are usually coupled to equations for the surface involving geometric quantities and surface energy functionals such the area or Willmore functionals. I shall discuss their numerical approximation using evolving surface finite elements. The context will be applications in cell biology involving biomembranes and cell motion.



Turing patterns: past and present

Björn Sandstede
Brown University, U.S.A.

In a seminal paper published in 1952, Alan Turing proposed a mechanism for the development of spots and stripes on animal coats that relies on the spontaneous formation of spatially periodic patterns based on diffusion and reaction of chemicals. These ideas have been tremendously influential not only in morphogenesis but also in other areas of biology, chemistry, and physics. I shall give an overview of Alan Turing's original idea, its mathematical manifestations, and its success in explaining many pattern-forming processes in nature. I shall also discuss recent efforts to model stripe formation on zebrafish that involve Turing's mechanism.

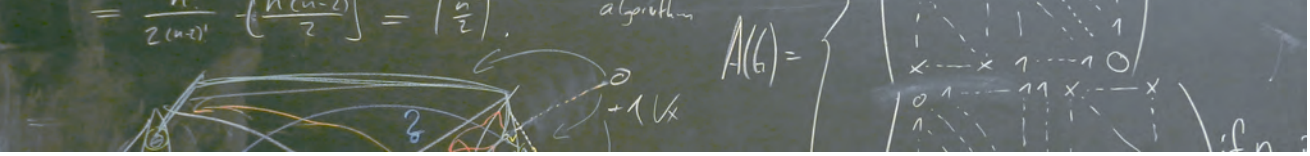


Interacting diffusions in the Kardar-Parisi-Zhang universality class

Herbert Spohn
Technische Universität München, Germany

The (one-dimensional) KPZ equation is a stochastic PDE describing the motion of growing fronts, generated when a stable phase is in contact with a metastable one. While the equation has been around since 1986, only recently we start to better understand its mathematical structure. In particular, the KPZ equation is a beautiful example for an integrable stochastic system. There are many other models which, either expected, numerically supported, or proved, have the same statistical properties as the KPZ equation when both are viewed on large space-time scales. I shall review the case of interacting diffusions. One can think of them as a collection of one-dimensional diffusions $x_j(t), j \in \mathbb{Z}$, where diffusion with label j interacts with its left neighbor, $x_{j-1}(t)$, and right neighbor, $x_{j+1}(t)$. In general, these models are expected to be in the KPZ universality class. But for a very particular choice of the interaction potential the model turns out to be integrable and thus allows for a deeper analysis.

Herbert Spohn wurde im Jahre 2014 die nach dem Gründungsvorsitzenden der Deutschen Mathematiker-Vereinigung benannte *Georg-Cantor-Medaille* verliehen. Die Georg-Cantor-Medaille wird seit 1990 höchstens jedes zweite Jahr für herausragende wissenschaftliche Leistungen in der Mathematik verliehen. Unter den vormaligen Preisträgern sind Jacques Tits, Yuri Manin und Friedrich Hirzebruch. Traditionsgemäß hält der Träger der Cantor-Medaille bei der auf die Preisverleihung folgenden Jahrestagung einen Hauptvortrag.



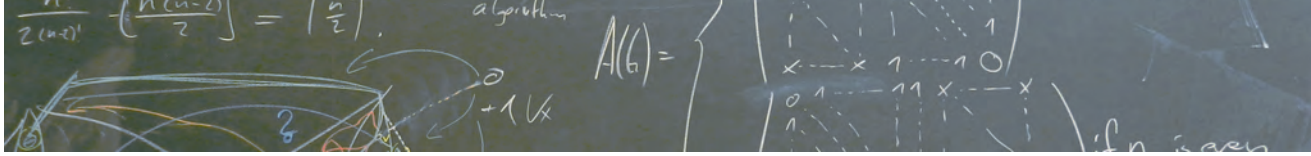
A descriptive view of infinite dimensional unitary representations

Simon Thomas
Rutgers University, U.S.A.

If G is a finite group, then G has finitely many irreducible finite dimensional representations, and each finite dimensional representation of G can be expressed uniquely as a direct sum of finitely many irreducible representations. Unfortunately, the basic theory of the infinite dimensional unitary representations of countably infinite groups is much less satisfactory. In particular, such a group typically has uncountably many irreducible infinite dimensional unitary representations. In this talk, I shall consider questions such as:

1. For which countably infinite groups G is it possible to classify its irreducible representations?
2. What does it mean to classify an uncountable set of irreducible representations?

Along the way, we shall see the representation theorists Mackey, Glimm and Efros making fundamental contributions to descriptive set theory, and the descriptive set theorists Kechris and Hjorth making fundamental contributions to representation theory.



Cycles in moduli spaces of graphs

Karen Vogtmann
University of Warwick, England
Cornell University, U.S.A.

Finite metric graphs are used to describe many phenomena in science, from phylogenetic trees in biology to Feynman diagrams in physics, so one would like to understand the spaces that parametrize such graphs. Techniques from geometric group theory have shown that the moduli space of all metric graphs with a fixed number of loops and marked points (or univalent vertices) is closely related to the group of automorphisms of a free group. Thus algebraic tools can be used to help understand the geometry and topology of these moduli spaces and, conversely, geometric tools can be used to help understand the algebraic structure of these automorphism groups. I shall discuss what we know about these spaces and groups, and then show how to bootstrap information about moduli spaces of graphs with a small number of loops to obtain new information about moduli spaces of larger graphs. This involves using tools from various different areas of mathematics, including group theory, algebraic topology, representation theory and modular forms.

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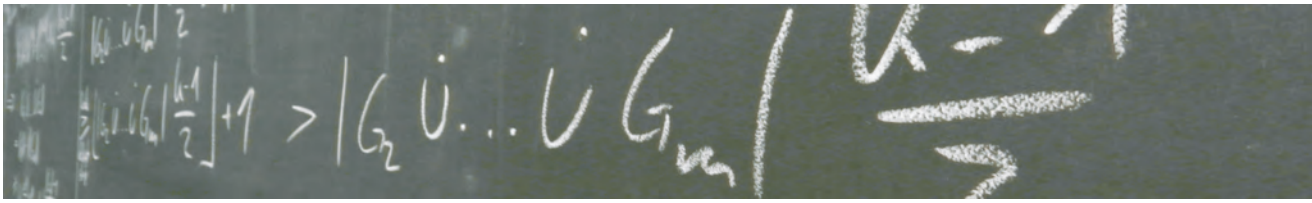


Sektionen / Sections

Sektion 1: Algebra & Zahlentheorie / Section 1: Algebra & Number Theory

Sektionsleitung / Coordination: Jens Carsten Jantzen (Aarhus), Christoph Schweigert (Hamburg)

Graded Brauer algebras and quantum symmetric pairs

Michael Ehrig
Rheinische Friedrich-Wilhelms-Universität Bonn, Germany

In this talk, I shall first recall the classical Brauer algebra and present a somewhat suprising fact relating the representation theory of Brauer algebras to evaluations of Kazhdan-Lusztig polynomials for special orthogonal Lie algebras.

To explain this connection, I shall introduce a category of representation for these Lie algebras with the Brauer algebra appearing as the endomorphism ring of a specific module. Using a graded analog of this category I shall explain how to equip this endomorphism ring with a grading and transfer this grading onto the Brauer algebra. This grading is inherently linked to Kazhdan-Lusztig theory and explains why the corresponding graded representation theory of this graded Brauer algebra is controlled by Kazhdan-Lusztig polynomials. Finally I want to link the branching behaviour of the family of Brauer algebras to the categorification of a representation for a quantum symmetric pair. All of this is based on joint work with C. Stroppel.

Intersection matrices in modular representation theory

Peter Fiebig
Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany

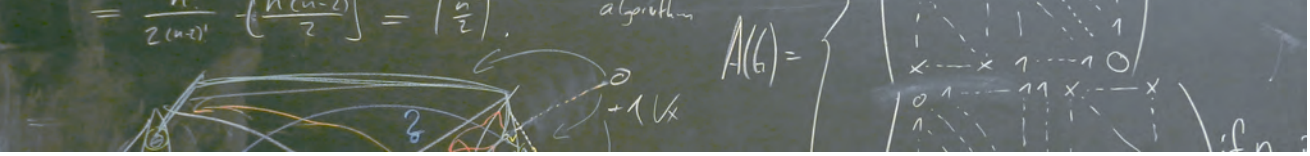
I shall report on several occurences of intersection matrices associated to geometric and representation theoretic problems in positive characteristics. These matrices govern the failure of Lusztig's formula for irreducible characters of reductive algebraic groups in small characteristics, and were used by Geordie Williamson in his recent counterexamples to Lusztig's conjecture.

PBW filtrations and degenerations of flag varieties

Ghislain Fourier
University of Glasgow, Scotland

I shall recall recent results about PBW filtration on the universal enveloping algebra of a simple complex Lie algebra and on their simple modules. Using these results we obtain a flat degeneration of the (partial) flag variety, which has been identified as Schubert variety as well as as quiver Grassmannian.

Generalizing this, I shall introduce a three families of degenerations, one of the classical flag variety considered as a Schubert variety, one of the flag variety considered as a highest weight



orbit, and one of the flag variety considered as a quiver Grassmannian and study their relations. Finally, interesting combinatorics such as string polytopes, torus fixed points and moment graphs related to these degenerations will be discussed.

Nichols algebras of diagonal type over arbitrary fields

Istvan Heckenberger
Philipps-Universität Marburg, Germany
Jing Wang
Philipps-Universität Marburg, Germany

After the discovery of quantum groups by Drinfeld and Jimbo in the 1980ies, the study of Hopf algebras and tensor categories became a quickly developing field in pure mathematics. The structure of pointed Hopf algebras appeared to be closely related to those in Lie theory, a fact which motivated N. Andruskiewitsch and H.-J. Schneider around 1998 to initiate a powerful method to classify pointed Hopf algebras [AS98]. The basic object in this program is the Nichols algebra of a braided vector space (or a Yetter-Drinfeld module).

In this talk, we introduce a new method to determine all Nichols algebras of diagonal type over arbitrary fields.

Irreducible decomposition of binomial ideals

Thomas Kahle
Otto von Guericke Universität Magdeburg, Germany
Ezra Miller
Duke University, United States of America
Christopher O'Neill
Texas A&M University, United States of America

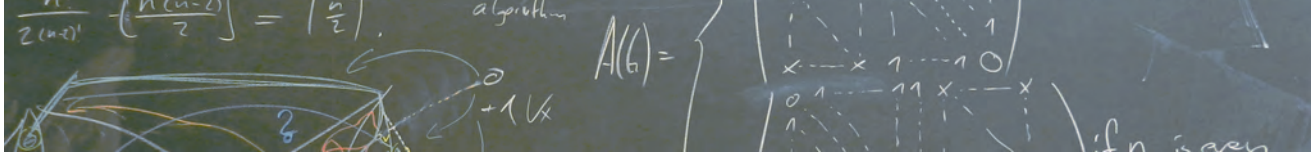
Building on coprincipal mesoprimary decomposition [Kahle and Miller, 2014], we combinatorially construct an irreducible decomposition of any given binomial ideal. In a parallel manner, for congruences in commutative monoids we construct decompositions that are direct combinatorial analogues of binomial irreducible decompositions, and for binomial ideals we construct decompositions into ideals that are as irreducible as possible while remaining binomial. We provide an example of a binomial ideal admitting no irreducible decomposition into binomial ideals, thus answering a question of Eisenbud and Sturmfels [1996].

Approximately periodic sequences attached to non-crystallographic root systems

Philipp Lampe
Bielefeld University, Germany

In the first part of the talk we give an introduction to Fomin-Zelevinsky's theory of cluster algebras. We see that cluster algebras of finite type are classified by finite type root systems. Especially, the mutation rule defines a periodic sequence for every root system of rank 2.

Next we study Fomin-Zelevinsky's mutation rule in the context of non-crystallographic root systems. In particular, we construct an almost periodic sequence of real numbers for every non-crystallographic root system of rank 2 and describe matrix mutation classes in rank 3.



Filtered modules on moment graphs and periodic patterns

Martina Lanini
Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany

In this talk I shall introduce the notion of group actions on moment graphs and apply it to construct a category of modules exhibiting a periodic behaviour. The periodic patterns arising in our category had been already studied by Lusztig and appear—or are expected to appear—in representation theory of affine Kac-Moody algebras, Lie algebras in positive characteristic, quantum groups at a root of unity, ... (This is joint work with Peter Fiebig.)

A categorical action for rational Cherednik algebras

Robert Laugwitz
University of Oxford, England

The Drinfeld and Heisenberg double are fundamental constructions in the theory of Quantum groups. The relation between the two constructions can be used to obtain a categorical action of modules of the former on modules of the latter. In a special case, this action can be restricted to give an action on representations of rational Cherednik algebras (where the parameter t is zero), using embeddings of Bazlov-Berenstein. In this case, the braided Drinfeld doubles of generalizations of the Fomin-Kirillov algebras (for any complex reflection group) are acting.

Quantum groups and logarithmic conformal field theories

Simon Lentner
Universität Hamburg, Germany

I shall first review Lusztig's quantum group of divided powers and how it leads to a non-semisimple "modular" category. This includes some own results, which remove restrictions on the order of the root of unity (e.g., even). Then I explain how one hopes to realize these categories from a uniformly constructed family of vertex algebras. I conclude by some examples.

Toward the colored $\mathfrak{sl}_n$-homology

Louis-Hadrien Robert
Universität Hamburg, Germany
Matt Hogancamp
University of Indiana, United States of America

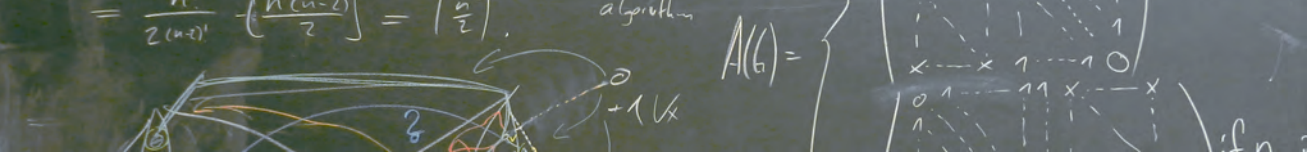
I shall start with a result on $\mathbf{U}_q(\mathfrak{sl}_n)$-representations: I shall give an explicit resolution of every simple $\mathbf{U}_q(\mathfrak{sl}_n)$-module in terms of tensor powers of the fundamental representations.

Then I shall recall the construction of Queffelec and Rose of the $\mathfrak{sl}_n$-link homology and explain how to use the first result to obtain an homology theory which decategorify on the colored $\mathfrak{sl}_n$-invariant for framed links.

Mixed super skew Howe duality

Antonio Sartori
Universität Freiburg, Germany

Skew Howe duality for the general linear group enables to describe the braiding of $\mathfrak{gl}(m)$-representations using a dual Lie algebra $\mathfrak{gl}(k)$. This has proven to be extremely useful, in particular in the quantized setting, for the combinatorial study as well as for categorification purposes.



In the talk, I shall present an extension of skew Howe duality in which the vector representation of the Lie superalgebra $\mathfrak{gl}(m|n)$ and its dual appear at the same time. This relates finite-dimensional representations of $\mathfrak{gl}(m|n)$ with infinite-dimensional representations of a dual Lie algebra $\mathfrak{gl}(k)$. All of this has a natural quantized version and should hopefully be of great help for understanding categorification of $\mathfrak{gl}(m|n)$-representations. (This is joint work with H. Queffelec)

Traces and centers from 3d topological field theory

Gregor Schaumann
Max-Planck-Institut für Mathematik, Germany

The string diagrammatic calculus is a well established tool for computations in linear algebra. A 3-dimensional topological field theory with defects can be regarded as a categorification of such a calculus: It encodes operations of various compositions, of generalized traces and center constructions.

As example we show how to compute the value of a cylinder with a defect line in a state-sum description of a Turaev-Viro theory. This produces known algebraic relations between Drinfeld centers of fusion categories. This is joint work with Christoph Schweigert and Jürgen Fuchs.

Obstruction Theory for Parameterized Higher WZW-Terms

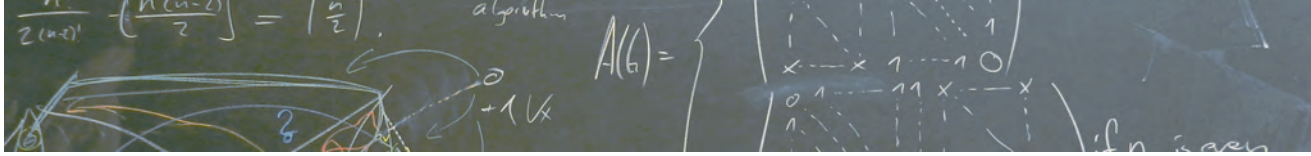
Urs Schreiber
Charles University Prague, Czech Republic

I present a general characterization of the obstructions for higher WZW-terms (higher gerbes with connection) defined on some higher (or derived) group stack G/H to have a parameterization over higher Cartan geometries locally modeled on G/H. Applied to the canonical Kostant-Souriau line bundle the construction reproduces metaplectic pre-quantization. For the traditional degree-3 WZW term it reproduces the Green-Schwarz anomaly; for the degree-7 WZW term we get a Fivebrane-analog, for the degree-11 term a Ninebrane-analog. Applied to the exceptional cocycles on extended super-Minkowski spacetimes the construction yields a forgetful innity-functor on globally dened (classical anomaly free) Green-Schwarz super p-brane sigma models propagating on higher super étale stacks, which sends these to G-structures on these super stacks, for G the higher Heisenberg group stack of the higher WZW term. Specically for the super-5-brane sigma-model this yields a forgetful innity-functor from its classical anomaly free backgrounds to super etale 3-stacks satisfying the equations of motion of 11-dimensional supergravity and satisfying a further topological constraint.

Equivariant motives in representation theory

Wolfgang Soergel
Universität Freiburg, Germany
Matthias Wendt
Universität Düsseldorf, Germany
Rahbar Virk
United States of America

We discuss how motivic sheaves help our understanding of graded representation categories.



Cellular structures using $\mathbf{U}_q$-tilting modules

Daniel Tubbenhauer
Université catholique de Louvain, Belgium

Classical Schur-Weyl duality says that the actions of $\mathbb{C}[S_d]$ and $\mathfrak{gl}_n$ on $T = (\mathbb{C}^n)^{\otimes d}$ commute and generate each others commutant. In particular, one can recover $\mathbb{C}[S_d]$ as $\mathrm{End}_{\mathfrak{gl}_n}(T)$ by taking $n \geq d$.

This is just the tip of the iceberg of a huge class of algebras called centralizer algebras. We discuss a general method to study their representation theory for the case where $\mathfrak{gl}_n$ is replaced by $\mathbf{U}_q(\mathfrak{g})$ and T is replaced by any $\mathbf{U}_q = \mathbf{U}_q(\mathfrak{g})$-tilting module. That is, we show that $\mathrm{End}_{\mathbf{U}_q}(T)$ is equipped with a cellular basis.

As an application, we explain how Jantzen's sum formula can be used to check semi-simplicity criteria for these centralizer algebras. (Joint work with Henning Haahr Andersen and Catharina Stroppel.)

Classification of Borel subalgebras of quantum groups

Karolina Vocke
Philipps-Universität Marburg, Germany

This talk will be about the classification of right coideal subalgebras C of a quantum group with generic q, where C has the additional property that all irreducible representations are 1-dimensional and C is maximal with this property.

We call such a right coideal subalgebra a Borel subalgebra. This is due to a theorem of Sophus Lie stating that the Borel subalgebras of a semisimple Lie algebra have only 1-dimensional representations and are maximal with this property. Borel subalgebra and subgroups are in the theory of algebraic groups, semisimple Lie algebras and representation theory the basic components of many standard constructions (flag varieties, spherical varieties, Verma modules and their irreducible quotient, etc.).

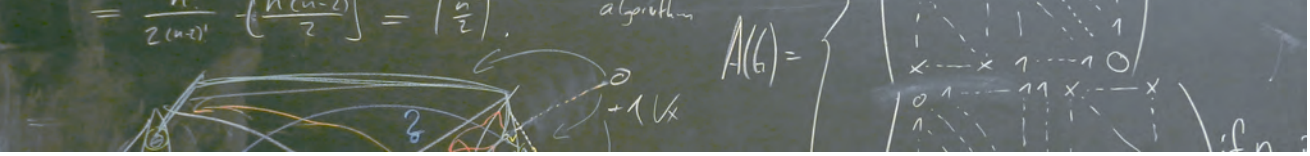
We shall see that indeed there are the so-called standard Borel subalgebras and their reflections which are parametrized by an element of the Weyl group. But there are more examples, already in $\mathbf{U}_q(\mathfrak{sl}_2)$ appears a family of Weyl algebras generated by two elements. So the question arises, which other kinds of Borel subalgebras exist.

Finite spectral representations of the partition and divisor function

Michael Weba
Goethe Universität Frankfurt am Main, Germany

A partition of a positive integer n is an additive decomposition of n into a sum where the summands are positive integers as well and the order of these summands does not matter. The partition function $p(n)$ counts the number of all partitions of n, and it is a traditional problem of constructive number theory to find an explicit *finite* representation of $p(n)$ (rather than infinite series expansions such as Rademacher's formula). Recently, Bruinier and Ono [2013] established the first finite representation of $p(n)$ as a finite sum of algebraic numbers being singular moduli for a certain weak Maass form. It is the purpose of this talk to establish several alternatives which exhibit a spectral nature of the partition function. The results may be summarized as follows:

1. The nth partition number $p(n)$ can be expressed and computed by means of the nth power of a certain sparse Hessenberg matrix H.
2. The function $p(n)$ admits an explicit representation as finite linear combination of powers of eigenvalues of H. This spectral representation shows that $p(n)$ can be regarded as a superposition of sinusoids which explains the oscillating behaviour of $p(n)$.



3. The above formulae yield several identities involving the divisor function or series of partition numbers.

[1] J. H. Bruinier and K. Ono: *Algebraic formulas for the coefficients of half-integral weight harmonic weak Maass forms,* Adv. Math. **246** (2013), 198-219

[2] M. Weba: *A finite spectral representation of the partition function,* tentatively accepted for publication by the Ramanujan Journal.

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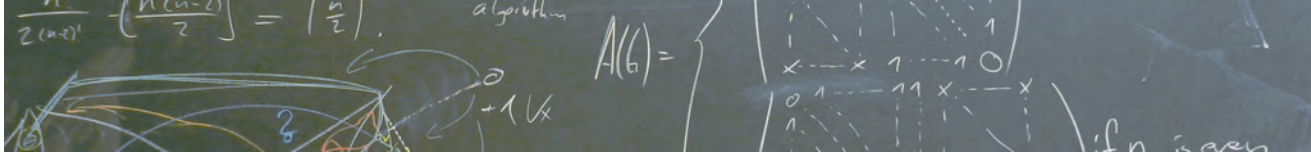


Sektion 2: Differentialgeometrie, globale Analysis & Anwendungen / Section 2: Differential Geometry, Global Analysis, & Applications

Sektionsleitung / Coordination: Vicente Cortés, Hamburg; Andrew Swann, Aarhus

Geometrically formal homogeneous metrics of positive curvature

Manuel Amann
Karlsruher Institut für Technologie, Germany
Wolfgang Ziller
University of Pennsylvania, United States of America

A Riemannian manifold is called geometrically formal if the wedge product of harmonic forms is again harmonic, which implies in the compact case that the manifold is topologically formal in the sense of rational homotopy theory. A manifold admitting a Riemannian metric of positive sectional curvature is conjectured to be topologically formal. In this talk I shall explain that among the homogeneous Riemannian metrics of positive sectional curvature a geometrically formal metric is either symmetric, or a metric on a rational homology sphere. The talk is based on joint work with Wolfgang Ziller.

Compact Pseudo-Riemannian Solvmanifolds

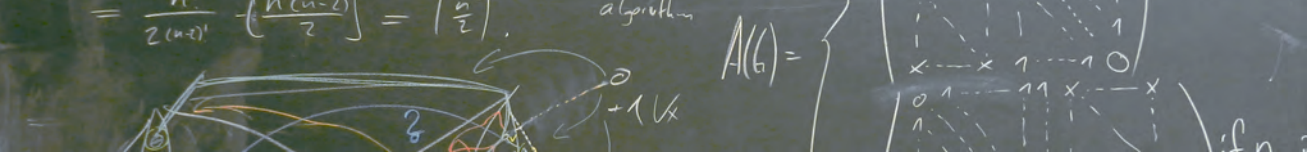
Oliver Baues
Georg-August-Universität Göttingen, Germany
Wolfgang Globke
The University of Adelaide, Australia

A pseudo-Riemannian solvmanifold is a homogeneous space M with pseudo-Riemannian metric g on which a connected solvable Lie group G of isometries acts transitively and almost effectively. We show that $M = G/\Gamma$, where Γ is a discrete cocompact subgroup of G, and that g is induced by a biinvariant pseudo-Riemannian metric on G.

Structure of curves in conformal manifolds

Florin Belgun
Universität Hamburg, Germany

One of the intrinsic structures induced by a smooth embedding of a curve in a conformal manifold (of dimension at least 3; for an ambient space of dimension 2 a Möbius structure is additionally required) is a projective structure (another iduced structure is a conformal structure, but this is trivial). For periodic curves with period 1, the moduli space of projective structures is a locally 1-dimensional, non-Hausdorff space (for a smooth loop in a Riemannian manifold the moduli space of lengths is also 1-dimensional), and it is given by the conjugacy class of $\tilde{R}(1)$, where R is the fundamental solution of the linear system associated to the Hill's equation characterizing the projective structure, and $\tilde{R}$ is its lift to the universal covering of $\mathrm{SL}(2,\mathbb{R})$. We show that a large part of the moduli space can be realized by embeddings of plane curves in euclidean spaces, in particular we give examples of non-homgeneous projective structures realized this way.



An explicit formula for the Dirac multiplicities on lens spaces

Sebastian Boldt
Humboldt-Universität zu Berlin, Germany

To every spin lens space L we associate an affine lattice that fully characterizes the isometry class of L. The multiplicities of the eigenvalues of the Dirac operator on L are connected to the size of the intersection of this lattice with the norm-one spheres by a simple formula. We use this formula to obtain an isospectrality criterion for lens spaces which leads to the identification of several isospectral families. This is joint work with Emilio Lauret.

Harmonic maps and geometric Cauchy problems

David Brander
Technical University of Denmark, Denmark

It has been known since the 1990's that harmonic maps from Riemannian or Lorentzian surfaces into Symmetric spaces admit loop group generalizations of the classical Weierstrass representation (Riemannian) or d'Alembert solution of the wave equation (Lorentzian). These allow one to construct solutions to the various geometric problems that are associated, via the Gauss map, to harmonic maps. The utility of these representations is obstructed by the loss of geometric information in the loop group decomposition that relates the harmonic map to the "Weierstrass" data. Recently, special types of Weierstrass data have been introduced that contain full geometric information along a curve. In this presentation, we shall discuss recent applications of this technique to the construction of all equivariant Willmore surfaces and the study of singularities of constant curvature surfaces.

Renormalization Group Flows as Geometric Flows

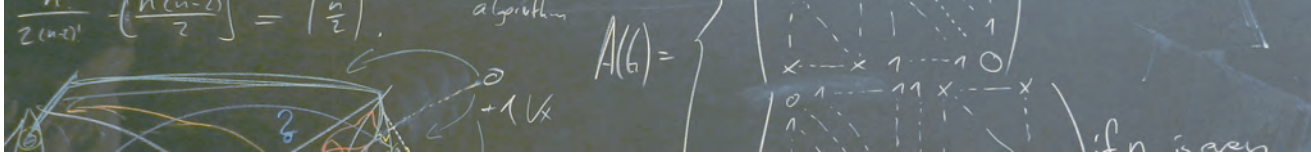
Volker Branding
Technische Universität Wien, Austria

We discuss several geometric flows that arise as renormalization group flows in perturbative quantum field theory. One example has become known in mathematics as second order renormalization group flow, which is a non-linear deformation of the Ricci flow. We shall study general properties of these flows from the point of view of global analysis and differential geometry. In particular, we shall point out new analytic and geometric phenomena that occur in the investigation of these flows.

Curvature properties of the Kähler/Kähler correspondence

Peter-Simon Dieterich
Universität Hamburg, Germany

The Kähler/Kähler correspondence is a special case of the hyper-Kähler/quaternionic Kähler correspondence, the latter of which relates the supergravity c-map to the rigid c-map. We describe the K/K correspondence in a more general context as the special case of a twist construction which was established by A. Swann, analyse how the Ricci curvatures are related, and present new twists which might relate the supergravity r-map to the rigid r-map.



Stable fixed points of the Einstein flow with positive cosmological constant

David Fajman
Universität Wien, Austria
Klaus Kröncke
Universität Regensburg, Germany

We prove nonlinear stability for a large class of solutions to the Einstein equations with a positive cosmological constant and compact spatial topology in arbitrary dimensions, where the spatial metric is Einstein with either positive or negative Einstein constant. The proof uses the CMC Einstein flow and stability follows by an energy argument. We prove in addition that the development of non-CMC initial data close to the background contains a CMC hypersurface, which in turn implies that stability holds for arbitrary perturbations. Furthermore, we construct a one-parameter family of initial data such that above a critical parameter value the corresponding development is future and past incomplete.

Einstein G_2 manifolds obtained as warped products

Marisa Fernández
University of the Basque Country, Spain
Anna Fino
Università degli Studi di Torino, Italy
Víctor Manero
University of the Basque Country, Spain

The presence of a G_2-structure on a manifold M is equivalent to the existence of a certain 3-form φ on M. Different classes of special G_2-structures can be described by the behavior of the 3-form φ. For example, a G_2-structure is called calibrated if φ is closed, and cocalibrated if φ is coclosed, that is, if $*\varphi$ is closed with $*$ denoting the Hodge star operator. In the latter case, if $*\varphi$ is proportional to $d\varphi$, then the G_2-structure φ is said to be nearly parallel.

As was shown in [2], the behaviour of the Ricci tensor associated to the metric g_φ is closely related with the behavior of the G_2-structure φ. By the results in [3] no compact 7-dimensional manifold can support a calibrated G_2-structure φ whose underlying metric g_φ is Einstein unless g_φ has holomomy contained in G_2. However, 7-dimensional manifolds with a nearly parallel G_2-structure are always Einstein.

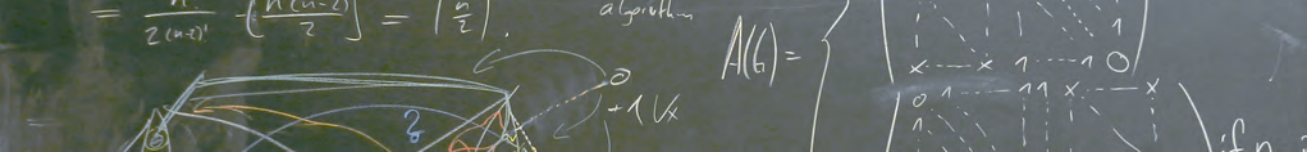
Using warped products, we show how to construct manifolds endowed with special G_2-structures from manifolds endowed with different classes of SU(3)-structures in such a way that the Einstein condition on the corresponding metric is preserved along this construction.

[1] Besse A., Einstein manifolds, Springer, Berlin, Heidelberg, New York, 1987.

[2] Bryant R. L., Some remarks on G_2-structrures, Proceedings of Gokova Geom.-Topology Conference 2005, 75-109, Gokova Geometry/Topology Conference (GGT), Gokova, 2006.

[3] Cleyton R. Ivanov S., On the geometry of closed G_2-structures, Commun. Math. Phys. 270 (2007), 53-67.

[4] O'Neill B., Semi-Riemannian Geometry with Applications to Relativity, Pure and Appl. Math. 103, Academic Press, New York, 1983.



The shear construction

Marco Freibert
Aarhus University, Denmark
Andrew Swann
Aarhus University, Denmark

The twist construction of Andrew Swann is a method to produce new interesting examples of geometric structures out of well-known ones and generalizes, e.g., the hK/qK correspondence and the construction of nilmanifolds from a torus by repeatedly adding differential relations. In this talk, we present a generalization of the twist construction: the shear construction. We present some interesting new examples of geometric structures obtained by the shear which cannot be obtained by the twist and indicate how the repeated application of the shear produces all 1-connected solvable Lie groups from $\mathbb{R}^n$.

The exponential map based at a singularity

Vincent Grandjean
Universidade Federal do Ceará, Brazil
Daniel Grieser
Carl von Ossietzky-Universität Oldenburg, Germany

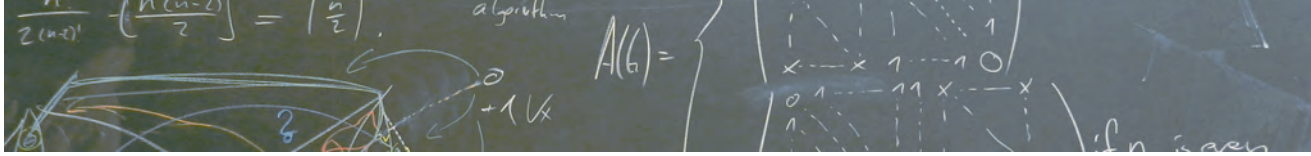
We study isolated singularities of a space embedded in a smooth Riemannian manifold from a differential geometric point of view. While there is a considerable literature on bi-Lipschitz invariants of singularities, we obtain a more precise (complete asymptotic) understanding of the metric properties of certain types of singularities. This involves the study of the family of geodesics emanating from the singular point. While for conical singularities this family of geodesics, and the exponential map defined by them, behaves much like in the smooth case, the situation is very different in the case of cuspidal singularities, where the exponential map may even fail to be locally injective. We also study a mixed conical-cuspidal case. Our methods involve the description of the geodesic flow as a Hamiltonian system and its resolution by blow-ups in phase space.

Variational calculus on supermanifolds

Florian Hanisch
Universität Potsdam, Germany

Supermanifolds are generalisations of manifolds, whose algebras of functions also contain anti-commuting elements. They have been applied, e.g., in index theory or classical field theory and hence, it is interesting from a geometric and physical point of view, to study variational problems and PDEs on these spaces.

We shall first describe an approach to mapping spaces that allows for a satisfactory construction of a variational calculus on supermanifolds. To study spaces of solutions, one may either reduce the problem to PDEs on a smooth manifold ("component decomposition") or generalise techniques from analysis in order to obtain an intrinsic PDE-theory on supermanifolds. We will discuss (closed) supergeodesics to illustrate the first strategy and present simple, explicit examples which highlight the influence of the underlying geometry on the associated spaces of solutions. We will finally look at hyperbolic equations and indicate, that some analytic methods (e.g., energy methods) can be carried over to supermanifolds. In good cases, such tools yield well-behaved (infinite-dim.) solution spaces which can be used as phase spaces in fermionic classical field theory (joint work with I. Khavkine).



Surgery and the positive mass conjecture

Andreas Hermann
Universität Potsdam, Germany

The Positive Mass Conjecture for asymptotically Euclidean manifolds has been proved in some special cases (e.g., for manifolds of dimension at most 7 or for spin manifolds) but the general case is still subject to current research. In this talk we present a surgery result might help to give a proof in the general case. This is joint work with Emmanuel Humbert (Université de Tours, France).

Conformally Kähler surfaces and orthogonal holomorphic bisectional curvature

Mustafa Kalafat
Tunceli University, Turkey
Caner Koca
Vanderbilt University, United States of America

We show that a compact complex surface which admits a conformally Kähler metric g of positive orthogonal holomorphic bisectional curvature is biholomorphic to the complex projective plane. In addition, if g is a Hermitian metric which is Einstein, then the biholomorphism can be chosen to be an isometry via which g becomes a multiple of the Fubini-Study metric.

[1] M. Kalafat, C. Koca, Conformally Kähler surfaces and orthogonal holomorphic bisectional curvature. Geom. Dedicata 174 (2015), 401–408.

On moduli spaces of supergravity backgrounds

Frank Klinker
Technische Universität Dortmund, Germany

We present families of homogeneous supergravity backgrounds. We will describe in detail the field ingredients and discuss the free parameters. Furthermore, we will discuss some properties of their moduli spaces.

Path Integrals on Manifolds with Boundary

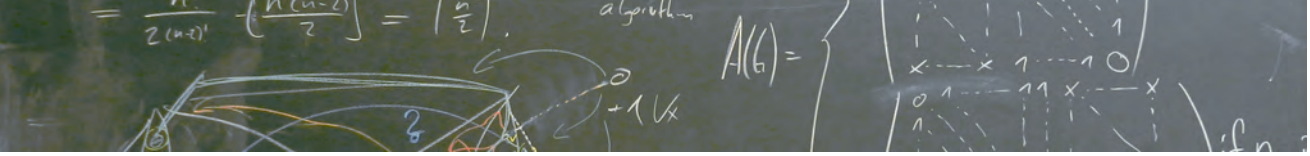
Matthias Ludewig
Universität Potsdam, Germany

Formally, the heat kernel corresponding to a Laplace-type operator on a Riemannian manifold can be written as an integral over the space of all paths that particles could take. One way to make this rigorous is by approximating the infinite-dimensional space of continuous paths by finite-dimensional paths of piece-wise geodesics. In the case that the manifold has a boundary, one has to take paths that reflect at the boundary; we discuss in particular, how different boundary conditions lead to different path integrals formulas.

(Special) geometry defined by 4-forms in dimension 8

Thomas Madsen
Aarhus University, Denmark

I shall discuss different aspects of special geometry (mainly) defined by 4-forms on 8-space. Particularly interesting are so-called quaternion Kähler and Spin(7) manifolds whose associated metrics are Einstein. I shall explain how symmetry techniques can be used so as to find and construct



explicit solutions. This talk is based on joint work, in progress, with Diego Conti (Milano-Bicocca) and Simon Salamon (King's College London).

Homogeneous pseudo-Hermitian irreducible spaces

Benedict Meinke
Universität Hamburg, Germany

A pseudo-Hermitian manifold in the classical sense is a pseudo-Riemannian manifold with an almost complex structure compatible with the metric. We study a more general setting with an almost hypercomplex and an almost quaternionic structure. It turns out that such manifolds with index 4 are already Hyperkähler or quaternionic Kähler manifolds if they are in addition homogeneous and have an irreducible isotropy group.

Systems of symplectic forms on four-manifolds

Paul Andi Nagy
University of Murcia, Spain

It is an open problem to determine how many compatible symplectic forms a given Riemannian metric may admit. To understand this in low dimensions we study almost Hermitian 4-manifolds with holonomy algebra, for the canonical Hermitian connection, of dimension at most one. We show how Riemannian 4-manifolds admitting five orthonormal symplectic forms fit therein and classify them. In this set-up we also fully describe almost Kähler 4-manifolds.

The higher-dimensional positive mass theorem for non-spin manifolds

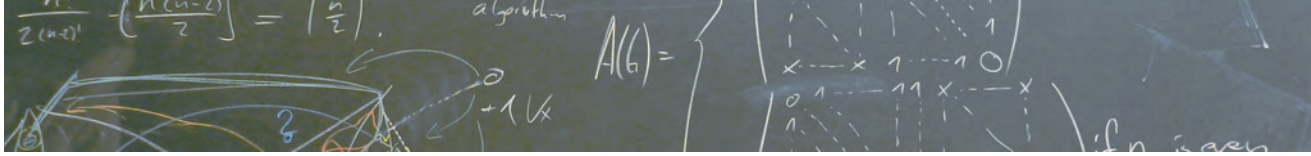
Marc Nardmann
Technische Universität Dortmund, Germany

The positive mass theorem (PMT) says that for every asymptotically flat manifold M of dimension $n > 2$ whose scalar curvature is nonnegative, each end of M has nonnegative mass; and that M is isometric to euclidean space if some end has mass zero. It has been known for decades that the PMT is true if $n < 8$ or M admits a spin structure. In this talk a proof of the PMT in the general case is presented: by a new method, the spinorial proof strategy is adapted to manifolds that do not admit a spin structure.

A structure result for locally conformal calibrated G_2-manifolds

Alberto Raffero
Università di Torino, Italy

Given a 7-manifold M, it admits a G_2-structure if the structure group of its frame bundle can be reduced to the exceptional Lie group G_2 or, equivalently, if it admits a stable 3-form φ from which it is possible to define a Riemannian metric and a volume form on M. If φ is not closed but is locally conformal equivalent to a stable closed 3-form, the G_2-structure is said to be locally conformal calibrated and represents the G_2-analogue of locally conformal symplectic structures on even dimensional manifolds. In this talk, I shall discuss a structure result for compact 7-manifolds endowed with a locally conformal calibrated G_2-structure. In detail, after recalling some preliminary results, I shall show that under some suitable and natural hypothesis on the 3-form φ, the 7-manifold is fibered over the circle and each fiber is a 6-manifold endowed with a coupled SU(3)-structure (ω, ψ), that is, an half-flat SU(3)-structure for which the exterior derivative of the Kähler form ω is proportional to the real part of the complex volume form ψ. I shall conclude giving some explicit examples.



Deformations of cohomogeneity-one G_2-manifolds

Frank Reidegeld
Technische Universität Dortmund, Germany

Riemannian manifolds with holonomy G_2 are an active research topic in differential geometry that has applications in theoretical physics, too. Most of the known non-compact, complete G_2-manifolds are of cohomogeneity one; i.e., they admit an isometric action whose generic orbits have codimension one. We study a special class of $\mathrm{SU}(2)^2$-invariant metrics of that kind and investigate if they have infinitesimal deformations that do not change the holonomy. This question is equivalent to an eigenvalue problem for a differential operator on the orbit $\mathrm{SU}(2)^2$. With help of the Peter-Weyl theorem our problem can be simplified even further. The spectrum of our operator coincides with the eigenvalues of an infinite series of matrices. Since we are interested only in the lowest eigenvalues, our question can be answered by numerical methods.

The elastic trefoil is the twice covered circle

Philipp Reiter
Universität Duisburg-Essen, Germany

(Joint work with Heiko von der Mosel and Henryk Gerlach.) In order to investigate the elastic behavior of knotted loops of springy wire, we minimize the classic bending energy regularized by ropelength, i.e., the quotient of length over thickness, in order to penalize self-intersection. Our main objective is to characterize the limit configurations of energy minimizers as the regularization parameter tends to zero, which will be referred to as elastic knots.

The elastic unknot turns out to be the round circle. In all non-trivial knot classes where the natural lower bound $(4\pi)^2$ for the bending energy is sharp, any elastic knot is shown to belong to the one-parameter family of tangential pairs of identical circles, where the parameter is the angle in between the circles ranging from 0 to π.

Finally, for every odd $b > 1$ and the respective class of $(2, b)$-torus knots (containing the trefoil) we obtain a complete picture showing that the respective elastic $(2, b)$-torus knot is the twice covered circle.

Integral geometry on non-compact harmonic spaces

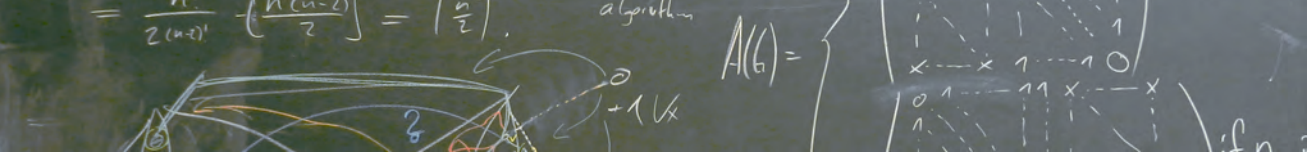
Evangelia Samiou
University of Cyprus, Cyprus
Norbert Peyerimhoff
Durham University, England

We prove that on non-compact harmonic spaces, the Abel transform and its dual are topological isomorphisms. Relying on L. Schwartz's classical result on mean periodic functions we then derive that functions satisfying the mean value property for two generic radii must be harmonic. Moreover, functions with vanishing integrals over all spheres (or balls) of two generic radii must be identically zero.

Miscellanea of H-surfaces with one-to-one Central Projection

Friedrich Sauvigny
Brandenburgische Technische Universität Cottbus-Senftenberg, Germany

When we consider surfaces of prescribed mean curvature H with a one-to-one orthogonal projection onto a plane, we have to study the nonparametric H-surface equation. Now the H-surfaces with a one-to-one central projection onto a plane lead to an intricate elliptic differential equation



which is derived in §1; in the case $H = 0$ this PDE has been invented by T. Radó. We establish the uniqueness of the Dirichlet problem for this H-surface equation in central projection in §2. Moreover, we develop an estimate for the maximal deviation of large H-surfaces from their boundary values, resembling an inequality by J. Serrin. In §3 we provide a Bernstein-type result for the case $H = 0$ with methods from the book on Minimal Surfaces by U. Dierkes, S. Hildebrandt, and F. Sauvigny; thus we can classify the entire solutions of the minimal surface equation in central projection. Furthermore, we solve the Dirichlet problem for $H = 0$ by a variational method. In §4 we construct solutions of the Dirichlet problem for nonvanishing H by the deformation method and an approximation. Finally, we investigate the boundary regularity under a suitable curvature restriction.

Subriemannian metrizability of some parabolic geometries

Jan Slovak
Masaryk University, Czech Republic

Recently, the classical linearized metrizability has been understood for a large class of parabolic geometries.

This leads to the quest for subriemannian metric partial connections within the class of the Weyl structures on a given parabolic geometry. I shall illustrate the procedure on some explicit examples like the Lie contact structures or quaternionic contact structures. The talk will reflect work in progress, joint with David M. J. Calderbank and Vladimir Soucek.

On pseudo-Riemannian surfaces all of whose geodesics are closed

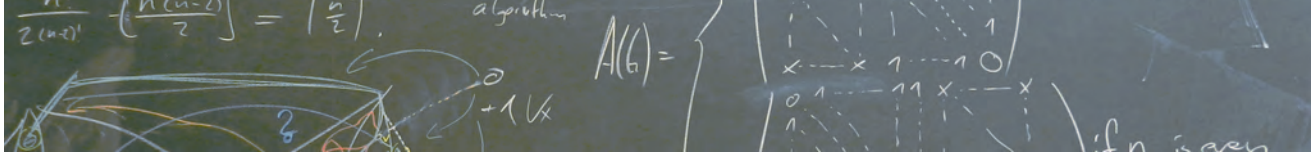
Stefan Suhr
Université Dauphine, France

The study of Riemannian manifolds all of whose geodesics are closed is a classical subject with anewed interest branching out into the field of contact geometry. I shall explain which results are known for the pseudo-Riemannian case, especially how the theorem of Waldsley on geodesic foliations generalises to the pseudo-Riemannian world. Further I shall give counterexamples to possible generalisations and comment on the problem of determining the set of pseudo-Riemannian metrics all of whose geodesics are closed.

On the asymptotic geometry of the Higgs bundle moduli space

Jan Swoboda
Ludwig Maximilians-Universität München, Germany

In this talk, I aim to give an overview of some known results and several open questions concerning geometric and topological properties of the moduli space of stable Higgs bundles of fixed rank and degree on a compact Riemannian surface. I shall in particular discuss its construction as the solution space of a certain system of nonlinear elliptic equations, called Hitchin's self-duality equations. A novel geometric compactification of the moduli space is presented by adding to its smooth part configurations which are singular in a finite number of points. We finally describe some aspects of the asymptotic geometry of a natural hyperkaehler metric moduli space is endowed with. (Joint work with Rafe Mazzeo, Stanford, Hartmut Weiß, Kiel, and Frederik Witt, Münster).



Closed Reeb orbits

Kai Zehmisch
Westfälische Wilhelms-Universität Münster, Germany

Weinstein conjectured in 1978 that any Reeb vector field on a closed contact manifold carries a periodic solution. The conjecture is far from being fully established. So-called "half-plugs" could be used to disprove the conjecture whose non-existence was conjectured by Hofer in 2012. In my talk I shall explain how to construct such "half-plugs" disproving Hofer's conjecture based on a joint work with Hansjörg Geiges and Nena Röttgen.

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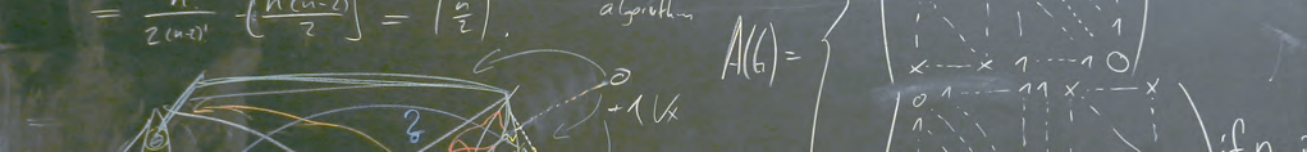


Sektion 3: Differentialgleichungen & Anwendungen / Section 3: Differential Equations & Applications

Sektionsleitung / Coordination: Reiner Lauterbach, Hamburg; Tobias Weth, Frankfurt

Continuous Multi-Scale Analysis for Ground States in Infrared-divergent Spin-Boson Models

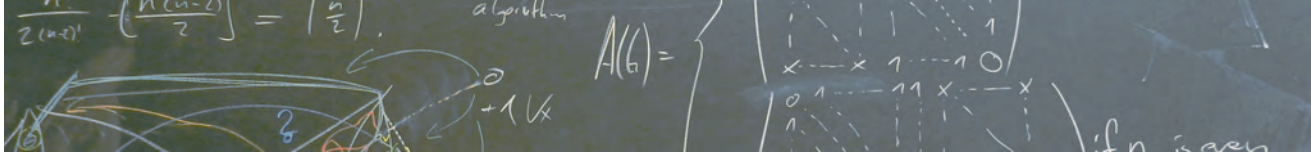
Volker Bach
Technische Universität Braunschweig, Germany
Miguel Ballesteros
Universidad Nacional Autónoma de México, Mexico
Martin Könenberg
Memorial University of Newfoundland, Canada
Lars Menrath
Technische Universität Braunschweig, Germany

We study an atom with a finite number of energy levels, coupled to an infrared-divergent boson field (the Spin-Boson Model). Without any regularization of the coupling function, we prove existence of the ground state energy and construct the ground state. Our method is based on the multi-scale analysis introduced by A. Pizzo in 2003, but we use the continuous version of it developed by V. Bach and M. Könenberg (2006). The main difficulty is the infrared divergence in the coupling function that behaves as $|k|^{-\frac{1}{2}}$ ($|k|$ being the norm of the momentum of the Boson), since such models do not necessarily admit ground states. Assuming some symmetries, it is proved by D. Hasler and I. Herbst in 2011 that the ground state exists in the model at stake, using the spectral renormalization group analysis introduced by V. Bach, J. Fröhlich and I. M. Sigal in 1998. On the contrary, in the present work we construct the ground state projection as a limit of projections P_t, $t \in [0, \infty)$, corresponding to infrared-regularized models, by proving that the norm of the derivative $\dot{P}_t$ is integrable.

Stability of hyperbolic attractors.

Nikita Begun
Freie Universität Berlin, Germany

The dynamical object which we study is a compact invariant set with a suitable hyperbolic structure. Stability of hyperbolic attractors was studied by Pliss and Sell. They assumed that the neutral and the stable linear spaces of the corresponding linearized systems satisfy Lipschitz condition. They showed that if a perturbation is small, then the perturbed system has a hyperbolic attractor M, which is homeomorphic to the hyperbolic attractor K of the initial system, close to K, and the dynamics on M is close to the dynamics on K. At the same time, it is known that the Lipschitz property is too strong in the sense that the set of systems without this property is generic. Hence, there was a need to introduce new methods of studying stability of hyperbolic attractors without Lipschitz condition. In our talk we shall show that even without Lipschitz condition there exists a continuous mapping h such that $h(K) = M$.



Controlled invariance for nonlinear descriptor systems

Thomas Berger
Universität Hamburg, Germany

We study the concept of locally controlled invariant submanifolds for nonlinear descriptor systems. In contrast to classical approaches, we define controlled invariance as the property of solution trajectories to evolve in a given submanifold whenever they start in it. It is then shown that this concept is equivalent to the existence of a feedback which renders the closed-loop vector field invariant in the descriptor sense. This result is motivated by a preliminary consideration of the linear case.

Local controlled invariance leads to the concept of output zeroing submanifolds. We show that the outcome of the differential-algebraic version of the zero dynamics algorithm yields a maximal output zeroing submanifold. The latter is then used to characterize the zero dynamics of the system. In order to guarantee that the zero dynamics are locally autonomous (i.e., locally resemble the behavior of an autonomous dynamical system), sufficient conditions involving the locally maximal output zeroing submanifold are presented.

Existence and stability of simple heteroclinic networks in $\mathbb{R}^4$, Part II

Sofia Castro
Universidade do Porto, Portugal
Alexander Lohse
Universität Hamburg, Germany
Universidade do Porto, Portugal

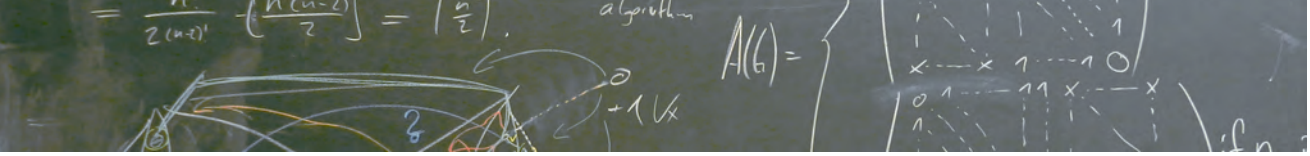
Heteroclinic cycles and networks occur as prototypes for stop-and-go dynamics in a wide range of applications from geophysics to neurosciences. They consist of finitely many equilibria ξ_j and connecting trajectories $[\xi_j \to \xi_{j+1}] \subset W^u(\xi_j) \cap W^s(\xi_{j+1})$, and may be structurally stable in systems with symmetry. In this talk we consider simple heteroclinic networks in $\mathbb{R}^4$-constructed from simple, non-homoclinic, robust cycles. There are few ways by which such cycles can be joined to form a network, and we provide a complete list of these. Using the stability index from Podvigina and Ashwin (Nonlinearity 24, 887–929, 2011), we describe non-asymptotic stability properties of individual cycles and derive information about stability of the entire network as well as nearby dynamics. This strongly depends on the equivariance of the system-networks with seemingly identical geometry, but different symmetry groups, display very different stability configurations. This talk will be divided into parts one and two.

Reaction-Diffusion Equations with Hysteresis in Higher Spatial Dimensions

Mark Curran
Freie Universität Berlin, Germany

We consider a reaction diffusion equation that models biological processes with a substance fixed at each spatial point that can be in one of two states. Moreover, points may switch state according to a hysteresis law. Points in different states segregate the domain into several subdomains and switching implies that these subdomains are separated by free boundaries.

For bounded domains in $\mathbb{R}^n$, numerical results reproduce the observed experimental patterns, but for $n \geq 2$, existence and uniqueness of solutions as well as their continuous dependence on initial data have not been rigorously addressed. We shall present recent progress on these questions under the assumption that the solution has non-vanishing derivative at the free boundary.



Justification of the Nonlinear Schrödinger equation for the evolution of gravity driven 2D surface water waves in a canal of finite depth

Wolf-Patrick Düll
Universität Stuttgart, Germany
Guido Schneider
Universität Stuttgart, Germany
C. Eugene Wayne
Boston University, United States of America

In 1968, V. E. Zakharov derived the Nonlinear Schrödinger equation for the two-dimensional water wave problem in the absence of surface tension, i.e., for the evolution of gravity driven surface water waves, in order to describe slow temporal and spatial modulations of a spatially and temporarily oscillating wave packet. In this talk we give a rigorous proof that the wave packets in the two-dimensional water wave problem in a canal of finite depth can be approximated over a physically relevant timespan by solutions of the Nonlinear Schrödinger equation.

Existence and asymptotic properties of real-valued solutions to the nonlinear Helmholtz equation

Gilles Evequoz
Goethe Universität Frankfurt am Main, Germany

The Helmholtz equation or reduced wave equation appears, in particular, as a model for the propagation of acoustic waves. We shall present in this talk existence and multiplicity results concerning nonlinear versions of the Helmholtz equation in the whole space. The asymptotic behavior of the solutions we obtain will also be discussed. Our main tool is a dual variational approach in Orlicz spaces which, combined with estimates for the resolvent Helmholtz operator, allows to prove the existence of real-valued solutions for nonlinearities which are not necessarily homogeneous.

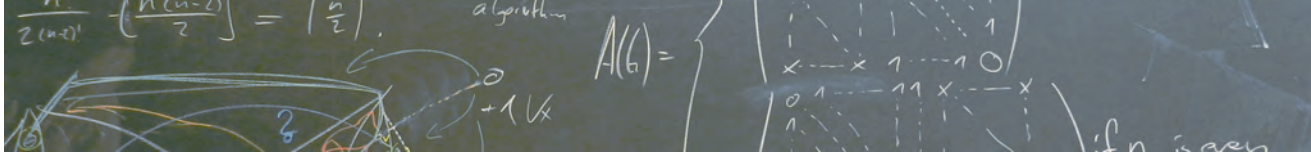
Overdetermined problems with fractional Laplacian

Mouhamed Moustapha Fall
African Institute for Mathematical Sciences, Senegal
Sven Jarohs
Goethe Universität Frankfurt am Main, Germany

Let $N \geq 1$ and $s \in (0,1)$. In the present work we characterize bounded open sets Ω with C^2 boundary (not necessarily connected) for which the overdetermined problem $(-\Delta)^s u = f(u)$ in Ω, $u = 0$ in $\mathbb{R}^N \setminus \Omega$ and $(\partial_\eta)_s u = \text{const}$ on $\partial\Omega$ has a nonnegative and nontrivial solution. Here η is the outer unit normal vector field along $\partial\Omega$ and for $x_0 \in \partial\Omega$

$$(\partial_\eta)_s\, u(x_0) = -\lim_{t\to 0} \frac{u(x_0 - t\eta(x_0))}{t^s}.$$

Under mild assumptions on f, we prove that Ω must be a ball. In the special case $f \equiv 1$, we obtain an extension of Serrin's result in 1971. The fact that Ω is not assumed to be connected is related to the nonlocal property of the fractional Laplacian. The main ingredients in our proof are maximum principles and the method of moving planes.



Synaptic transmission and ethanol

Jan Fuhrmann
Johannes Gutenberg University Mainz, Germany

The addictive power of many drugs including ethanol relies on their ability to change synaptic transmission in the brain's reward system. As part of this system we consider glutamatergic synapses on medium spiny neurons (MSN) in the Nucleus Accumbens which are modulated by dopaminergic input from the midbrain.

Depending on their input the strength of these synapses changes to increase or decrease synaptic transmission and thereby mediate a coupling between incentives and behavior. In case of addictive drugs this plasticity is altered which leads to craving for the drug and expecting pleasure from consumption of the drug.

Ethanol interferes with the functions of several receptors known to be respsonsible for the plastic changes at the synapses such as glutamate receptors of NMDA type and dopamine receptors of D1 or D2 type. Physiologically, it has for instance been observed that stimulations which under normal conditions induce long term depression (decrease of synaptic strength) can instead induce long term potentiation (increase of synaptic strength) at the same synapses when ethanol is present at sufficiently high doses.

To understand the alterations of the synaptic response due to the presence of ethanol we propose a model for the synaptic transmission in the Nucleus accumbens where the expected effects of ethanol on each kind of receptor is taken into account. The model comprises a fast time scale describing electric currents through receptor channels and a slow time scale for the resulting modifications of proteins like phosphorylation. On an even lower time scale, structural changes in the composition of the synapse will be responsible for prolonged potentiation or depression of the synapse.

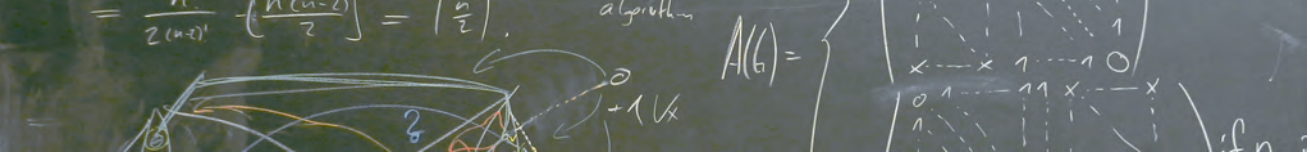
To validate our model we use data of single cell measurements obtained from brain slices of mice with and without added ethanol. In a first step we try to capture the acute effects of ethanol on the synaptic transmission. Moreover, we shall describe the changes in synaptic plasticity due to the presence of ethanol.

From a dynamical systems point of view we obtain a slow-fast system where certain inputs to the fast system may or may not be able to induce changes of the slow system leading to shifts of equilibrium values. These shifts can then be interpreted as expressions of synaptic plasticity.

Interaction of modulated water waves of finite depth

Ioannis Giannoulis
University of Ioannina, Greece

Starting from the Zakharov/Craig-Sulem formulation for the water waves problem with and without surface tension (gravity-capillary and gravity waves, respectively), we are interested in the macroscopic manifestation of the interaction of different weakly amplitude-modulated plane waves of the linearized problem when amplitude, macroscopic space and macroscopic time have the same scaling coefficient. Apart from the formal derivation of the corresponding modulation equations, we present results concerning their justification in the case of purely gravity waves, which are based on recent work of Alvarez-Samaniego and Lannes on the long-time well-posedness of the water waves problem of finite depth.



Determination of the Basin of Attraction by Contraction Metrics

Peter Giesl
University of Sussex, England

The determination of the basin of attraction of an equilibrium or periodic can be achieved by different methods. In this talk, we discuss a local method, which does not require any knowledge of the position of the equilibrium or periodic orbit, using a contraction metric. A contraction metric is a Riemannian metric with a local contraction property. It can be used to prove existence and uniqueness of a periodic orbit or equilibrium and determine a subset of its basin of attraction. We discuss both how contraction metrics can be used to determine the basin of attraction and converse theorems, ensuring the existence of such contraction metrics.

The CPA Method to compute Lyapunov functions via linear programming

Sigurður Hafstein
Reykjavik University, Iceland

Lyapunov functions give important information on the basin of attraction and robustness of attractors. Their generation for nonlinear systems is, however, a difficult task. In the talk a generally applicable method to compute continuous and piecewise affine Lyapunov functions for nonlinear systems via linear programming is described.

Dynamics of the MAPkinase Cascade

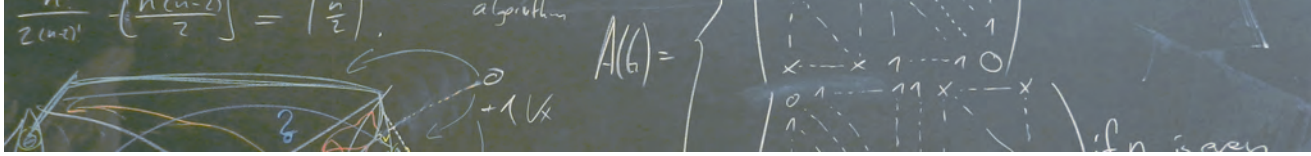
Juliette Hell
Freie Universität Berlin, Germany

The MAPKinase cascade is part of a signaling network in many organisms. In each layer of the cascade, a protein is phosphorylated or dephosphorylated via enzymatic reactions. In other words, phosphate groups are attached to or detached from the protein. A single layer of the cascade is called a (multiple) futile cycle. The fully phosphorylated form of the protein is the enzyme for the phosphorylation on the layer below. We show that the dual futile cycle shows bistability—a feature that explains a property called "good switch" by biologists. Furthermore we show that oscillations appear in a cascade of at least two layers. The results are based on bifurcation theory and geometric singular perturbation theory. This talk reports about joint work with Alan Rendall.

Existence of solutions to the Ericksen-Leslie model for a general class of free energies

Robert Lasarzik
Technische Universität Berlin, Germany

Tablets, smartphones as well as cardiograms and many other electronic devices make use of liquid crystals—a matter which shares properties of both conventional fluids and solid crystals. Liquid crystals are ubiquitous in our everyday life and, consequently, in the focus of ongoing research. In this talk, we study the equation of motion for nematic liquid crystals as a system of coupled nonlinear evolution equations. We present results on existence of generalized solutions to the Ericksen-Leslie model under general assumptions on the free energy potential. The method of proof relies on a suitable approximation scheme. Finally, we discuss possible relaxations of the model and an adaptation of the method of proof to non-nematic liquid crystals.



Perturbation of the eigenvalue problem of the 1-Laplace operator

Samuel Littig
Universität zu Köln, Germany

We consider the perturbed eigenvalue problem of the 1-Laplace operator, which is formally given by the equation

$$-\mathrm{Div}\frac{Du}{|Du|} + f(x,u) = \lambda\Big(\frac{u}{|u|} + g(x,u)\Big) \qquad (*)$$

We stipulate certain growth, but not continuity assumptions on f and g. This equation is highly singular and not well defined in the stated form. The associated variational problem is nonsmooth and non-convex. However, in the last years the unperturbed case (with $f = g = 0$) has successfully been treated with methods of nonsmooth critical point theory, in particular eigenfunctions u are defined as critical points and eigenvalues λ as critical values of the associated variational problem. Since f and g break the homogeneity of the problem, this definition does not directly apply in the perturbed case. We shall demonstrate, how to define reasonable solutions of $(*)$, prove the existence of a sequence of eigensolutions and provide a bifurcation result for the perturbed problem. In particular the eigenvalues of the unperturbed 1-Laplace operator turn out to be bifurcation values of the eigenvalues of the perturbed problem.

Equilibration of unit mass solutions to a degenerate parabolic equation with a nonlocal gradient nonlinearity

Johannes Lankeit
Universität Paderborn, Germany

In this talk we shall consider the long-term behaviour of solutions to the Dirichlet-problem of a degenerate parabolic equation with a nonlinear and nonlocal contribution of the gradient, which arises in the context of evolutionary game dynamics. We shall identify the (nonzero) $\mathrm{W}^{1,2}$-limit of solutions to

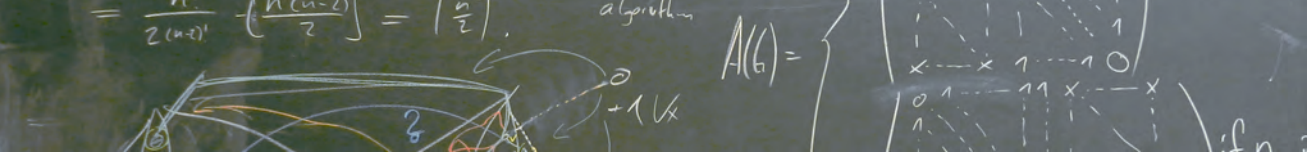
$$u_t = u\Delta u + u\int_\Omega |\nabla u|^2$$

in a bounded smooth domain under Dirichlet boundary conditions and prove convergence, if the initial data satisfy $\int u_0 = 1$. (This long-term behaviour is significantly different from cases where the initial mass is either smaller or larger than 1.)

Existence and stability of simple heteroclinic networks in $\mathbb{R}^4$, Part I

Alexander Lohse
Universität Hamburg, Germany
Universidade do Porto, Portugal
Sofia Castro
Universidade do Porto, Portugal

Heteroclinic cycles and networks occur as prototypes for stop-and-go dynamics in a wide range of applications from geophysics to neurosciences. They consist of finitely many equilibria ξ_j and connecting trajectories $[\xi_j \to \xi_{j+1}] \subset W^u(\xi_j) \cap W^s(\xi_{j+1})$, and may be structurally stable in systems with symmetry. In this talk we consider *simple* heteroclinic networks in $\mathbb{R}^4$-constructed from simple, non-homoclinic, robust cycles. There are few ways by which such cycles can be joined to form a network, and we provide a complete list of these. Using the stability index from Podvigina and Ashwin (Nonlinearity 24, 887–929, 2011), we describe non-asymptotic stability properties of individual cycles and derive information about stability of the entire network as well as nearby dynamics. This strongly depends on the equivariance of the system-networks with seemingly identical geometry, but different symmetry groups, display very different stability configurations.



Infinitely many global continua bifurcating from a single solution of an elliptic problem with a concave-convex nonlinearity

Rainer Mandel
Scuola Normale Superiore di Pisa, Italy
Thomas Bartsch
Justus-Liebig-Universität Gießen, Germany

In the talk I shall present global bifurcation results for semilinear elliptic boundary value problems on annuli which are of Ambrosetti-Brézis-Cerami type, i.e., where the nonlinearity is sublinear near zero and superlinear near infinity and looks like $\lambda u^q + u^p$ for $1 < q < 2 < p$. It is proved that there are infinitely many global continua of nodal solutions emanating from the trivial solution.

Doubly nonlinear evolution equations with nonpotential or dynamic relation between state variables

Jochen Merker
Hochschule für Technik, Wirtschaft und Kultur Leipzig, Germany
Aleš Matas
University of West Bohemia, Czech Republic

This talk is about doubly nonlinear evolution equations of the form $\frac{d}{dt}Bu + Au = f$, where A, B are nonlinear operators and B does not admit a potential. A particular case are systems of doubly nonlinear reaction-diffusion equations

$$\frac{\partial v}{\partial t} - \operatorname{div}\left(a(\nabla u)\right) = f$$

where u is vector-valued and the operator $Au = -\operatorname{div}\left(a(\nabla u)\right)$ may be degenerate or singular. We discuss existence and further properties of solutions on the one hand for static relations $v = b(u)$ between u and v which are nonpotential, i.e., b is not the derivative of a function φ_b, and on the other hand for additional dynamic equations for u determining the relation between u and v, which are closely related to thermodynamics like, e.g., $\frac{\partial u}{\partial t} = \frac{1}{\varepsilon}(v - b(u))$ with a relaxation time $\varepsilon > 0$.

[1] E. Di Benedetto, R. E. Showalter, Implicit degenerate evolution equations and applications, SIAM J. Math. Anal. 12 (1981), 731–751.

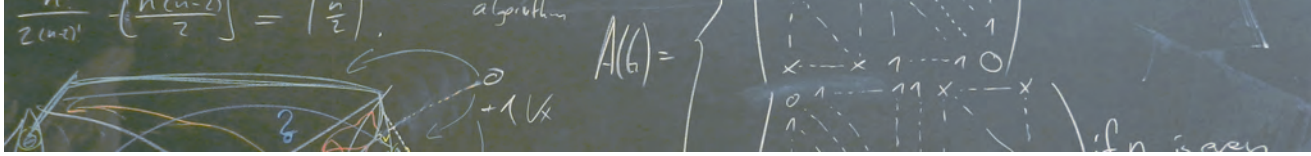
[2] J. Merker, M. Krüger, On a variational principle in thermodynamics, Continuum Mechanics and Thermodynamics 25 (2013), 779-793.

[3] J. Merker, A. Matas, On doubly nonlinear evolution equations with nonpotential or dynamic relation between the state variables, preprint

Pseudo-simple cycles in $\mathbb{R}^4$ and their properties

Olga Podvigina
Institute of Earthquake Prediction Theory and Mathematical Geophysics, Russia
Pascal Chossat
Université de Nice Sophia-Antipolis, France

In a recent paper the authors have identified a new type of robust heteroclinic cycle for equivariant vector fields in $\mathbb{R}^4$, which had been formerly mixed-up with the class of simple heteroclinic cycles. Simple cycles have well-known properties, in particular their asymptotic stability follows classical conditions on the eigenvalues of the Jacobian matrix evaluated at the equilibria which compose the cycle. In contrast pseudo-simple cycles appear to have different asymptotic behavior, being



for example generically completely unstable if the symmetry group of the vector field belongs to SO(4) and fragmentarily stable if the eigenvalues satisfy certain conditions and the symmetry group contains reflections in $\mathbb{R}^4$. We present these objects and their properties.

Existence results to the nonlinear peridynamic model in nonlocal elastodynamics

Dimitri Puhst
Technische Universität Berlin, Germany

Peridynamics is a nonlocal elasticity theory based on differences in the deformation instead of the deformation gradient. It is therefore suitable to describe long range forces as well as material failure. In this talk, we shall give an introduction into the theory of peridynamics and consider its equation of motion as a nonlinear second order evolution equation. We present results on existence of weak and measure-valued solutions in the absence of any monotonicity assumption on the peridynamic operator. The method of proof also applies to other nonlocal partial differential equations.

Eliminating restrictions of time-delayed feedback control using equivariance

Isabelle Schneider
Freie Universität Berlin, Germany
Matthias Bosewitz
Freie Universität Berlin, Germany

Pyragas control is a widely used time-delayed feedback control for the stabilization of periodic orbits in dynamical systems. In this talk we investigate how we can use equivariance to eliminate restrictions of Pyragas control, both to select periodic orbits for stabilization by their spatio-temporal pattern and to render Pyragas control possible at all for those orbits. Another important aspect is the optimization of equivariant Pyragas control, i.e., to construct larger control regions. The ring of n identical Stuart-Landau oscillators coupled diffusively in a bidirectional ring serves as our model.

On periodic orbits of exchange rate equations with state-dependent delay

Eugen Stumpf
Universität Hamburg, Germany

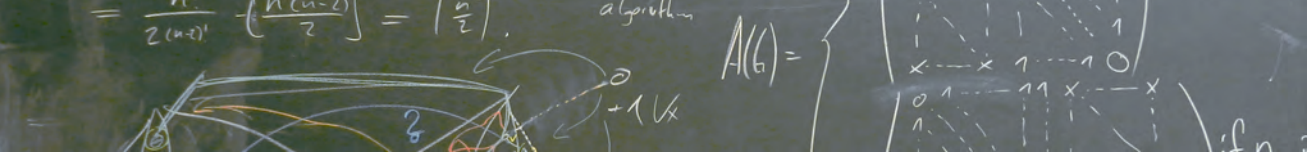
In this talk we consider a currency exchange rate model given by a differential equation with state-dependent delay. After describing the basic assumptions and properties of the differential equation under consideration, we state a result about the existence of periodic orbits and briefly explain its proof. Afterwards we introduce a more general exchange rate equation with state-dependent delay and discuss the attempt to carry over the result about the existence of periodic orbits to this more general situation.

Reparametrisations in the shadowing theory for vector fields.

Sergey Tikhomirov
Max Planck Institute for Mathematics in the Science, Germany

Shadowing theory studies properties of approximate trajectories (pseudotrajectories). The main question of the shadowing theory is the following: when for any pseudotrajectory does there exist a close exact trajectory?

The main difference between the shadowing problem for vector fields and the similar problem for discrete time dynamical systems is related to the necessity of reparametrization of shadowing



trajectories in the former case. In the modern theory of shadowing the most important types of allowed reparametrizations correspond to standard and oriented shadowing properties, investigated in the 80's by Komuro and Thomas. In 1984 Komuro proved that those notions are equivalent for nonsingular vector fields and asked whether those two notions are different in general.

We provide an example showing that those shadowing properties are not equivalent. An example is a non-structurally stable 4-dimensional vector field based on a special 2-dimensional vector field whose trajectories look like spirals.

The semiflow of a delay differential equation on its solution manifold

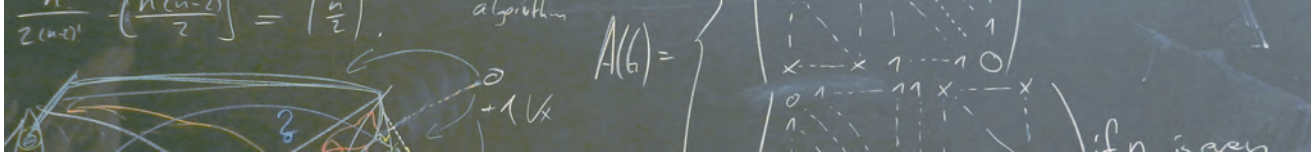
Hans-Otto Walther
Justus-Liebig-Universität Gießen, Germany

We construct a semiflow of differentiable solution operators for an autonomous delay differential equation in the general case which covers time-invariant and state-dependent delay, bounded or unbounded. This semiflow lives on a submanifold of finite codimension in the Fréchet space of continuously differentiable maps on the nonpositive reals. The hypothesis on the functional defining the differential equation is continuous differentiability (in the sense of Michel and Bastiani) together with a mild extension property for the derivatives.

On bifurcation for semilinear elliptic Dirichlet problems on shrinking domains

Nils Waterstraat
University of Kent, England

We study bifurcation from a branch of trivial solutions of semilinear systems of elliptic Dirichlet boundary value problems on star-shaped domains, where the bifurcation parameter is introduced by shrinking the domain. We associate to this bifurcation problem two curves of Lagrangian subspaces of a symplectic Hilbert space and construct a Maslov index, which, roughly speaking, counts the number of intersections of these curves. Our main result states that a non-vanishing Maslov index entails bifurcation. Our proof uses a generalised Morse index theorem for the linearised equations, which reduces for strongly elliptic equations to a theorem of Stephen Smale from the sixties. This is joint work with Alessandro Portaluri from the University of Turin.



Sektion 4: Diskrete Mathematik / Section 4: Discrete Mathematics

Sektionsleitung / Coordination: Mathias Schacht, Hamburg; Volkmar Welker, Marburg

Tessellation Inversion and Tomography Applications

Andreas Alpers
Technische Universität München, Germany

The Voronoi diagram of a finite set of points (sites) decomposes the d-dimensional space into cells such that, for all points in a cell, the Euclidean distance to the site within that cell is not larger than the distance to all other sites. In this talk we consider the inverse problem for rather general distance functions: recover the sites and parameters of the distance functions for a given tessellation.

While special cases have been studied in the past, there is much recent interest in the general problem originating from several applications. Along with an application from the field of tomographic imaging of polycrystalline structures, we present new general results that lead to an efficient inversion algorithm for Voronoi, Laguerre, and generalized power diagrams. This is joint work with Andreas Brieden (Universität der Bundeswehr München) and Peter Gritzmann (Technische Universität München).

The homogenized hives matrix has a regular unimodular triangulation

Christian Haase
Freie Universität Berlin, Germany

In their breakthrough paper, Knutson and Tao proved the saturation conjecture about the representation theory of $\mathrm{GL}_n(\mathbb{C})$: for partitions λ, μ, ν and an integer N the irreducible representation V_ν occurs as a subrepresentation of $V_\lambda \otimes V_\mu$ if $V_{N\nu}$ occurs inside $V_{N\lambda} \otimes V_{N\mu}$.

They reformulated the conjecture in terms of the hives polytope $H(\lambda, \mu, \nu)$, and show that $H(\lambda, \mu, \nu)$ is non-empty only if it contains a point with all coordinates integral.

De Loera and McAllister observe that this would follow if the defining matrix of $H(\lambda, \mu, \nu)$, considered as a vector configuration, had a unimodular cover. Based on computer experiments they conjecture that this homogenized hives matrix even has a unimodular triangulation.

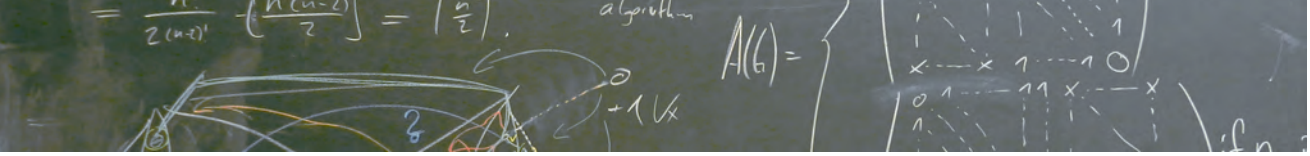
In this talk, I shall argue that the original proof by Knutson and Tao already implies the existence of a regular unimodular triangulation.

Cuts and cycles in transitive graphs

Matthias Hamann
Universität Hamburg, Germany

We discuss the connections between the cycle space and the cut space of transitive graphs. In particular, we shall see that the cut space of a transitive graph G is a finitely generated $\mathrm{Aut}(G)$-module as soon as the same holds for the cycle space.

In addition, we discuss accessibility in transitive locally finite graphs: when does there exist some positive integer n such that any two ends can be separated by removing at most n vertices? We use our previously mentioned result to see that this is the case if the cycle space is generated



by cycles of bounded length. It turns out that this condition on the cycle space is satisfied by various natural classes of graphs.

Forcing Hamilton cycles in infinite graphs

Karl Heuer
Universität Hamburg, Germany

We want to investigate when an infinite graph has a Hamilton cycle. To overcome the problem what an infinite cycle should be, we use a definition which depends not just on the graph itself but on a topological space consisting of the graph together with its ends. To be more precise, we look at the Freudenthal compactification of the graph. This enables us to extend theorems about the existence of Hamilton cycles in finite graphs to locally finite graphs. In particular we extend a theorem of Oberly and Sumner and, partially, a theorem of Asratian and Khachatrian to locally finite graphs.

Plethysm and lattice point counting

Thomas Kahle
Otto von Guericke Universität Magdeburg, Germany
Mateusz Michałek
University of California at Berkeley, United States of America

We show that the coefficient of the Schur functor S^λ in the decomposition of the plethysm $S^\mu(S^k)$ into irreducibles is the solution to a lattice point counting problem. Consequently, for each fixed μ the solution to this problem is a piecewise quasi-polynomial in (λ, k). We show how to use computer algebra to determine this function explicitly when μ is a partition of 4 or 5. We also discuss asymptotics of the resulting piecewise quasi-polynomials. This is joint work with Mateusz Michałek.

Affine Symmetries of Orbit Polytopes

Frieder Ladisch
Universität Rostock, Germany

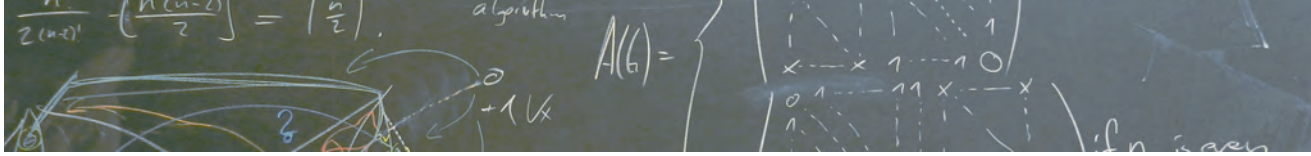
An orbit polytope is the convex hull of an orbit under a finite group $G \leq \mathrm{GL}(d, \mathbb{R})$. We consider the possible affine symmetry groups of orbit polytopes. For every group, there is an open and dense set of "generic points" such that the orbit polytopes of generic points have conjugated affine symmetry groups and are minimal in a certain sense. For some groups G, the affine symmetry group of every orbit polytope is strictly larger than G, but for most groups, this is not the case. The affine symmetry group of a generic orbit polytope can be computed from the character of the group G.

We also show that every abstract group that is isomorphic to the full euclidian symmetry group of an orbit polytope, is also isomorphic to the full affine symmetry group of an orbit polytope, with exactly three exceptions: the elementary abelian groups of orders 4, 8 and 16. This answers a question of Babai (1977). This is joint work with Erik Friese.

On convex subsets of lattice tilings

Barbara Langfeld
Christian-Albrechts-Universität zu Kiel, Germany

A set $K \subseteq \mathbb{R}^d$ is called *lattice-convex* if K is the intersection of $\mathbb{Z}^d$ and a convex subset of $\mathbb{R}^d$. A *tiling* is a partition of $\mathbb{Z}^d$ into identical translated copies of some finite, lattice-convex set T. In this talk we consider *lattice tilings*, i.e., the translation vectors form a sublattice $\mathbb{L}$ of $\mathbb{Z}$.



We study subsets of the form $S \oplus T$ of lattice tilings $(\mathbb{L}, T)$, where $S \subseteq \mathbb{L}$ is finite and full-dimensional. We present a necessary and a sufficient condition for the existence of *lattice-convex* subsets of this form and show that these are 'rare' in the plane if one additionally requires S to be not centrally symmetric. We apply our results to answer a problem in the the realm of discrete covariograms. This is joint work with Gennadiy Averkov.

Turan problem in weakly quasirandom hypergraphs

Christian Reiher
Universität Hamburg, Germany
Vojtech Rödl
Emory University, United States of America
Mathias Schacht
Universität Hamburg, Germany

In recent work, we found a new proof of a conjecture due to Erdős and Sós stating that large quasirandom 3-uniform hypergraphs that are weakly quasirandom with density greater than $\frac{1}{4}$ contain four vertices spanning at least three hyperedges. This was proved earlier by Glebov, Kral, and Volec with the help of flag algebras and computers. The new proof is based on the hypergraph regularity method and gave rise to further developments in this field that are surveyed in this talk.

Coxeter elements from Springer theory

Coxeter elements from Springer theory
Victor Reiner
University of Minnesota, United States of America
Vivien Ripoll
Universität Wien, Austria
Christian Stump
Freie Universität Berlin, Germany

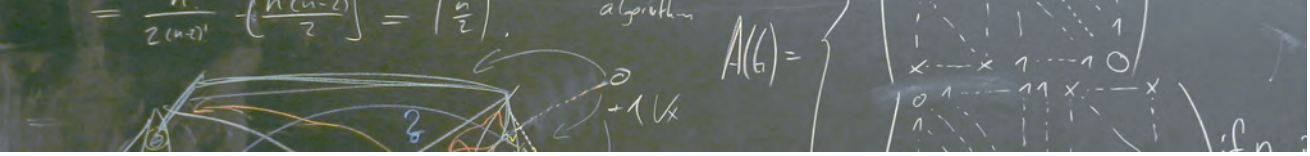
Coxeter elements play an important role in the theory of finite Coxeter groups. One can generalize their definition and call an element c in a Coxeter group W *Coxeter element* if c is maximally regular in the sense of Springer theory. In this talk, I shall show that an element c in W is a Coxeter element in this generalized sense if and only if there exists a simple system of reflections such that c is the product of the generators in this simple system.

If time permits, I shall also provide analogous statements for Shephard groups and for complex reflection groups, and I shall also show that this general definition yields a simple transitive action of the Galois group of the field of definition on the set of conjugacy classes of Coxeter elements.

The 2-factor theorem—a remarkable achievement of a German genius

Bjarne Toft
University of Southern Denmark, Denmark

A 2-factor in a graph is a set of disjoint cycles covering all vertices of the graph. A complete characterization of the maximal graphs without 2-factors is presented. The proof is based on the general 2-factor theorem. Also an easy proof of the theorem that any $(2r+1)$-regular graph with at most $2r$ bridges has a 2-factor is given, and moreover all $(2r+1)$-regular graphs with $2r+1$ bridges without a 2-factor are found. This generalizes Julius Petersen's famous theorem (1891) that any 3-regular graph with at most two bridges has a 1-factor, and in addition the Sylvester graphs. The results will be put into a historical context.



The first to obtain the general 2-factor theorem was Hans-Boris Belck in 1949 in his Ph.D. thesis, written at the University of Frankfurt, when he was only 20 years old. In fact Belck obtained the general k-factor theorem, and he also presented the first purely graph theoretic proof of Tutte's 1-factor theorem from 1947. In addition to his dissertation Belck published only one mathematical paper (in Crelle's Journal 1950), and thereafter he disappeared out of sight. The lecture will present biographical details about Belck. It is really a pity that he was not properly honoured in his lifetime for his remarkable mathematical achievements.

However, the terminology of Belck was unusual and his proofs not as easy to read as the very elegant theory of 1-factors, presented in 1950 by T. Gallai (who obtained as a byproduct what we now call the Edmonds-Gallai Theorem). In 1951 Tutte obtained the general f-factor theorem as a generalization of the k-factor theorem, and in 1953 he showed how to reduce it in a simple way to his 1-factor theorem.

The research behind this talk was initiated at the Department of Mathematics at London School of Economics in the fall of 2011, in collaboration with Jan van den Heuvel.

Classification of Trading Networks with Combinatorial Optimization

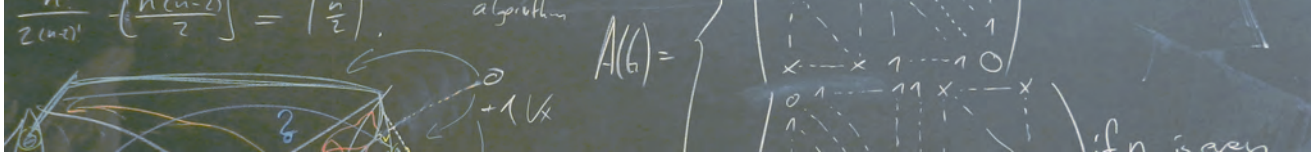
Stefan Wiesberg
Universität Heidelberg, Germany
Gerhard Reinelt
Universität Heidelberg, Germany

Trading networks can be modeled as directed graphs: The vertices correspond to companies or countries, the arcs indicate the flow of trade goods within a given period of time.

The underlying trading markets can be organized in different ways. Some resemble production chains, where goods are iteratively sold from one group of companies to the next one (hierarchical market structure). Others have a group of companies in the center of the market, which sell their goods to several peripheral company groups (center-peripheral market structure). To classify a given market in this manner is hence interesting from both a scientific and a strategic viewpoint.

The market classification can be modeled as a combinatorial optimization problem. We express it as a nonlinear integer program, which is actually a generalization of well-known problems such as the Quadratic Assignment, Linear Ordering, and the Traveling Salesman Problem. An exact solver is presented which uses new linearization techniques and exploits the relations to the problem's well-known special cases. It is able to classify networks up to 10,000 times faster than comparable approaches from the literature.

The solver is applied to real-world trading network data. We present results for the recent trading between German photo agencies as well as for international trading data provided by the United Nations.



Sektion 5: Funktionalanalysis, Reelle & Komplexe Analysis / Section 5: Functional Analysis, Real & Complex Analysis

Sektionsleitung / Coordination: Dorothea Bahns, Göttingen; Lutz Weis, Karlsruhe

Nonsmooth Pseudodifferential Operators and Applications

Helmut Abels
University of Regensburg, Germany
Christine Pfeuffer
University of Regensburg, Germany

We discuss the calculus of non-smooth pseudodifferential operators with coefficients, which have a limiting regularity with respect to the spacial variable x. Although the standard results on arbitrary compostions of pseudodifferential operators break down and the operators have limiting mapping properties, they can still be used to construct parametrizes for (parameter-)elliptic operators and various applications of it. We shall discuss some applications and present a recent result on characterization of non-smooth pseudodifferential operators and spectral invariance.

On perturbations of generators of analytic semigroups

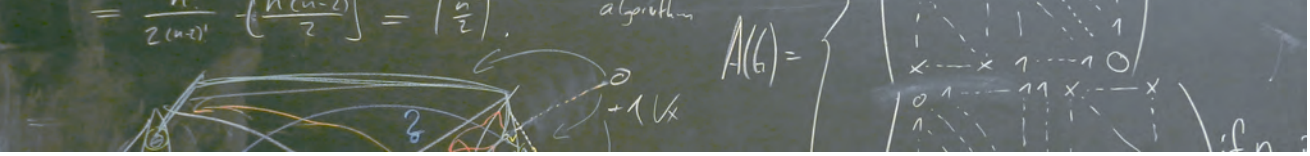
Martin Adler
University of Tübingen, Germany
Miriam Bombieri
University of Tübingen, Germany
Klaus-Jochen Engel
University of L'Aquila, Italy

In a recent paper the authors presented a general perturbation result for generators of strongly continuous semigroups. It is our aim to replace in case the unperturbed semigroup is analytic, the various conditions appearing in our former result by simpler assumptions on the domain and range of the operators involved. The power of our main result consists in the systematic treatment of various classes of PDE's.

Entire functions, zero-location and structured minors: Characterizations, structural operations and applications

Prashant Batra
Technische Universität Hamburg-Harburg, Germany

For real entire functions with exclusively negative zeros important connections to totally non-negative (TNN) matrices exist. Characterization of those entire functions whose Taylor expansion $\sum a_k z^k$, $a_0 > 0$, generates totally non-negative matrices $(a_{j-i})_{i,j=0}^{\infty}$, is a consequence of the AESW-theorem (theorem of Aissen, Edrei, Schoenberg, and Whitney). The structured matrices $H(g,h)$, exhibited by Hurwitz in his variant of the Hermite-Jacobi approach to quadratic forms, are known to have all minors non-negative if and only if the polynomial $f(z) = h(z^2) + zg(z^2)$ with positive coefficients has all zeros in the closed left half-plane, i.e., if and only if (g,h) is a generalized positive pair with positive coefficients. Recent work by Holtz and Tyaglov (2012) connected total



non-negativity of an infinite supermatrix $\hat{H}$ of $H(g', g)$ with the zero-location of g via continued fractions and factorizations of infinite TNN matrices. Dyachenko (2014) gave a complete characterization of those series generating a TNN matrix $\hat{H}$. In connection with transforms of the Riemann Ξ-function the TNN minors yield a set of coefficient inequalities (exponentially growing with the number of considered coefficients) bearing on the Riemann hypothesis.

We contribute the following: For real entire functions f of the form $f(z) = e^{\beta \cdot z} g(z), \beta \geq 0$, where g is of genus zero, we generalize the Holtz-Tyaglov result on polynomials, and exhibit its dependency from the AESW-theorem. Our analytic proof reveals for the first time the intimate connection of $\hat{H}$ and $H(f', f)$. Hence, we generalize our results to the case of a positive pair (f_1, f_2) with positive coefficients; this yields an independent simple, self-contained proof of Dyachenko's result for the considered functions. We proceed and show that the componentwise (Schur-Hadamard) product of matrices $\hat{H}_i$ and $\hat{H}_j$ is totally non-negative, thus extending a result of Garloff and Wagner (1996) to the supermatrices $\hat{H}$, and entire functions. We find an essential set of minors in $\hat{H}$ which determines total non-negativity considering Grommer's seemingly different characterization of exclusively negative zeros in terms of Markov moments (which can be related to the AESW-theorem via Mittag-Leffler expansions). The Grommer characterization is computationally transformed here to reveal an essential set of minors in $\hat{H}$, in the polynomial and, more important, in the transcendental case. This yields a transcendental, computational characterization of correctness of the Riemann hypothesis involving only essential minors. We show that the Laguerre-Turán inequalities (involving three consecutive coefficients) discussed in this connection since Pólya's question of 1927, and the successive four term improvement by Craven-Csordas (2002), are a weaker necessary criterion for the Riemann hypothesis than the four term inequality from the first non-trivial of our essential minors.

Dirichlet forms for singular diffusion processes

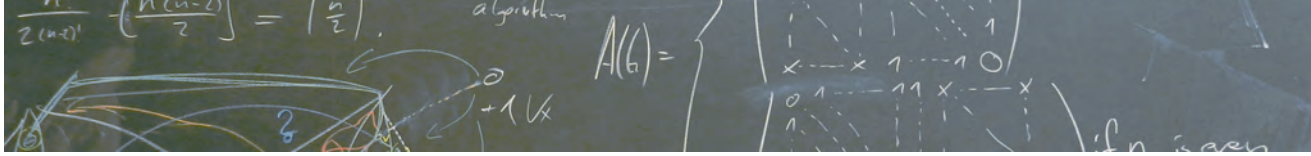
Uta Freiberg
Universität Stuttgart, Germany
Christian Seifert
Technische Universität Hamburg-Harburg, Germany

We study Dirichlet forms on bounded open subsets of euclidean spaces describing diffusion processes. By introducing speed measures supported on proper subsets we obtain so-called singular diffusions. For the process this corresponds to a time change allowing for jumps. This setup yields an analytic description of a jump-diffusion process, for example on Koch's snowflake.

On Spectral Properties of Certain Random Operators

Raffael Hagger
Technische Universität Hamburg-Harburg, Germany

After the introduction of random operators to nuclear physics by Eugene Wigner in 1955, random quantum systems have grown in popularity. Wigner's idea was to consider families of Hamiltonians that underlie a certain probability distribution to describe overly complicated systems. Of particular interest are, of course, the spectra of these Hamiltonians. In this talk we consider random, in general non-self-adjoint, tridiagonal operators on the Hilbert space of square-summable sequences, which can be used to describe quantum particles on a lattice. In particular, we are interested in the so-called Feinberg-Zee random hopping matrix, that, despite its simple appearance, seems to have a very complicated spectrum.



The moment problem on infinite dimensional basic semi-algebraic sets

Maria Infusino
Universität Konstanz, Germany

This talk aims to introduce an infinite dimensional version of the classical moment problem, namely the full moment problem on nuclear spaces, and to explore certain instances of this problem. Given a nuclear space X, the question addressed is whether an infinite sequence of functions m_n, s.t. each m_n is an element of the n-th symmetric tensor product of the topological dual X', is actually the sequence of moment functions of a finite non-negative Borel measure supported on a given subset K of X'.

I present recent joint work with Tobias Kuna and Aldo Rota about the case in which K is a generic closed basic semi-algebraic subset of the space of generalized functions on $\mathbb{R}^d$. Our approach combines a classical result about the analogue of the Hamburger moment problem on nuclear spaces with some techniques recently developed for the moment problem on basic semi-algebraic sets of $\mathbb{R}^d$. In this way, we derive a complete characterization of the support K of the realizing measure in terms of its moment functions. As concrete examples, I show how to apply our theorem to the set of all Radon measures, the set of all sub-probabilities, the set of all simple point configurations.

Starting from this result, I shall also sketch some new directions that I am currently investigating in relation to the infinite dimensional moment problem.

Ball convex bodies in Minkowski spaces

Thomas Jahn
Technische Universität Chemnitz, Germany
Horst Martini
Technische Universität Chemnitz, Germany
Christian Richter
Friedrich-Schiller-Universität Jena, Germany

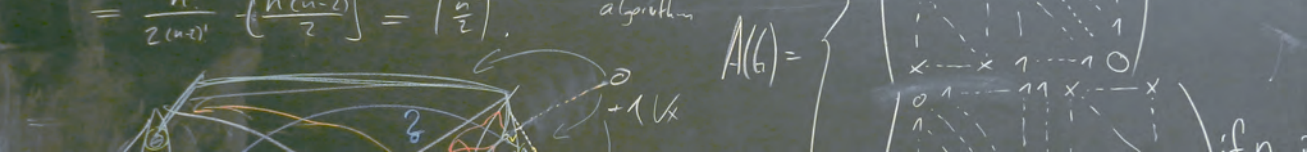
A non-empty intersection of closed balls of unit radius in a finite-dimensional normed space is called a *ball convex body*. We discuss representations of ball convex bodies that can be seen as analogues of representations of classical convex bodies from inside (unions of simplices) and outside (intersections of half-spaces). The situation turns out to be more convenient if the underlying norm is strictly convex.

An application concerns the representation of diametrically maximal bodies. These are sets whose diameters increase as soon as one adds at least one point.

Ideals and Bands in Pre-Riesz Spaces

Anke Kalauch
Technische Universität Dresden, Germany

In the theory of vector lattices, ideals, disjointness and bands are well-investigated notions and a fundamental tool for the study of operators on vector lattices. Spaces of operators between vector lattices have a natural partial order, but are not vector lattices, in general. We introduce the above notions in partially ordered vector spaces and present their properties in pre-Riesz spaces, which cover all Archimedean directed partially ordered vector spaces. Moreover, disjointness preserving and band preserving operators on pre-Riesz spaces are discussed.



Infinite Dimensional Continuity and Fokker-Planck-Kolmogorov Equations

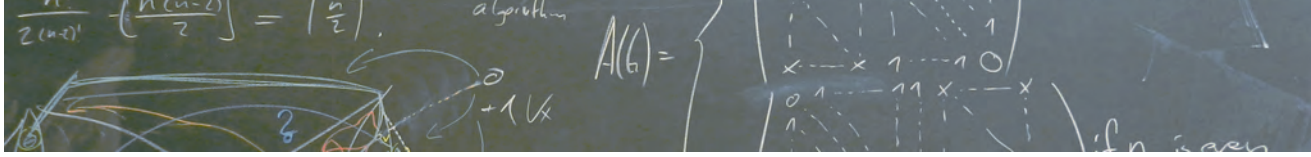
Michael Röckner
Universität Bielefeld, Germany

We present a new uniqueness result for solutions to Fokker-Planck-Kolmogorov (FPK) equations for probability measures on infinite-dimensional spaces. We consider infinite-dimensional drifts that admit certain finite dimensional approximations. In contrast to most of the previous work on FPK-equations in infinite dimensions, we include cases with non-constant coefficients in the second order part and also include degenerate cases where these can even be zero, i.e., we prove uniqueness of solutions to continuity equations. Also new existence results are proved. Applications to proving well-posedness of Fokker-Planck-Kolmogorov equations associated with SPDEs and of continuity equations associated with PDE are discussed. This is joint work with Vladimir Bogachev, Giuseppe Da Prato and Stanislav Shaposhnikov

On finite elements in some vector lattices of nonlinear operators

Martin R. Weber
Technische Universität Dresden, Germany
Marat A. Pliev
South Mathematical Institute of the Russian Academy of Sciences, Russia

Orthogonally additive and order bounded (not necessary linear) operators between vector lattices E and F form a Dedekind complete vector lattice $\mathcal{U}(E,F)$ provided F is Dedekind complete (1990). Those operators are called abstract Uryson operators and generalize the well known Uryson integral operators. In Archimedean vector lattices finite elements (as abstract analogon to continuous functions with compact support) have been introduced in 1972 and are actively studied in the last years. In the talk finite elements in $\mathcal{U}(E,F)$ are dealt with. A description of the finite elements is given, in particular, for $\mathcal{U}(\mathbb{R}^n,\mathbb{R}^m)$. Some cases are considered when rank one operators are finite elements in $\mathcal{U}(E,F)$.



Sektion 6: Geometrie & Topologie / Section 6: Geometry & Topology

Sektionsleitung / Coordination: Birgit Richter, Hamburg; Nathalie Wahl, Copenhagen

K-theory is algorithmically computable

Michal Adamaszek
University of Copenhagen, Denmark

Ordinary homology and cohomology of simplicial complexes can be easily calculated by a computer, and has become an instrumental tool in computational topology. Many other interesting homotopy invariants are either provably uncomputable (like the fundamental group) or their complexity status is not known.

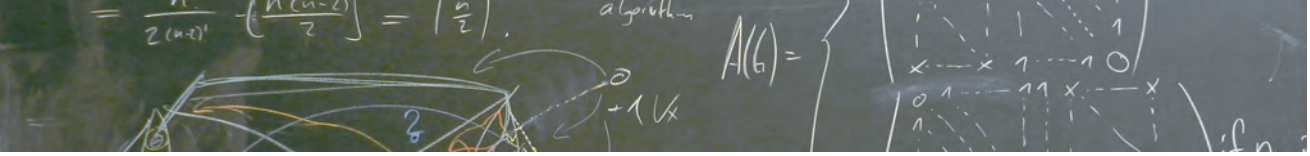
We present an algorithm which takes a finite simplicial complex X and in finitely many steps computes its complex topological K-theory group $\mathrm{K}(X)$. Our approach is based on recent progress in computational homotopy theory, in particular on the computability of Postnikov systems and homotopy classes of maps. Joint work with Marek Krcal and Uli Wagner (IST Vienna).

Geometric permutations and two applications

Johannes Böhm
Friedrich-Schiller-Universität Jena, Germany

An orthoscheme is a special simplex first explained by L. Schläfli in 1859. An orthoscheme in d-dimensional space of constant curvature generates at first a Napier cycle and then a Napier cycle type. To a Napier cycle type belongs a set of special permutations, called geometric permutations. As a represent of these permutations a special permutation of these ones can be chosen, called excellent permutation. This permutation generates of course also the Napier cycle type. The intersection of all the orthoschemes of a Napier cycle is called the hyperbolic kernel belonging to this Napier cycle.

In 1936, H. S. M. Coxeter and G. T. Bennett formulated a geometric connection between elements of elliptic rectangular triangles (orthoschemes) and a special configuration of semi-circles over a line (Coxeter-Bennett configuration), called Coxeter Theorem. Coxeter extended these results to the d-dimensional elliptic case and then to the hyperbolic case. His hints to the case of a Minkowskian space find a generalization of this theorem here. Thus a generalization of Napier's rule can be given. Generally for Minkowskian spaces of arbitrary dimension the connection between types of orthoschemes and permutations can be described. For proving some important assertions the knowledge of the structure of geometric permutations is used. The theory for hyperbolic kernels is a first application of geometric permutations. A second application of geometric permutations is the theory of self-dual 2−colored necklaces with $2n$ beads searched by R. W. Robinson and E. M. Palmer in 1984 and later by W. J. A. Sloane in 1995. Here can by shown that the number of hyperbolic kernel types of dimension d agrees with the number of necklace types having $2(d+3)$ beads and beings self-dual and 2-colored.



Proper equivariant stable homotopy theory

Dieter Degrijse
University of Copenhagen, Denmark
Markus Hausmann
Rheinische Friedrich-Wilhelms-Universität Bonn, Germany
Wolfgang Lück
Rheinische Friedrich-Wilhelms-Universität Bonn, Germany
Irakli Patchkoria
University of Copenhagen, Denmark
Stefan Schwede
Rheinische Friedrich-Wilhelms-Universität Bonn, Germany

We construct a symmetric monoidal stable model category of proper G-spectra where G is any Lie group. The homotopy category of this model category is generated as a triangulated category by the G-orbits with compact isotropy and admits restriction functors to genuine H-spectra for any compact subgroup H of G. When G is discrete, a proper G-spectrum gives rise to a G-Mackey functor by taking homotopy groups. If G has enough bundle representations, then on finite proper G-CW complexes we identify the cohomology theory represented by the sphere G-spectrum as Lück's equivariant stable cohomotopy. Further we shall provide an algebraic model for rational proper G-spectra for a discrete group G. If time permits we shall also discuss relations to equivariant K-theory.

Stable finiteness properties of infinite discrete groups

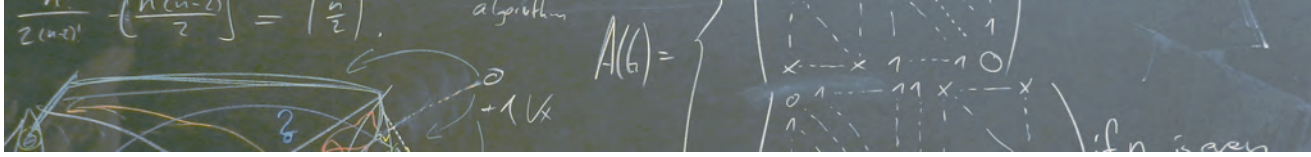
Dieter Degrijse
University of Copenhagen, Denmark
Irakli Patchkoria
University of Copenhagen, Denmark
Noé Bárcenas
Universidad Nacional Autónoma de México, Mexico

Let G be an infinite discrete group. A classifying space for proper actions of G is a proper G-CW-complex X such that the fixed point sets X^H are contractible for all finite subgroups H of G. In this paper we consider the stable analogue of the classifying space for proper actions in the category of proper G-spectra and study finiteness properties of such a stable classifying space for proper actions. We investigate when G admits a stable classifying space for proper actions that is finite or of finite type and relate these conditions to the smallness of the sphere spectrum in the homotopy category of proper G-spectra and to classical finiteness properties of the Weyl groups of finite subgroups of G. If G is virtually torsion-free, we show that the smallest possible dimension of a stable classifying space for proper actions coincides with the virtual cohomological dimension of G thus providing a geometric interpretation of the virtual cohomological dimension of a group. We also present and example of a group that admits a stable classifying space for proper actions of strictly smaller dimension than the dimension of any classifying space for proper actions.

TMF-charakteristische Zahlen

Gerd Laures
Ruhr-Universität Bochum, Germany

Bordismenringe erhält man, wenn man auf einer Menge von Mannigfaltigkeiten zwei Objekte miteinander identifiziert, die sich nur um einen Rand einer höher dimensionalen Mannigfaltigkeit unterscheiden. Charakteristische Zahlen spielen bei ihrer Berechnung eine wichtige Rolle. Zum Beispiel bestimmen Stiefel-Whitney Zahlen und K-theoretische Pontryagin-Zahlen die Bordismen-



klassen von orientierten und Spin-Mannigfaltigkeiten. Allerdings stimmt das nicht mehr, wenn man Strukturen betrachtet, die näher an einer Trivialisierung des Tangentialbündels liegen. In dem Vortrag werden neue charakteristische Zahlen für String-Mannigfaltigkeiten vorgestellt, die in der Kohomologietheorie der topologischen Modulformen liegen.

Descent up to nilpotence in equivariant stable homotopy theory

Niko Naumann
Universität Regensburg, Germany

We report on joint work in progress with Akhil Mathew and Justin Noel. It permits to understand classical results like Quillen's F-isomorphism, Brauer induction and the Hopkins-Kuhn-Ravenel character theory on an equal footing and leads to new results.

Stable motivic homotopy groups of spheres

Oliver Röndigs
Universität Osnabrück, Germany

In joint work with Markus Spitzweck and Paul Arne Østvar, we study the spectral sequence based on Voevodsky's slice filtration. This filtration on the stable homotopy category of motivic spectra over a field F measures the amount of Tate suspensions which are necessary to construct a given motivic spectrum. Work of Levine and Voevodsky shows that the slices of the motivic sphere spectrum are determined by the second page of the topological Adams-Novikov spectral sequence. We use this information to compute the zeroth and the first stable motivic homotopy groups of spheres over fields of characteristic zero. This supplies an independent proof of Morel's identification of the zeroth stable stem with the graded Milnor-Witt K-theory of the base field, up to completion with respect to the Hopf map. The first stable stem is described as an extension of a Milnor K-theory group modulo 24 and the image of the unit map for hermitian K-theory. An important ingredient are convergence results for the slice spectral sequence of cellular motivic spectra of finite type.

Signature and higher index theory

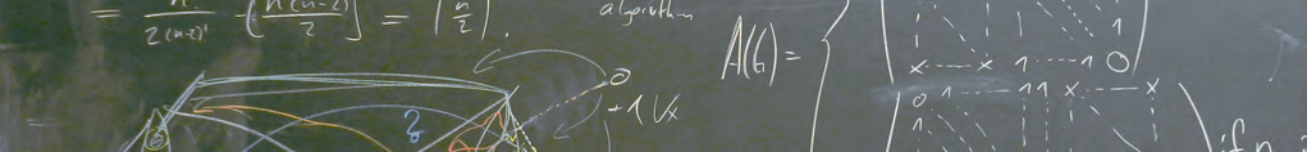
Thomas Schick
Georg-August-Universität Göttingen, Germany

Higson and Roe have used homological algebra over C^*-algebras to map the surgery exact sequence for smooth manifolds to an exact sequence of K-theory groups of C^*-algebras (the latter containing as particular case the Baum-Connes assembly map). Jointly with Paolo Piazza, we have developped an appropriate secondary large scale index theory to directly construct all the maps involved in terms of higher index theory of the signature operator. This allows in particular to extend the result to the topological category. We present this result. To obtain numerical results we show how one can systematically map further to cyclic homology groups to obtain numerical invariants.

Homology and the stability problem in the Thompson group family

Markus Szymik
NTNU Norwegian University of Science and Technology, Norway

I shall present the result that Thompson's group V is acyclic. This embeds into a general discussion of the symmetries of algebraic theories and their algebraic K-theory. Other examples and applications of this circle of ideas will be given insomuch as time permits.



A dihedral version of the Jones isomorphism

Massimiliano Ungheretti
University of Copenhagen, Denmark

The Jones isomorphism relates Hochschild homology $HH_{-\bullet}(S^*X)$ and cohomology of the free loop space $H^\bullet(LX)$, for any simply connected space X. This and its S^1-equivariant version have provided algebraic models for string topology. In work in progress, we use similar simplicial methods to explore the $O(2)$-equivariant case and give an isomorphism $DH_{-\bullet}(S^*X) \cong H^\bullet_{O(2)}(LX)$, involving a flavour of dihedral homology.

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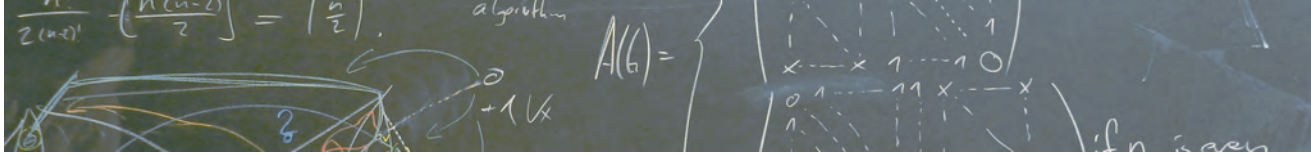


Sektion 7: Geschichte & Didaktik der Mathematik / Section 7: History of Mathematics & Mathematics Education

Sektionsleitung / Coordination: Gabriele Kaiser, Hamburg; Reinhard Siegmund-Schultze, Agder

Mathematik mit digitalen Werkzeugen: lernen.verstehen.lehren

Bärbel Barzel
University of Duisburg-Essen, Germany
Marcel Klinger
University of Duisburg-Essen, Germany
Daniel Thurm
University of Duisburg-Essen, Germany

Im Rahmen einer Kooperation des DZLM mit dem Kultusministerium in NRW wurde die staatliche Lehrerfortbildungsreihe „GTR kompakt“ durchgeführt, um Lehrkräfte auf einen sinnvollen Einsatz digitaler Werkzeuge im Mathematikunterricht der Oberstufe vorzubereiten.

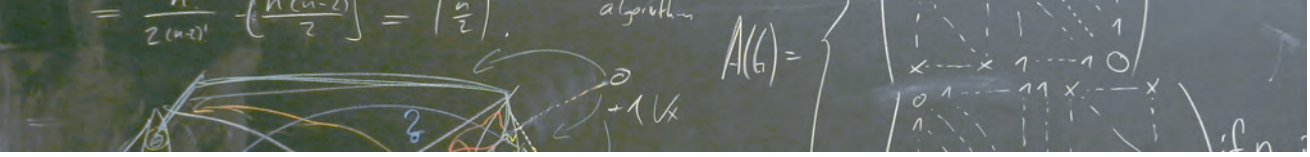
Die Konzeption der Fortbildung wurde von einer Gruppe von Lehrenden aus Schule und Universität gemeinschaftlich und theoriebasiert entwickelt. Im Mittelpunkt stand, die Möglichkeiten und Gefahren des Rechnereinsatzes insbesondere im Bereich der Analysis aufzuzeigen und sinnvolle Unterrichtswege anzubahnen. Gezielter Vorstellungsaufbau, Repräsentationswechsel, verstehensorientierte Aufgaben und schülerzentriertes Unterrichten markieren dabei zentrale Aspekte im Bereich der Möglichkeiten. Gezieltes Entwickeln händischer Fertigkeiten und mathematischer Nomenklatur trotz vorkommender „Rechnersprache“ sowie Veränderungen im Lehrprozess stehen für besondere Problemfelder beim Rechnereinsatz, die in der Fortbildung gezielt bearbeitet wurden. „GTR kompakt“ wurde im Rahmen zweier Begleitstudien in ihrer Wirksamkeit auf Lehrer- und auf Schülerebene untersucht.

Im Vortrag werden die Grundzüge der Konzeption sowie der Begleitstudie mit ersten Erkenntnissen vorgestellt.

Apollonius analyticus. Algebra im ländlichen England im 17. Jahrhundert

Philip Beeley
University of Oxford, England

Historische Untersuchungen zur Entwicklung der Mathematik in England in der frühen Neuzeit haben sich bisher fast ausschliesslich mit zentralen und bekannten Figuren wie Wallis, Brouncker oder Newton befasst. In diesem Vortrag wird der Blick auf die englischen Provinzen gerichtet, speziell auf die Grafschaft Somerset. Der dort lebende Algebraiker Thomas Strode hat eine bemerkenswerte Arbeit über Kegelschnitte verfasst, in der auch Ideen aus Kinckhuysens Algebra Aufnahme finden. Über Strodes Apollonius analyticus berichtet Oldenburg auch mehrfach in seiner umfangreichen Korrespondenz mit Leibniz.



Was Mathematiker/innen über den „fachfremd“ erteilten Mathematikunterricht wissen sollten

Marc Bosse
Universität Duisburg-Essen, Germany

In Deutschland unterrichten Lehrerinnen und Lehrer das Fach Mathematik, die dazu formal nicht qualifiziert sind. In vielen Fällen haben sie andere Fächer an der Hochschule studiert und sind mit der Mathematik lediglich in der eigenen Schulzeit in Berührung gekommen. Es stellt sich die Herausforderung, dieses Phänomen nicht nur defizitorientiert zu begreifen: Was macht fachfremd unterrichtende Lehrkräfte jenseits mangelndem fachlichen und fachdidaktischen Wissen aus und wie verstehen und gestalten sie mathematisches Lehren und Lernen? Schließlich ist es von Interesse, Erkenntnisse darüber zu gewinnen, wie diese Lehrerinnen und Lehrer durch Interventionsmaßnahmen unterstützt werden können.

Es wird eine qualitative, empirische Studie vorgestellt, für die 21 fachfremd unterrichtende Mathematiklehrerinnen und -lehrer der Sekundarstufe I zu ihrem Bild von Mathematik und von Mathematikunterricht interviewt wurden. Außerdem wurden 5 Unterrichtsstunden von 4 Lehrpersonen der Stichprobe videographiert.

Professionelle Kompetenz von Mathematiklehrkräften

Andreas Busse
Universität Hamburg, Germany

Professionelle Kompetenz von Mathematiklehrkräften setzt sich aus verschiedenen Komponenten zusammen. Dabei spielen zum einen Wissen—hier speziell mathematisches, mathematikdidaktisches und pädagogisches Wissen—als auch Wahrnehmung und Können im Kontext dieser Wissensaspekte eine zentrale Rolle.

Im Vortrag wird dargelegt, wie die verschiedenen Kompetenzkomponenten methodisch erfasst werden können. Dazu werden Konzepte und Realisierungen aktueller empirischer Studien darlegt und auf Itemebene illustriert. Ausgewählte Ergebnisse werden präsentiert.

Václav Hlavatý (1894–1969) and the educational reform in postwar Czechoslovakia

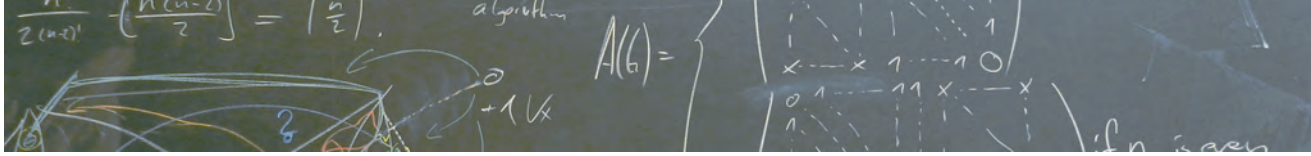
Helena Durnova
Masaryk University, Czech Republic

Although Václav Hlavatý himself considered his achievements in differential geometry, especially in connection with relativity theory and unified field theory, more important, he was one of the few mathematicians who were closely involved in politics. This did not come out of the situation created in emigration, where he was deeply involved in the activities of Czechoslovak emigré community in the United States of America (1948–1969), but is apparent also in the earlier period. In this contribution, I shall pay attention especially to the changes in the style of education of doctoral students in the turbulent years after the second world war, when Hlavatý was in strong opposition to mass breeding of doctoral students in mathematics.

Die interaktive Funktionenlupe—Ein Vorschlag zur visuellen Vermittlung von Grundvorstellungen der Analysis

Hans-Jürgen Elschenbroich
Marie-Curie-Gymnasium in Neuss, Germany

Das Funktionenmikroskop von A. Kirsch war ein Klassiker für die Erarbeitung eines Grundverständnisses von Differenzierbarkeit im Sinne der „Idee der ‚lokalen Glättung‘ des Graphen



bei fortwährender Vergrößerung“. Zunächst ein aufwändiger Foliensatz in Lehrerhand, konnte die Grundidee des ’Hineinzoomens’ später mit gängigen Funktionenplottern digital umgesetzt werden.

In dem Vortrag wird nun eine interaktive digitale „Funktionenlupe“ vorgestellt, Funktionenmikroskop 2.0 gewissermaßen, die mit zwei Graphikfenstern und Ortslinien einen entdeckenden, anschaulichen und kalkülfreien Zugang lokal zur Steigung des Funktionsgraphen und global zur Ableitung der Funktion sowie zur Krümmung bietet.

Die Funktionenlupe ist eine interaktive Lernumgebung für Schüler und ermöglicht beim Einstieg in die Analysis einen zunächst kalkülfreien Aufbau von Grundvorstellungen.

Aufmerksamkeit in Mathematik-Lehrveranstaltungen

Roland Gunesch
Pädagogische Hochschule Vorarlberg, Austria

Das Thema Aufmerksamkeit von in Mathematik-Lehrveranstaltungen ist deswegen besonders wichtig, weil Lernende leicht den Anschluss verlieren können und dann darauffolgendes Lehrmaterial nicht verstehen. Allerdings ist noch zu wenig erforscht, in welchem Umfang und zu welchen Zeitpunkten Lernende mehr bzw. weniger aufmerksam sind. Entsprechende wissenschaftliche Untersuchungen gibt es in der Literatur zwar seit Jahrzehnten, doch erstens sind die Ergebnisse in der Regel nicht mathematikspezifisch und zweitens ziehen neue wissenschaftliche Erkenntnisse einige der älteren Ergebnisse in Zweifel.

In diesem Vortrag werden erstens theoretische Grundlagen und historisch wichtige Studien zu Aufmerksamkeit von Studierenden in Hochschulvorlesungen vorgestellt, verglichen und diskutiert. Zweitens werden Methoden diskutiert, wie Aufmerksamkeit speziell in Mathematik-Lehrveranstaltungen untersucht werden kann. Erste Ergebnisse eines speziell dafür geschaffenen Untersuchungsinstruments (eingesetzt in Hochschulvorlesungen) werden vorgestellt und das Instrument selbst kritisch beleuchtet.

Fachliche Perspektiven auf mathematische Unterrichtsgegenstände

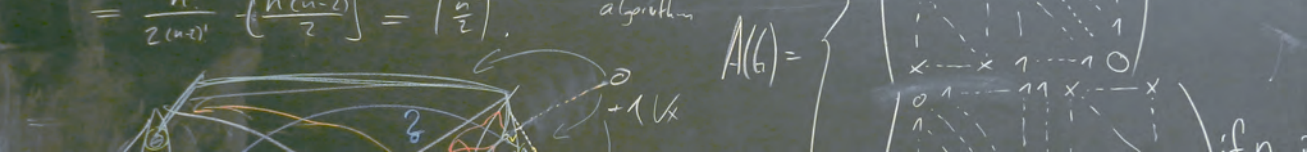
Lisa Hefendehl-Hebeker
Universität Duisburg-Essen, Germany

Es gibt verschiedene fachliche Perspektiven, aus denen ein mathematischer Unterrichtsgegenstand betrachtet werden kann. Dazu gehören die Schulmathematik vom höheren Standpunkt im Sinne Felix Kleins, die didaktische Phänomenologie mathematischer Strukturen im Sinne Freudenthals und die epistemologische Detailanalyse. Diese Sichtweisen sind je für sich wichtig und erst ihr Zusammenspiel erzeugt das rechte Hintergrundwissen für den Unterricht. Der Vortrag möchte diese Auffassung an Beispielen entfalten.

Die Integration von Rückmeldungen der Studenten in die universelle Oberfläche für CAS

Hans-Dieter Janetzko
HTWG Konstanz, Germany

CATO ist eine in Java geschriebene Oberfläche, die die Eingaben für verschiedene CAS erleichtert und demzufolge in Mathematikvorlesungen für Ingenieure an Fachhochschule eingesetzt wird. Sie ist intuitiv benutzbar und lenkt daher beim unterstützendem Einsatz von der Mathematik nicht ab. Der Autor hat während der Verwendung von CATO mit einem CAS die Rückmeldungen und Verbesserungsvorschläge der Studenten gesammelt und sie in der Version 1.2 umgesetzt. Sie ließen sich problemlos in die Konzepte von CATO integrieren: Sei es das Zusammenstellen von häufig verwendeten Befehlen zu eigenen Paketen, verbesserte Hinweise bei der Führung zur Befehlsauswahl



oder die Erklärung eigener Umschreibungen für einparametrige Befehle. Der Autor wird in seinem Vortrag CATO vorführen, die verschiedenen Prinzipien ansprechen und die Neuerungen erläutern. Selbstverständlich gilt für CATO immer noch, bei der Befehlseingabe ist es für den Benutzer nicht ersichtlich, welches CA-System er anspricht, die Eingabe bei CATO ist immer unabhängig von dem jeweils angebundenem System.

Entdeckendes, forschendes und projektartiges Lernen im Mathematikunterricht

Matthias Ludwig
Goethe Universität Frankfurt am Main, Germany

Die Diskussion um das forschende Lernen im Mathematikunterricht hat sich in den letzten Jahren national und international belebt. Forschendes Lernen und Projektlernen ist vermutlich der Arbeitsweise von Mathematikern aus der Perspektive der Unterrichtsformen am ähnlichsten. Obwohl Hattie dem forschenden Lernen eine Effektstärke von nur 0.38 zuschreibt und es sich damit im hinteren Drittel der erfolgreichen Unterrichtsmethoden befindet, halten wir forschendes Lernen für eine Chance, das Betreiben von Mathematik authentisch zu erleben.

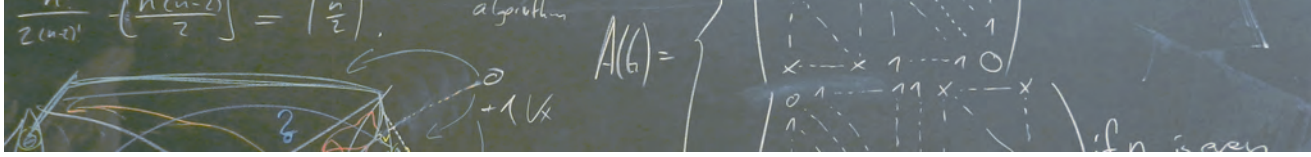
Im Vortrag wird über das Projekt Mathe.Forscher berichtet, welches seit fast 5 Jahren an mehr als 20 Schulen bundesweit durchgeführt wird. Es wird aufgezeigt, wie sich Schüler aber auch Lehrerinnen und Lehrer auf das forschende und Projektlernen einlassen und welchen Nutzen Sie daraus ziehen. Die Schwierigkeiten bei diesem Unterrichtsansatz sollen aber nicht ausgespart werden.

Die kurze Blüte der interdisziplinären Zeitschrift "Quellen und Studien zur Geschichte der Mathematik"

Jenny Mumm
Universität Mainz, Germany

In diesem Zeitschriftenprojekt bündeln sich vielfältige Motive unterschiedlicher Disziplinen sich in den 1920/30er Jahren systematisch der Mathematikgeschichtsforschung zuzuwenden und eine erste Institutionalisierung dieser Disziplin zu begründen. Dieses Vorhaben wurde ab 1926 von den Mathematikern Otto Toeplitz und Otto Neugebauer und dem Altphilologen Julius Stenzel vorbereitet, die erste Ausgabe erschien 1929 bei Springer. Die Mathematiker versprachen sich Orientierung in ihrer noch schwelenden philosophischen Grundlagendebatte und sie suchten für den immensen Studentenansturm der Zeit nach didaktischen Methoden für ihre Lehrtätigkeit. Otto Toeplitz entwickelte hierzu seine indirekt-genetische Methode in Abgrenzung zu Felix Kleins genetischer Methode. Von Seiten der Altphilologen hoffte man im Austausch mit Mathematikern auf Klärung der bislang umschifften dunklen Stellen in Platons Spätwerk.

Methodisch galt es über den Disziplinenrand hinaus zusammenzuarbeiten und in wechselseitigem Austausch von Mathematikern, Philosophen und Sprachwissenschaftlern, Klärung und neue Interpretationen zu erhalten und zudem jederzeit direkt an den historischen Quellen zu arbeiten und eigene Übersetzungen anzufertigen. Der politische Druck ließ das motivierte Projekt abrupt enden. Julius Stenzel war aus politischen Gründen 1933 strafversetzt worden und im Herbst 1935 verstorben, Otto Toeplitz erhielt ab Herbst 1935 Lehrverbot und wurde Ende 1938 als jüdischer Herausgeber denunziert, was letztlich Otto Neugebauer, der bereits 1934 emigriert war, dazu brachte, im Februar 1939 ebenfalls die Herausgeberschaft der Zeitschrift niederzulegen.



Carl Gustav Jacob Jacobi und sein Verhältnis zur Musik

Alexander Odefey
Hamburg, Germany

Carl Gustav Jacob Jacobi (1804–1851) zählt unbestritten zu den herausragenden Mathematikern des 19. Jahrhunderts. Seine Arbeiten zur Theorie der elliptischen Funktionen, seine zahlentheoretischen Erkenntnisse, seine Untersuchungen zur Differentialgeometrie, zur Variationsrechnung, zu partiellen Differentialgleichungen und einer Vielzahl weiterer Gebiete haben die Entwicklung der Mathematik maßgeblich beeinflußt.

Wenig bekannt ist dagegen, daß Jacobi eine ausgeprägte Neigung zur Musik hatte und mit mehreren bedeutenden Komponisten bekannt oder sogar befreundet war. Der Vortrag beleuchtet unter anderem seine Beziehungen zu Felix Mendelssohn Bartholdy, Fanny Hensel, Robert und Clara Schumann sowie Franz Liszt.

Der Briefwechsel Emil Artin & Helmut Hasse in den 50er Jahren

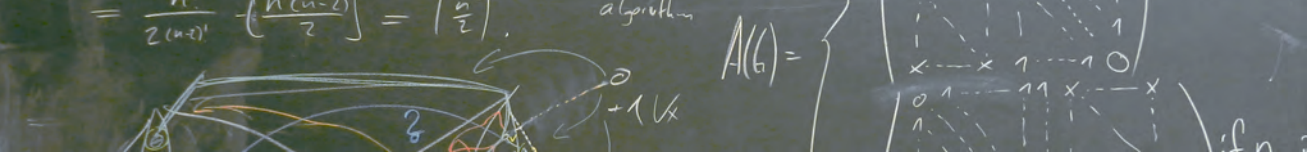
Karin Reich
Universität Hamburg, Germany

Emil Artin und Helmut Hasse sind in demselben Jahr geboren, Artin am 3. März 1898 in Wien und Hasse am 25. August 1898 in Kassel. Der Briefwechsel reicht bis in das Jahr 1923 zurück; der frühe Briefwechsel ist vor allem mathematischen Themen gewidmet, man arbeitete auf denselben Gebieten. In diesem Beitrag jedoch wird der Schwerpunkt auf die Nachkriegszeit gelegt. Der Briefwechsel wurde 1953 wieder aufgenommen. Artin, der 1938 Hamburg hatte verlassen müssen, wirkte seit 1946 in Princeton. Erste Kontakte Artins zu Hamburg nach dem Krieg gab es bereits seit dem Jahre 1946. Helmut Hasse bekleidete seit 1950 eine Professur an der Universität Hamburg; seinen Bemühungen, war es schließlich zu verdanken, dass Artin 1958 nach Hamburg zurückkehrte und am 1. Oktober 1958 an der Universität wieder eine Professur übernahm. Diese war für ihn neu geschaffen worden. Artin gehörte damit zu den ganz wenigen Professoren, die wieder nach Deutschland zurückkehrten. Der Briefwechsel zwischen den beiden Mathematikern macht deutlich, wie sich zwischen 1953 und 1958 eine über die wissenschaftlichen Belange hinausgehende Freundschaft entwickelte. Diese führte dazu, dass aus dem „Lieber Herr Hasse“/„Lieber Herr Artin“ schließlich ein „Lieber Hasse“/„Lieber Artin“ wurde und man zum Du überging. In Hamburg erlebten sowohl Artin wie auch Hasse eine sehr fruchtbare Zeit; leider verstarb Artin bereits 20. Dezember 1962, Hasse am 26. Dezember 1979. Die BMGN-Bibliothek in Hamburg verfügt über zahlreiche Mitschriften von Artins Vorlesungen. Und Hasse betreute in Hamburg 10 Doktorarbeiten.

Schülervorstellungen zu Konzepten der Analysis: Rolle von Concept image—Concept definition für den Begriffserwerb

Bettina Rösken-Winter
Humboldt-Universität zu Berlin, Germany

Im Kontext des Lernens von Mathematik im Schulunterricht spielen mentale Repräsentationen für den Aufbau adäquater Grundvorstellungen bei Schülerinnen und Schülern eine zentrale Rolle. In diesem Vortrag wird anhand des Modells von Concept Image—Concept Definition das herausfordernde Wechselspiel zwischen formalen Aspekten der mathematischen Theorie und individuell unterschiedlichen Vorstellungen der Lernenden am Beispiel von Visualisierungen im Oberstufenunterricht aufgezeigt. Eine Schlüsselfrage ist dabei, inwiefern Lehrerinnen und Lehrer in ihrer fachlichen und fachdidaktischen Ausbildung für diese Problematik sensibilisiert werden können, um umfassende begriffliche Vorstellungen bei den Schülerinnen und Schülern zu fördern und Fehlvorstellungen entgegenzuwirken.



Mit den Mathe-Wichteln Mathematik entdecken—Wieso, weshalb, warum?

Stephanie Schiemann
Freie Universität Berlin, Germany

Die Mathe-Wichtel stammen aus dem DMV-Schülerwettbewerb, bekannt als „Mathe im Advent“. Weltweit nehmen inzwischen jährlich 150.000 Schüler/innen, 6.500 Lehrer/innen mit 10.000 Klassen und 5.000 Spaßspieler/innen daran teil. 2014 war „Mathe im Advent“ ein BMBF-Projekt im Wissenschaftsjahr 2014 „Die digitale Gesellschaft“. 30.000.000 Seitenaufrufen im Advent (page impressions) und eine durchschnittlichen Verweildauer von 8 Minuten auf der Webseite bestätigten die Beliebtheit des digitalen Angebots.

Die humorvollen Aufgaben, Lösungen, mathematischen Exkursionen und Blicke über den Tellerrand dieses Wettbewerbs geben einen wunderbaren Einblick in die Vielfalt der Mathematik. Sie fördern den mathematischen Entdeckungsdrang und das kreative Weiterdenken auch in benachbarte Disziplinen auf spielerische Weise. So erweitern sie das in der Schule vermittelte Bild der Mathematik und begeistern selbst diejenigen, die mit ihr bisher auf Kriegsfuß standen. An dem Wettbewerb können Schüler/innen, Lehrer/innen der Grund- und Sekundarstufe I und Spaßspieler/innen jeden Alters teilnehmen. 2014 sind über die schönsten Aufgaben zwei Bücher im Springer Spektrum Verlag erschienen.

Die Referentin stellt den Weg zum erfolgreiche Konzept des Schülerwettbewerbs vor und analysiert die Stärken und Schwächen des Online-Angebots, die aus 600.000 Emails der Teilnehmer pro Saison gewonnen wurden. Sie erläutert zudem das didaktische Konzept, welches hinter den Aufgaben, Lösungen und Zusatzangeboten steckt.

Eine Theorie mathematischer Vorstellungsbildung

Gregor Schneider
Ludwig-Maximilians-Universität München, Germany

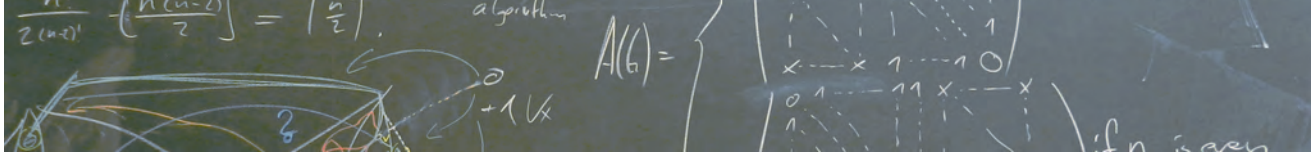
In der Mathematikdidaktik und -geschichte dominiert der Gegensatz von abstraktem mathematischen Inhalt versus seine Veranschaulichung und Visualisierung. Was die das Denken begleitenden mathematischen Bilder als mathematische ausmacht und von anderen Phantasien wesentlich unterscheidet, ist dabei nicht geklärt.

In dem Vortrag wird eine Theorie mathematischer Vorstellungsbildung vorgestellt, die aus der pädagogischen Praxis abstrahiert wurde, aber philosophisch begründet wird. Mit ihr ergibt sich eine enge und direkte Verbindung zwischen mathematischem Phantasiebild und gedanklichem Inhalt, ein neues Verständnis von dem Verhältnis der euklidischen Definitionen und Postulate in den Elementen und einige grundlegende Anregungen für den Mathematikunterricht.

Karl Weierstraß' Approximationssatz (1885), und seine Bemühungen um dessen Verallgemeinerung unter dem Einfluss seines Schülers Georg Cantor

Reinhard Siegmund-Schultze
Universitetet i Agder Kristiansand, Norway

Bevor Karl Weierstraß 1885 den Beweis seines Approximationssatzes (WAS) in der reellen Funktionentheorie veröffentlichte, erörterte er in Briefwechseln mit seiner Schülerin Sofja Kovalevskaja, mit Paul du Bois-Reymond und mit Hermann Amandus Schwarz die Möglichkeit, Cantors neuen Begriff des Inhalts von Punktmengen für die Verallgemeinerung des im Beweise benutzten Riemannschen Integralbegriffs zu benutzen. Am Ende gelangte Weierstraß nur zum nichtadditiven oberen Darbouxschen Integral und verzichtete auf eine Publikation dieser Überlegungen. Der Vortrag wird auch einige weitergehende Bemerkungen über das Verhältnis von Weierstraß zu seinem ehemaligen Schüler Georg Cantor enthalten, zu einer Zeit, da beide zunehmenden Angriffen von Leopold Kronecker ausgesetzt waren.



Mathematiklehrerfortbildungen als Interventionsaktivitäten—Einsichten nach 4 Jahren DZLM-Erfahrungen

Günter Törner
Universität Duisburg-Essen, Germany

Eine Mathematiklehrerfortbildung, die als nachhaltiges Projekt intendiert wird und über Kompetenzveränderungen der Teilnehmer schließlich auch die Kompetenzfaktoren von Schüler/innen in den Klassen erreicht, ist mehr als nur eine gute Idee, die eines engagierten Kursleiter und durchaus begeisterte Kursteilnehmer bedarf.

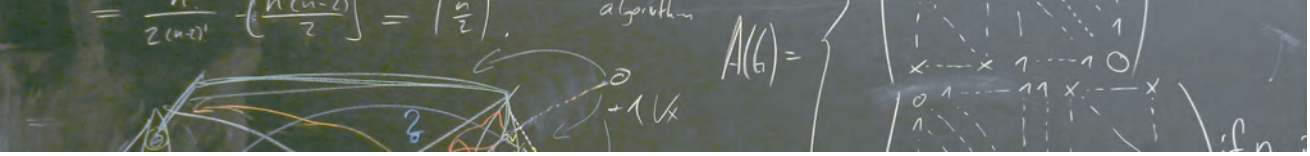
Der Autor berichtet aus seiner Tätigkeit im Design von Fortbildungsveranstaltungen im Deutschen Zentrum für Lehrerfortbildung Mathematik (DZLM) und die hier zugrunde gelegten Prinzipien. Wirklich nachhaltige Veranstaltungen müssen systemische und letztlich auch politische Implikationen anstreben und realisierbar machen. In den beiden letzten Jahrzehnten haben sich international wichtige Paradigmenwechsel für die Professionalisierung von Lehrpersonen vollzogen, die in Deutschland dekliniert werden müssen.

Karl Weierstraß als Algebraiker

Peter Ullrich
Universität Koblenz-Landau, Germany

Bei Würdigungen von Karl Weierstraß (1815–1897) anlässlich seines 200sten Geburtstags in diesem Jahr wird er zumeist als Analytiker gekennzeichnet. Allerdings gibt es in seinem Werk durchaus Beziehungen zur Algebra: So betonte er in seinem vielzitierten „Glaubensbekenntnis“, dass die Funktionentheorie „auf dem Fundamente algebraischer Wahrheiten aufgebaut werden muss“. Ebenso ist eine Normalform linearer Abbildungen nach ihm benannt. In dem Vortrag wird unter diesem Aspekt ein genauerer Blick auf sein mathematisches Werk geworfen, der Weierstraß in seinen algebraischen Arbeiten als erstaunlich „modern“ (im Sinne von van der Waerden bzw. Artin und Noether) zeigt, etwa bei seiner axiomatischen Charakterisierung der Determinante.

www.mediaserver.hamburg.de / Christian Spahrbier



Sektion 8: Logik & Theoretische Informatik / Section 8: Logic & Theoretical Computer Science

Sektionsleitung / Coordination: Steve Awodey, Pittsburgh PA; Stefan Geschke, Hamburg

Compact Complex Manifolds with a generic Automorphism

Martin Bays
McMaster University, Canada

I shall present some recent work with Martin Hils and Rahim Moosa on the model theory of holomorphic discrete dynamics on compact complex manifolds. I shall describe a classification of minimal dynamics (including the Zilber trichotomy via the Canonical Base Property), and make some remarks on quotient structures (geometric eliminination of imaginaries; failure of full EI due to failure of 3-uniqueness in CCM).

Modal Logics of Set Theoretic Multiverses

Alexander C. Block
Universität Hamburg, Germany

With a set theoretic multiverse I essentially mean the collection of "all" models of a fixed set theory with a relation on this collection representing the ability to get from one model to another related model via a given set theoretic model construction (e.g., via generic extensions, symmetric extensions or inner models). The modal logic of a given multiverse shall be the set of all basic modal formulas which are valid in every set theoretic model with arbitrary interpretation of the propositional variables as set theoretic sentences and of the modal operators in terms of the relation on the multiverse.

Of course it is not immediately clear how we can formalize the above notions inside of set theory itself. The aim of my talk will be to present an approach for a set theoretic framework that allows us to treat arbitrary set theoretic multiverses along the above lines. I shall also show how known results from the modal logic of forcing—which were established in a purely syntactic framework—lift to this rather semantic new framework. (Based on joint work with Benedikt Löwe.)

Chameleons and flutters

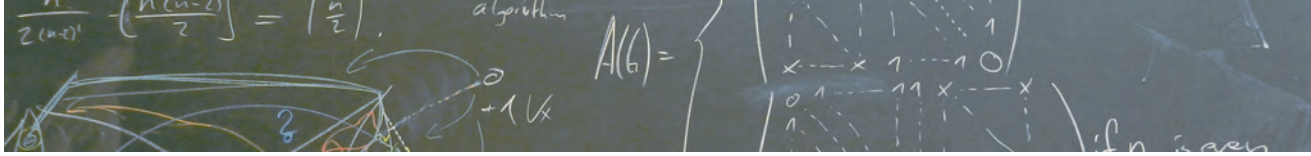
Nathan Bowler
Universität Hamburg, Germany

We shall discuss two closely related families of structures whose existence follows from weak forms of AC and whose non-existence follows from the principle that every invariant colouring of the set of infinite sets of natural numbers is Ramsey.

Weihrauch degrees for generalized Baire space

Lorenzo Galeotti
Universiteit van Amsterdam, The Netherlands

The theory of Weihrauch degrees is about representing classical theorems of analysis in Baire space and comparing their strength (measured as the Weihrauch degree). In this talk, we are exploring a version of this theory for generalized Baire space. The first step in this generalization



is that of finding a suitable generalization of the real numbers on which we can prove generalized version of theorems from classical analysis. Due to the fact that the real numbers are the only complete ordered field and that completeness is crucial in most theorems of analysis, classical topological approaches fail in the generalized context. For this reason, in generalizing results from classical analysis, different tools have to be used. The first part of the talk will be devoted to the presentation of these tools and to the construction of an extension of the real numbers on which they can be used to prove basic theorems form analysis (i.e., Intermediate Value Theorem). In the second part of the talk we shall be focusing on generalizing notions from computable analysis and investigate how this new framework can be used to characterize the strength of the generalized version of a basic theorem of analysis we presented in the first half of the talk.

Dp-minimal ordered fields

Franziska Jahnke
Westfälische Wilhelms-Universität Münster, Germany

Model Theory studies the interplay of combinatorial properties of first-order theories and structural (often: algebraic) properties of their models. A particularly 'nice' class of theories are stable theories, and a well-known open conjecture in Model Theory is that every infinite field whose theory is stable (in the language of rings) is already separably closed. The stable fields conjecture is strongly related to a conjecture by Shelah on fields with a so-called NIP theory. NIP is a property of a theory implied by stability and which is currently extensively studied in the context of 'neo-stability'.

In this talk, I shall explain a theorem (proven in joint work with Pierre Simon and Erik Walsberg) which asserts a special case of the Shelah conjecture.

Infinitely equal trees and Cohen reals

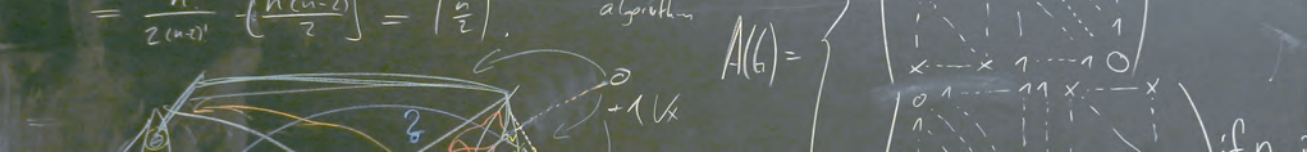
Yurii Khomskii
Universität Hamburg, Germany

A real is called *infinitely often equal (ioe)* iff it coincides with every ground model real infinitely often. In joint work with Giorgio Laguzzi, we analysed the σ-ideal and the forcing partial order naturally related to ioe reals. Does such a forcing add Cohen reals? By unpublished work of Goldstern and Shelah, we know that some conditions do; but it is open whether all conditions do. I shall present some results that could provide an answer. If there are conditions forcing that no Cohen reals are added, then this would provide an alternative solution to Fremlin's problem "can we add ioe reals without adding Cohen reals", recently solved by Zapletal.

Nonstandard Number Fields

Heiko Knospe
Cologne University of Applied Sciences, Germany
Christian Serpé
University of Münster, Germany

We apply the methods of nonstandard analysis to algebraic number theory and extend the results of G. L. Cherlin and others on nonstandard number fields. The ideal structure of the ring of integers of internal number fields is much richer than that of Dedekind domains. The ideals can be classified using filters on a lattice of internal ideals. The results are particularly interesting for external maximal and prime ideals. We determine various valuation rings and their residue class fields. The usual completion of a number field and the rings of adeles can be described as



a subquotient of the enlarged field. Furthermore, we show that the nonstandard extension of the algebraic closure of a number field can be used to define $\mathbb{C}_p$ and a spherical completion.

Game-theoretic approach to Fraïssé limits

Wieslaw Kubis
Academy of Sciences, Czech Republic

We shall present an abstract version of the Banach-Mazur-Choquet game, where two players alternately choose finitely generated models, building an increasing sequence whose union typically is a "random" or "generic" countably generated model. It turns out that various universal structures with high level of homogeneity (in particular, Fraïssé limits) can be explained by the existence of a winning strategy of one of the players. We shall discuss applications of this approach beyond the standard model theory.

A null ideal for inaccessible?

Giorgio Laguzzi
Albert-Ludwigs-Universität Freiburg, Germany

We try to shed light on the non-trivial question of generalizing the random forcing for 2^κ, with κ uncountable. We answer a question posed by Shelah, asking whether one can construct a tree-like forcing adding new subsets of κ, which is simultaneously $<\kappa$-closed, κ^κ-bounding and satisfies κ^+-c.c., for κ inaccessible. We further investigate some properties of this forcing, comparing it with Shelah's one for κ weakly compact. (Based on a joint work with Sy Friedman.)

Game characterizations of functions of finite Baire class

Hugo Nobrega
Universiteit van Amsterdam, The Netherlands

Since the seminal work by Wadge in the 70s and 80s, a tradition has been established in descriptive set theory of using games to characterize certain important notions and classes of objects. Particular attention has been devoted to characterizing classes of functions in Baire space by games, with Wadge's game for continuous functions and Duparc's eraser game for the Baire class 1 functions as two important examples. In his PhD thesis, Brian Semmes introduced his tree game which characterizes the Borel measurable functions, and a restriction of the tree game which characterizes the Baire class 2 functions.

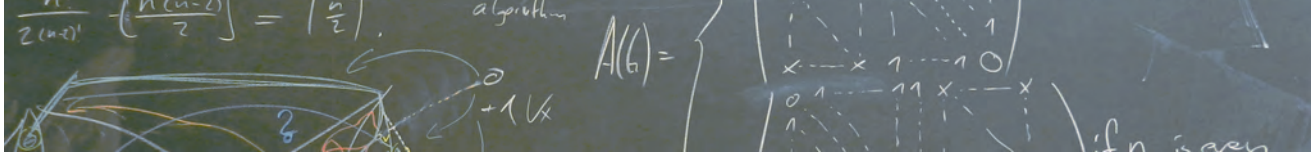
In this work, we show how to restrict Semmes's tree game in order to obtain games characterizing each finite Baire class, in a uniform way. The Wadge and eraser games are particular cases of our construction, but interestingly enough our construction for Baire class 2 gives a different—though of course equivalent—game than Semmes's.

The author would like to acknowledge that Alain Louveau and Brian Semmes proved the main result independently with a different proof.

Basic homotopy theory of Bishop spaces

Iosif Petrakis
University of Munich, Germany

The theory of Bishop spaces (TBS) is so far the least developed approach to constructive topology with points. Bishop introduced function spaces, here called Bishop spaces, in 1967, without really exploring them, and in 2012 Bridges revived the subject. A Bishop space is a pair (X, F), where X is an inhabited set and F, which is called a Bishop topology, or simply a topology, is a set



of functions of type $X \to R$ which includes the constant maps and it is closed under addition, uniform limits and composition with the Bishop-continuous functions of type $R \to R$. The main motivation behind the introduction of Bishop spaces is that function-based concepts are more suitable to constructive study than set-based ones. Since a morphism between two Bishop spaces and most of the topological notions related to Bishop spaces are defined in a function-theoretic way, and since all our proofs are within Bishop's informal system of constructive mathematics BISH, TBS is an approach to constructive point-function topology.

However remarkable the development of Homotopy Type Theory (HoTT) has been, we would like to provide a straightforward elementary counterpart of classical homotopy theory within BISH. We report on the current status of our reconstruction of basic homotopy theory within TBS. A similar study within formal topology was initiated by Palmgren in 2009. Since TBS is a function-theoretic approach to constructive topology, and since classical homotopy theory contains many function-theoretic concepts, it seems natural to try to develop such a reconstruction within TBS. If (X, F) is a Bishop space, an F-path is a morphism from $[0, 1]$, endowed with the topology of the uniformly continuous functions, to (X, F). In contrast to the "logical" character of paths in HoTT, not every Bishop space has the path joining property (PJP). We study the rich class of codense Bishop spaces, which generalizes the class of complete metric spaces in TBS, and we show that every codense Bishop space has the PJP. Also, the homotopy joining property holds for (X, Y) when X is a Bishop space and Y is a codense Bishop space. Having these concepts as starting point, we translate some basic facts of the classical theory of the homotopy type into TBS.

The size of Dedekind finite sets

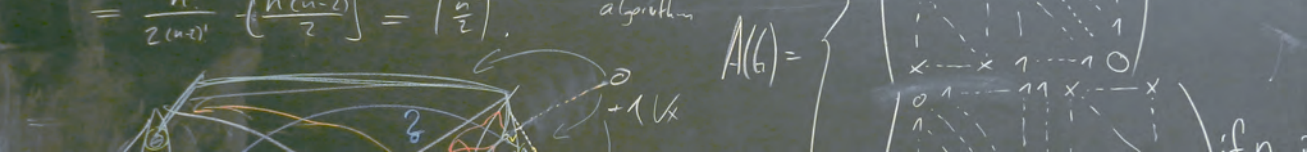
Philipp Schlicht
Westfälische Wilhelms-Universität Münster, Germany

Suppose that A is a Dedekind finite set in a model of set theory without choice. We consider the possible sizes which A might have in generic extensions. For instance, we show that it is consistent that the injective collapse of any Dedekind finite set A to an infinite cardinal preserves cardinals, and therefore A may be arbitrarily large in cardinal preserving extensions. This is a joint project with Asaf Karagila.

Transfinite Methods as Admissible Rules

Peter Michael Schuster
Università degli Studi di Verona, Italy
Davide Rinaldi
University of Leeds, England

Let C be a Tarski-style mono-conclusion consequence relation on a monoid $(S, *, 1)$ that satisfies the counterpart of disjunction elimination, with $*$ in place of disjunction. Let E be the multi-conclusion entailment relation, in the sense of Scott, that extends C and captures what it means that $*$ and 1 are viewed as disjunction and absurdity, respectively. Then E and C have the same mono-conclusion sequents. In particular, we eliminate the Krull-Lindenbaum Lemma, the appropriate instance of Zorn's Lemma, from otherwise elementary proofs. Instances include that the theory of integral domains is conservative, for definite Horn clauses, over the theory of commutative reduced rings. Our approach appears to be somewhat more direct and/or more general than the related results obtained with dynamical algebra.



Combinatorial cardinal characteristics of the generalized continuum

Ilya Sharankou
Universität Hamburg, Germany

Cardinal characteristics such as unbounding and dominating number have been being studied for long time and have applications to real numbers, connections to topology on the Baire and Cantor spaces, regularity properties of subsets of reals and tree forcing notions. However, many of them are defined in a purely combinatorial way which allows natural generalizations to an arbitrary uncountable cardinal kappa. Inspired by the standard work systematically dealing with the classical countable case being done by A. Blass (Combinatorial Cardinal Characteristics of the Continuum) I would like to give an overview of the current state of the art for the generalized case, remarking the similarities and deviations from the countable case.

Meager ideal is Tukey reducible to the Mycielski ideal

Otmar Spinas
Christian-Albrechts-Universität zu Kiel, Germany

We outline the proof of the theorem stated in the title. As a corollary we obtain that the additivity of the Mycielski ideal is less or equal than the additiviy of the meager ideal. In forcing terminology this means that every reasonable amoeba for Silver forcing adds both Cohen and dominating reals. We also give some background of the open problem whether there is a Tukey reduction of the Mycielski to the null ideal, which, by Pawlikowski's theorem, would be a strengthening of our result.

Pure Patterns of Resemblance

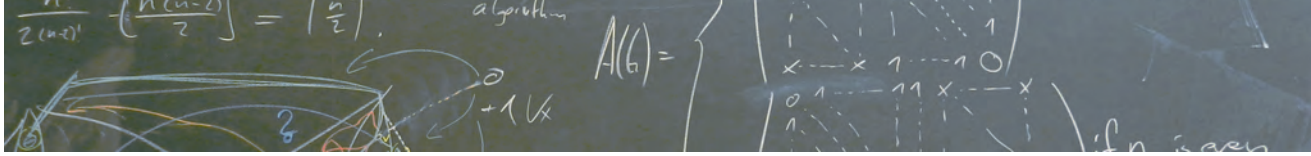
Gunnar Wilken
Okinawa Institute of Science and Technology Graduate University, Japan

Elementary patterns of resemblance, which are finite structures of nested trees, were discovered by Timothy J. Carlson and constitute the basic levels of his general program on patterns of embeddings as an ultrafine-structural approach to Goedel's idea of using large cardinals to solve mathematical incompleteness. In this talk I shall explain the arithmetical analysis and computation of patterns of resemblance, starting from an overview of their basic structural properties. Recent results will be presented. See also my contribution to the minisymposium on well-quasi orders.

Analogues of strong measure zero sets defined in terms of translations

Wolfgang Wohofsky
Universität Hamburg, Germany

The Galvin-Mycielski-Solovay theorem confirms a conjecture of Příkrý saying that a set of reals is strong measure zero if and only if it can be translated away from each meager set. This connection gives rise to a variety of new "notions of smallness", among them the notion of strongly meager where meager is replaced by null in the translation characterization. In my talk, however, I shall focus on another variant based on the ideal of Marczewski null sets which is connected to Sacks forcing. In order to further explore the situation, I shall introduce the notion of Sacks dense ideals, that is, translation-invariant sigma-ideals dense in Sacks forcing. Moreover, I shall discuss why the cofinality question for ideals such as the one of Marczewski null sets is related to this. (Partially joint work with Jörg Brendle and Yurii Khomskii.)



Sektion 9: Numerik & Wissenschaftliches Rechnen / Section 9: Numerical Analysis & Scientific Computing

Sektionsleitung / Coordination: Lubomir Banas, Bielefeld; Michael Hinze, Hamburg

HJB-POD feeback control of advection-diffusion equation with a model predictive control snapshot sampling.

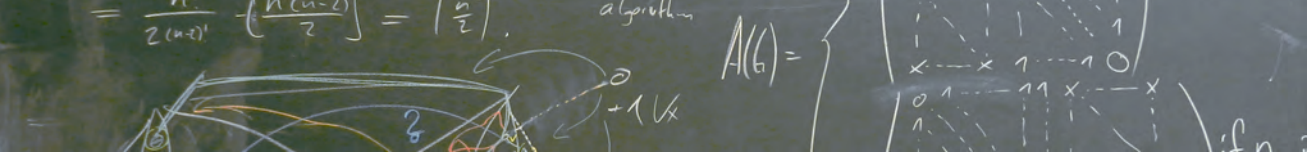
Alessandro Alla
Universität Hamburg, Germany
Michael Hinze
Universität Hamburg, Germany

We present the approximation of an infinite horizon optimal control problem for evolutive advection-diffusion equations. The method is based on a model reduction technique, using a Proper Orthogonal Decomposition (POD) approximation, coupled with a Hamilton-Jacobi-Bellman (HJB) equation which characterizes the value function of the corresponding control problem for the reduced system. We show that it is possible to improve the surrogate model by means of a Model Predictive Control (MPC) solver. Finally, we present numerical tests to illustrate our approach and to show the effectiveness of the method in comparison to existing approaches.

Using a standard SQP solver for optimization problems involving probabilistic constraints

Ingo Bremer
Weierstrass Institute for Applied Analysis and Stochastics, Germany

From practical applications in the area of wind and water power management we have prediction models with uncertain data which results in optimization problems with probabilistic constraints, so called chance constraints. Suppose such a problem can be transformed to a deterministic one by using the analytic expression of the distribution function of the probabilistic part, and that this distribution function has a reasonable numeric approximation, as this is the case for multivariate normal-distributed values. Why not using an SQP method to solve this problem? In general the accuracy of the numeric approximation of a high dimensional multivariate cdf does not fit the needs of SQP solver for smooth nonlinear problems. The talk shows which problems arises and how to deal with them, especially with the non-smooth character of the approximation in use. Numeric results also shows the effect of parallelization and automatic differentiation.



Shape optimization for surface functionals in Navier–Stokes flow using a phase field approach

Harald Garcke
Universität Regensburg, Germany
Claudia Hecht
Universität Regensburg, Germany
Michael Hinze
Universität Hamburg
Christian Kahle
Universität Hamburg
Kei Fong Lam
Universität Regensburg, Germany

We investigate the problem of optimal topologies of fluid domains. In a given container we search for a topology of a fluid domain, filling a given proportion of the container, such that a functional of the resulting velocity field inside this domain is minimized. Here the velocity owes to the Navier–Stokes system. The problem is handled by both using a porosity approach and a phase field concept. The Navier–Stokes system is solved on the whole domain, where the phase field serves as an indicator function for the two phases, namely the fluid domain (high porosity) and the dense domain (low porosity). The phase field itself is obtained by a gradient flow for a specific inner product. In this talk we sketch the underlying concept and investigate numerically the properties of the overall concept.

Kinetic-Induced Moment System for non-linear balance laws

Diana Gil
Universität Hamburg, Germany
Jens Struckmeier
Universität Hamburg, Germany

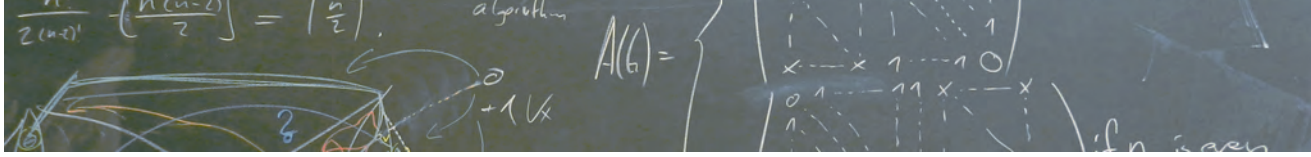
Based on the relation between kinetic theory and non-linear hyperbolic equations, we derive a general kinetic-induced infinite moment system for a spatially one-dimensional non-linear balance law. The derivation is based on an artificial Boltzmann-like transport equation with a BGK-relaxation. Using Chapman-Enskog-like asymptotic expansion techniques, it will be shown that at each order of ε, a scale-induced closure is possible, which results in a finite number of moment equations.

The obtained result is then applied to the one dimensional Burgers' equation in order to study its numerical and spectral properties.

Newton-like iterations beyond the Kung-Traub conjecture

Stefan Heitmann
Collatz-Centre, University of Hamburg, Germany

A number of higher-order Newton's method have been suggested in the last decade. All confirm the conjecture by Kung-Traub from 1974 according to which an optimal iterative method based on $n+1$ evaluations may achieve a maximum convergence order of $2n$. We derive many well-known methods by means of an alternative convergence theory. This theory aims to identify the secant that connects initial guess and root. The existence of this secant is provided by the mean value theorem. The classical Newton's method serves as an auxiliary step defining a success parameter similar to the trust region in optimization. The slope of the corresponding secant is approximated as a power series in this success parameter. It is demonstrated that roots of quadratic and asymptotically even cubic functions may be computed in arbitrary accuracy.



Finite element analysis of Free Material Optimization problems

Michael Hinze
Universität Hamburg, Germany
Tobias Jordan
Universität Hamburg, Germany

In Free Material Optimization, the design variable is the full material tensor of an elastic body. Written in matrix notation one obtains a control-in-the-coefficients problem for the material tensor.

In this talk we discuss recent results in the finite element analysis in Free Material Optimization. We employ the variational discretization approach, where the control, i.e., the material tensor, is only implicitly discretized. Using techniques from the identification of matrix-valued diffusion coefficients, we derive error estimates depending on the coupling of the discretization and Tikhonov regularization parameters. Furthermore, this approach allows to also take into account a noise level on the measured data. Numerical examples supplement our analytical findings.

Numerical approximation of level set power mean curvature flow

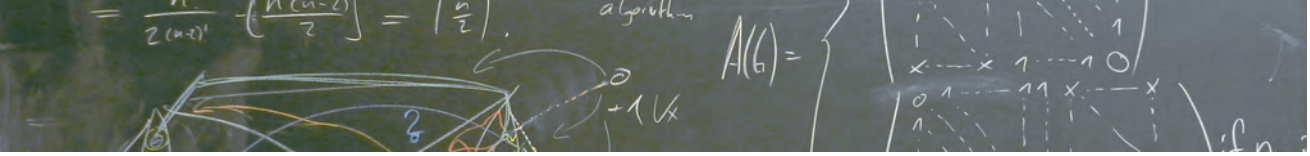
Heiko Kröner
Universität Hamburg, Germany
Eva Kröner
Georg-August Universität Göttingen, Germany
Axel Kröner
INRIA Saclay and CMAP, Ecole Polytechnique, France

In this paper we investigate the numerical approximation of a variant of the mean curvature flow. We consider the evolution of hypersurfaces with normal speed given by H_k, $k = 1$, where H denotes the mean curvature. We use a level set formulation of this flow and discretize the regularized level set equation with finite elements. In a previous paper we proved an a priori estimate for the approximation error between the finite element solution and the solution of the original level set equation. We obtained an upper bound for this error which is polynomial in the discretization parameter and the reciprocal regularization parameter. The aim of the present paper is the numerical study of the behavior of the evolution and the numerical verification of certain convergence rates. We restrict the consideration to the case that the level set function depends on two variables, i.e., the moving hypersurfaces are curves. Furthermore, we confirm for specific initial curves and different values of k that the flow improves the isoperimetrical deficit.

Error estimates for nonstationary optimal control problems with state constraints

Francesco Ludovici
Universität Hamburg, Germany
Ira Neitzel
Technische Universität München, Germany
Winnifried Wollner
Universität Hamburg, Germany

This talk deals with a priori error estimates for space-time finite elements discretization of semilinear parabolic optimal control problems subject to inequality constraints on the state variable and its first derivative. These constraints are understood pointwise in time and averaged in space. Consideration of these constraints is motivated by industrial application in the steel and glass production, where stress averages are often considered in order to avoid material failure. Making use of the discontinuous Galerkin method for the time discretization and of standard conforming finite elements for the space discretization, we derive convergence rates as temporal and spatial mesh size tends to zero.



Optimization and model order reduction of a permanent magnet machine

Ulrich Matthes
Universität Hamburg, Germany
Alessandro Alla
Universität Hamburg, Germany
Michael Hinze
Universität Hamburg, Germany

A permanent magnet machine is a generator where the excitation field is provided by a permanent magnet instead of a coil. The center of the generator, the rotor, contains the magnet. Our goal is to find the minimum volume of the rotor which guarantees a desired electromotive force. We apply model order reduction to speed up the optimization. We use snapshot POD to construct the reduced order model.

Optimal Control of Thermoviscoplasticity

Ailyn Schäfer
Technische Universität Chemnitz, Germany
Roland Herzog
Technische Universität Chemnitz, Germany
Christian Meyer
Technische Universität Dortmund, Germany

Elastoplastic deformations play a tremendous role in industrial forming. Many of these processes happen at non-isothermal conditions. Therefore, the optimization of such problems is of interest not only mathematically but also for applications.

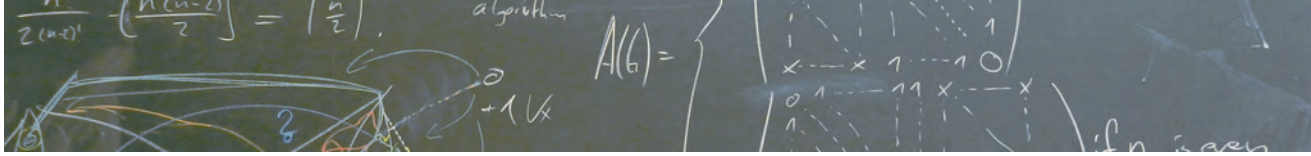
In this talk we shall present the analysis of the existence of a global solution of an optimal control problem governed by a thermovisco(elasto)plastic model. We shall point out the difficulties arising from the nonlinear coupling of the heat equation with the mechanical part of the model. Finally, we shall discuss first steps to show the directional differentiability of the control-to-state mapping and to obtain necessary optimality conditions. The talk is based on joint work with Roland Herzog and Christian Meyer.

On numerical simulation of tsunami run-up generated by submarine landslide

Nina Shokina
Albert-Ludwigs-Universität Freiburg, Germany

The adaptive grid method is presented for numerical modelling of impulse water waves generated by submarine landslides moving along irregular bottom profiles and consecutive run-up of the generated waves on the coast. A nonuniform submarine landslide moving on a nonuniform slope is modelled by a "quasi-deformed" rigid body [1]. The surface water waves are simulated using the hierarchy of mathematical models including the nonlinear dispersive shallow water model, the nonlinear shallow water model, and the potential flow model. The wave run-up on coast is modelled by the moving mesh approach with the allocation of waterfront. The formulas for waterfront position and velocity are obtained using the exact analytical solutions of the shallow water equations in the vicinity of waterfront [2]. The predictor-corrector scheme on moving grids is used [2]. The grid is constructed by the equidistribution method [3]. The numerical results are presented for several test problems.

[1] N. Shokina, V. Aizinger, Submitted to Environ. Earth Sci. (2015)



[2] N. Shokina, Proc. Appl. Math. Mech., Special Issue: 84th Annual Meeting of the International Association of Applied Mathematics and Mechanics (GAMM), Erlangen 2014. 14(1), 853–854 (2014)

[3] G. S. Khakimzyanov, N. Y. Shokina, Comput. Technol. 17(2), 79–98 (2012)

A Posteriori Error Estimation for State-Constrained Elliptic Optimal Control Problems

Simeon Steinig
Technische Universität Dortmund, Germany

In this talk we focus on reliable a posteriori error estimation techniques for state-constrained optimal control problems, a particular emphasis will be laid on convergence results for a sequence of discrete solutions computed on adaptive grids without the use of maximum-norm error estimates.

Analysis and optimal control of a gradient enhanced damage model

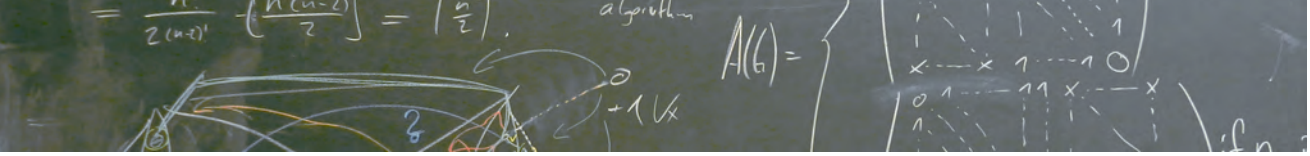
Livia Susu
Technische Universität Dortmund, Germany
Christian Meyer
Technische Universität Dortmund, Germany

The talk is concerned with a damage model including two damage variables, a local and a non-local one, which are coupled through a penalty term in the free energy functional. After introducing the precise model, we prove existence and uniqueness for the viscous regularization thereof. Moreover, we rigorously study the limit for penalization parameter tending to infinity. It turns out that in the limit both damage variables coincide and satisfy a classical viscous damage.

Matrix coefficient identification in an elliptic equation

Quyen Tam Nhan Tran
Universität Hamburg, Germany

In this talk I would like to present about the inverse problem of identifying the diffusion matrix in the Dirichlet problem for an elliptic partial differential equation of second-order, when a solution of the direct problem is imprecisely given by the observation data. The convex energy functional method with Tikhonov regularization is used to our identification problem. We analyze convergence rates of the method under a new source condition which is weaker than that of the theory of regularization for nonlinear ill-posed problems. In discrete case the finite element method is applied to strictly convex minimization problems for solving the identification problem. We investigate an error bound of the finite element approximation solutions. Furthermore, a gradient-projection algorithm is employed for finding minimizers of these minimization problems. The strong convergence of iterative solutions to that of the identification problem is shown without smooth assumption on the sought matrix. Finally, we present a numerical experiment which illustrates our theoretical results.



Mesh refinement for the numerical approximation of Neumann boundary control problems on polyhedra

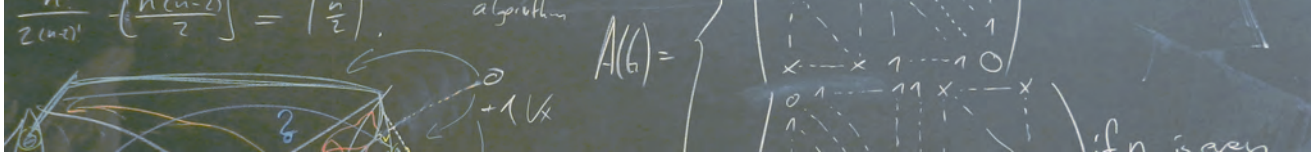
Max Winkler
Universität der Bundeswehr München, Germany
Thomas Apel
Universität der Bundeswehr München, Germany
Johannes Pfefferer
Universität der Bundeswehr München, Germany

In this talk the numerical approximation of Neumann boundary control problems governed by linear elliptic partial differential equations is discussed. The naive strategy of using a full finite element discretization of the optimality system with piecewise linear finite elements for the state and dual state, and a piecewise constant approximation of the control yields only the convergence rate one for the discrete control in the $L^2(\Gamma)$-norm. This poor convergence behaviour can be improved with advanced strategies like postprocessing and variational discretization which allow an improvement up to the convergence rate two when the computational domain has a smooth boundary. However, on polyhedral domains the solution does not possess the required regularity as singularities can occur in the vicinity of edges and corners. For this reason local mesh refinement can be used to preserve the optimal convergence rates, and we study in detail how strong the refinement has to be, and in which cases optimal convergence is guaranteed even on quasi-uniform meshes.

Optimizing Finite Difference Implementations

Gerhard Zumbusch
Friedrich-Schiller-Universität Jena, Germany

Current processor architectures are able to perform many more floating point operations per time than typical used by numeric codes. Processors heavily use data and instruction parallelism at different levels, together with a deep memory hierarchy. Standard programming approaches cannot exploit this parallelism in total or adapt to the memory layout. However, many numerical algorithms on current systems tend to be memory bandwidth limited, which is a severe limitation. We shall discuss cache aware algorithms, vectorization strategies and memory layouts for the case of Finite Differences stencil computations.



Sektion 10: Stochastik, Statistik & Finanzmathematik / Section 10: Stochastics, Statistics, & Financial Mathematics

Sektionsleitung / Coordination: Holger Drees, Hamburg; Peter Eichelsbacher, Bochum

Forward stochastic Volterra integral equations in Banach spaces

Mahdi Azimi
Martin-Luther-Universität Halle-Wittenberg, Germany
Wilfried Grecksch
Martin-Luther-Universität Halle-Wittenberg, Germany

In this paper we consider forward stochastic Volterra integral equations (FSVIE) in $L^q(S, \mathcal{S}, \mu)$, where μ is finite measure. L^p-stochastic integrability in unconditional Martingal difference (UMD) Banach spaces is used for the stochastic integration. Stochastic integral is defined with respects to one dimensional Wiener process. By setting appropriate assumptions on coefficients of FSVIE in L^q on a given filtered probability space, its solubility is considered. We find the unique stochastic solution by using fix-point theorem in Banach spaces. Some properties of solution are also being discussed.

On Buehler confidence regions

Todor Dinev
Universität Trier, Germany

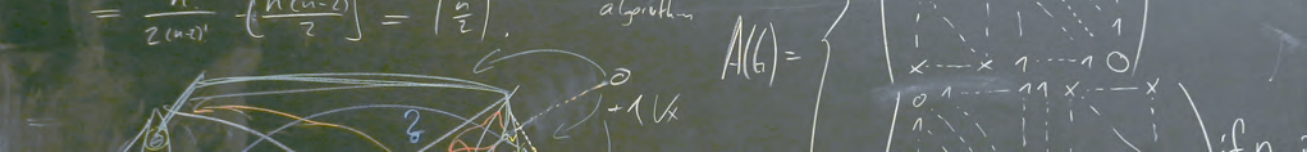
We generalize a method of constructing the smallest (w.r.t. set inclusion) monotonic (with respect to a "designated statistic") confidence region for a general parameter of interest in an arbitrary model on a totally preordered sample space. This method, dating back to 1957 and due to Robert J. Buehler, is originally known from reliability theory, but is applicable to statistical interval estimation rather generally, and deserves, in our opinion, more attention.

Apart from establishing some of the optimality properties of Buehler confidence regions, we briefly address the problem of selecting meaningful designated statistics by presenting some examples.

Optimal Liquidation in a Multiplicative Market Impact Model

Peter Frentrup
Humboldt-Universität zu Berlin, Germany
Todor Bilarev
Humboldt-Universität zu Berlin, Germany
Dirk Becherer
Humboldt-Universität zu Berlin, Germany

We describe a market model for trading a single risky asset, in which a large investor seeks to liquidate his position in an infinite time horizon, while maximizing expected proceeds. Trading large orders has an adverse effect on the asset's price, which is determined by the investor's current volume impact and is multiplicative in relation to the current price. The volume impact is a deterministically mean-reverting process whenever no trade occurs. We justify why the proceeds



should have a certain form, heuristically by describing a multiplicative limit order book, and also by drawing a link to Marcus type SDEs. The martingale optimality principle suggests that the two dimensional state space of volume impact and number of held assets is separated by a free boundary into a wait- and a sell-region. We derive this free boundary using classical calculus of variations and prove optimality. If time permits, we discuss a variant of our model with stochastic volume impact, in which case verification of optimality reduces to showing certain analytic properties of Hermite functions, some of which remain to be fully proven.

Poisson polyhedra in high dimensions

Julia Hörrmann
Ruhr University Bochum, Germany
Daniel Hug
Karlsruhe Institute for Technology (KIT), Germany
Matthias Reitzner
Osnabrück University, Germany
Christoph Thäle
Ruhr University Bochum, Germany

The zero cell of a parametric class of random hyperplane tessellations depending on a distance exponent and an intensity parameter is investigated, as the space dimension tends to infinity. The model includes the zero cell of stationary and isotropic Poisson hyperplane tessellations as well as the typical cell of a stationary Poisson Voronoi tessellation as special cases. It is shown that asymptotically in the space dimension, with overwhelming probability these cells satisfy the hyperplane conjecture, if the distance exponent and the intensity parameter are suitably chosen dimension-dependent functions. Also the high dimensional limits of the mean number of faces are explored and the asymptotic behaviour of an isoperimetric ratio is analysed. In the background are new identities linking the f-vector of the zero cell to certain dual intrinsic volumes.

Hedging under good-deal bounds and model uncertainty

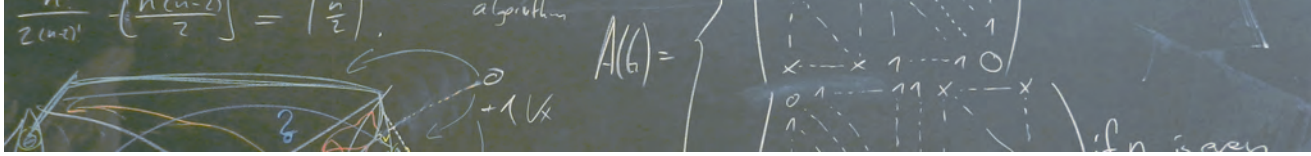
Klebert Kentia
Humboldt-Universität zu Berlin, Germany
Dirk Becherer
Humboldt-Universität zu Berlin, Germany

We present a notion of good-deal hedging, that corresponds to good-deal valuation and is defined by a uniform supermartingale property for the tracking errors of hedging strategies. No-good-deal restrictions are defined in terms of constraints on the Girsanov kernels of pricing measures, and good-deal valuations and hedges are derived from backward stochastic differential equations. Under model uncertainty about the market prices of risk of hedging assets, a robust approach leads to a reduction or even elimination of a speculative component in good-deal hedging, which is shown to be equivalent to global risk-minimization if uncertainty is sufficiently large.

Bootstrapping Locally Stationary Processes

Jens-Peter Kreiss
Technische Universität Braunschweig, Germany
Efstathios Paparoditis
University of Cyprus, Cyprus

A non-parametric method to bootstrap locally stationary processes will be proposed, which combines a time domain wild bootstrap approach with a non-parametric frequency domain approach.



The method generates pseudo time series which mimic (asymptotically) correctly the local second- and to the necessary extent the fourth-order moment structure of the underlying process. Thus it can be applied to approximate the distribution of several statistics that are based on observations of the locally stationary process. We prove a bootstrap central limit theorem for a general class of statistics that can be expressed as functionals of the preperiodogram, the latter being a useful tool for inferring properties of locally stationary processes. Some simulations and a real data example shed light on the finite sample properties and illustrate the ability of the bootstrap method proposed.

Stochastic Mixed-Mode Oscillations

Christian Kuehn
Technische Universität Wien, Austria
Nils Berglund
Université d'Orléans, France
Barbara Gentz
Universität Bielefeld, Germany

We are interested in the effect of Gaussian white noise on fast-slow dynamical systems with one fast and two slow variables. In the absence of noise, these systems can display mixed-mode oscillations, which are oscillation patterns in which small-amplitude and large-amplitude oscillations alternate. In particular, the system we study is not in gradient-form and contains several generic, but non-hyperbolic, singular points which generate the oscillations. The effect of weak noise can be quantified by analyzing the continuous-space, discrete-time Markov chain describing the returns of sample paths to a cross-section. The main result yields estimates of sample paths to deviate from the deterministic solution. The result implies estimates on transition probabilities of the discrete-time Markov chain on the finite state state space of mixed-mode patterns.

Spin models on random networks

Matthias Löwe
Universität Münster, Germany

I shall report on some recent progess on spon models on random networks, such as the Curie-Weiss model or the Hopfield model on an Erdős-Renyi graph or more general graphs. This is based on joint work with Zakhar Kabluchko (Münster) and Franck Vermet (Brest).

An optimal Berry-Esseen type theorem for expectations of smooth functions

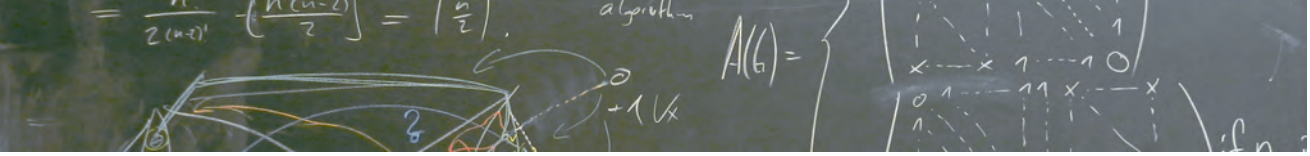
Lutz Mattner
Universität Trier, Germany

We present an optimal Berry-Esseen type theorem for approximating expectations of smooth functions (like $f(x) = (1/6)|x|^3$) of a standardized sum of i. i. d. random variables by corresponding expectations with respect to standardized symmetric binomial laws. Comparing the latter expectations to standard normal ones yields, as a corollary, a partial improvement of a theorem of Tyurin (2009). This is joint work with Irina Shevtsova.

Limit theorems for random geometric graphs

Matthias Schulte
Karlsruhe Institute of Technology, Germany

A random geometric graph is constructed by connecting two points of a Poisson process in a compact convex set whenever their distance does not exceed a prescribed distance. The aim of



this talk is to investigate the asymptotic behaviour of the total edge length or, more general, sums of powers of the edge lengths of this random graph as the intensity of the underlying Poisson process is increased and the threshold for connecting points is adjusted. Depending on the interplay of these two parameters one obtains limit theorems where the limiting distribution can be Gaussian, compound Poisson or stable. This talk is based on joint work with Laurent Decreusefond, Matthias Reitzner and Christoph Thäle.

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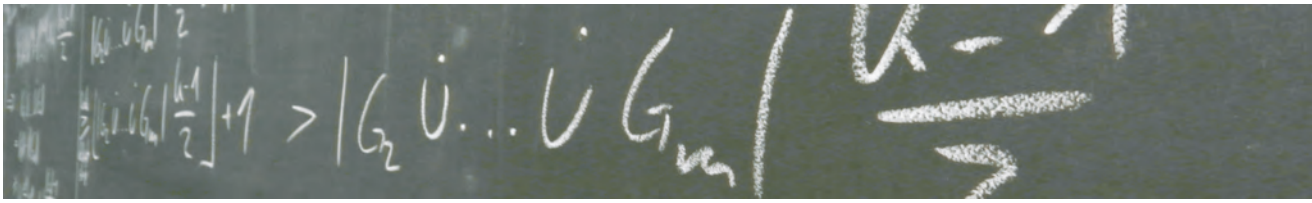


Minisymposien / Mini-Symposia

MS#1: Abiturstandards—Möglichkeiten, Chancen und Grenzen ihrer Umsetzung

Organisatorin: Gabriele Kaiser, Hamburg

In dem Minisymposium sollen die 2012 von der Kultusministerkonferenz erlassenen Bildungsstandards im Fach Mathematik für die Allgemeine Hochschulreife (sogenannte Abiturstandards) aus verschiedenen Perspektiven beleuchtet werden. So sollen die Abiturstandards diskutiert werden unter der Frage, welche Möglichkeiten zur Veränderung des herkömmlichen Mathematikunterrichts diese Standards bieten, wie sich Mathematikunterricht durch diese neuen Bildungsstandards innovativ weiterentwickeln kann, z.B. durch eine Verbesserung des begrifflichen Verständnisses zentraler Konzepte und Stärkung von Grundvorstellungen, der Stärkung des Rechnereinsatzes, der Erhöhung der Bedeutung von Modellierung und Anwendung. Es soll aber auch intensiv reflektiert werden, welche Gefahren diese neuen Standards beinhalten bzgl. eines möglichen Verlusts der Bedeutung innermathematischer Fragestellungen oder allgemeiner Aspekte wie Beweisen. Die Beteiligten an dem Mini-Symposium waren bzw. sind an zentraler Stelle mit der Entwicklung der Abiturstandards beteiligt bzw. an ihrer Realisierung in Hamburg.

Modellieren im Abitur—was geht und was geht nicht?

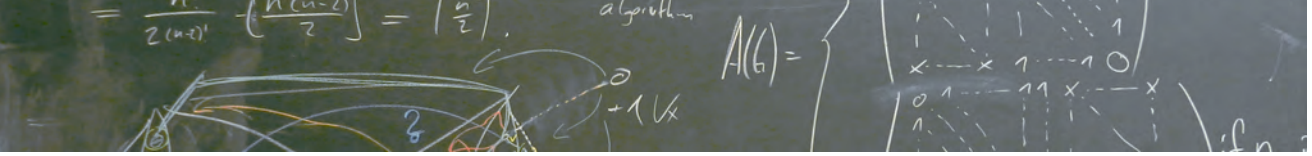
Werner Blum
Universität Kassel, Germany

Modellieren ist eine der sechs allgemeinen Kompetenzen, die Schülerinnen und Schüler anhand von Oberstufeninhalten (weiter)entwickeln sollen und die im Abitur verbindlich überprüft werden sollen. Gängige Abituraufgaben enthalten i. A. nur bescheidene Modellierungsanforderungen. Im Vortrag soll erörtert werden, inwiefern diese Beschränkungen den Rahmenbedingungen des Abiturs geschuldet sind und welche Modellierungsanforderungen man sinnvoll im Abitur verlangen kann oder sollte.

Zur Modellierung des Anforderungsprofils von Abituraufgaben: Deutschland und Österreich im Vergleich

Regina Bruder
Technische Universität Darmstadt, Germany

Um die Vergleichbarkeit der Anforderungen an die zentrale Matura in Österreich begründen zu können, wurde ein dreidimensionales Modell entworfen und empirisch geprüft mit den Kompetenzbereichen Operieren, Modellieren und Argumentieren. Im Vortrag werden die theoretischen Hintergründe (Modellierungsansätze) vorgestellt und die aktuellen Abituraufgaben in Österreich und Deutschland (exemplarisch) miteinander verglichen.



Die Hamburger Abituraufgaben im Fach Mathematik—Stärken, Schwächen, Perspektiven

Andreas Busse
Universität Hamburg, Germany

Abiturprüfungen gerade im Fach Mathematik stehen schnell und häufig im Fokus der öffentlichen Aufmerksamkeit. Dabei ist im vergangenen Jahr auch die Art und Weise, wie die Hamburger Abituraufgaben konzipiert sind, über Presseveröffentlichungen in die öffentliche Diskussion geraten. Die Spannweite der Einschätzungen dieser Aufgaben ist dabei beträchtlich: Manche sehen eine zunehmende Trivialisierung der Anforderungen, andere betrachten die Hamburger Aufgaben als bundesweit vorbildlich und richtungsweisend. Unbestritten ist, dass die heutigen Anforderungen einen anderen Charakter haben als die früherer Jahre. Während vor gut zehn Jahren stärker theorie- und insbesondere fertigkeitsbezogene Anforderungen zu bewältigen waren, liegt der Schwerpunkt in den letzten Jahren deutlich im Bereich der Realitätsbezüge, wobei übertragungsleistungen zwischen verbal und mathematisch beschriebener Realität eine wichtige Rolle spielen. In dem Vortrag werden Kritikpunkte aufgegriffen, Stärken und Schwächen in der aktuellen Aufgabenkonzeption gegenübergestellt und Perspektiven aufgezeigt.

Abituraufgaben in Zeiten von Bildungsstandards

Gilbert Greefrath
Westfälische Wilhelms-Universität Münster, Germany

In den Bildungsstandards im Fach Mathematik für die allgemeine Hochschulreife gibt es fachspezifische Hinweise zur Gestaltung der schriftlichen Prüfungsaufgabe im Fach Mathematik. Auf dieser Grundlage arbeiten die Länder am Aufbau eines gemeinsamen Pools von Abiturprüfungsaufgaben für das Fach Mathematik ab dem Jahr 2017. Dieser Aufgabenpool soll Qualität und Vielfalt von Prüfungsaufgaben in den Ländern sowie gleichzeitig die notwendige Vergleichbarkeit sichern. Im Vortrag werden Qualitätskriterien für die Erstellung von Prüfungsaufgaben auf der Basis der Bildungsstandards vorgestellt und mit Hilfe von Beispielaufgaben erläutert. Dabei wird auch der Einsatz digitaler Mathematikwerkzeuge berücksichtigt.

MS#2: Algebraic Aspects of Cryptology

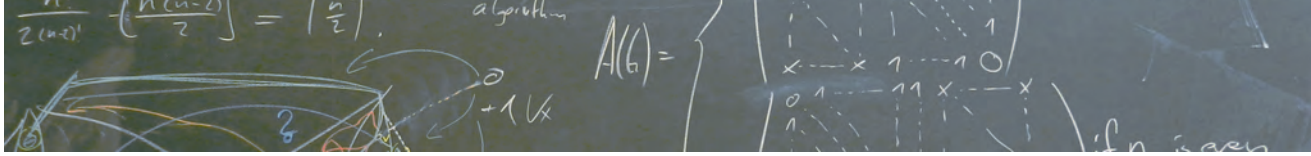
Organisatoren: Benjamin Fine, Fairfield CT; Anja Moldenhauer, Hamburg; Gerhard Rosenberger, Hamburg

In the mini-symposium *Algebraic Aspects of Cryptology* we aim to discuss various aspects, methods and theories of mathematical cryptology. In addition to number theoretic cryptosystems and protocols, we plan to focus on algebraic cryptology using methods of group theory and noncommutative Gröbner bases as well as cryptanalysis.

Provably Secure Password Security System

Benjamin Fine
Fairfield University, United States of America
Gerhard Rosenberger
University of Hamburg, Germany

We describe a group based protocol on a secure password exchange.



How useful is the word problem?

Robert Gilman
Stevens Institute of Technology, United States of America

The word problem and word search problem for finitely presented groups are the basis of several proposed cryptosystems. In this talk we discuss the feasibility of sampling hard instances of these problems for given groups.

Matrix Assumptions and Polynomial Spaces

Gottfried Herold
University of Bochum, Germany

One of the most important cryptographic assumptions is arguably the Decisional Diffie-Hellman Assumption, asking to tell whether a group element is of the form g^{ab}, given g, g^a, g^b in some cyclic group. This assumption does not to hold in groups that allow a symmetric pairing, so we need to generalize and replace DDH by other similar assumptions if we want to enjoy the functionalities that groups with such pairing offer. In general, the type of assumption that we consider is of the form that some solving a elementary problem from linear algebra like teling whether a vector v is in a subspace described as the image of a matrix, is infeasible if we are only given the inputs "in the exponent". Security analysis in an appropriate model boils down to the analysis of generic polynomial relations between the exponents. For the case of membership in the image of a matrix, the ideal formed by these relations is typically generated by determinants, which allows for an extremely analysis. Additionally, taking this algebraic point of view allows to interpret the vectors v themselves as polynomials, giving additional structure that leads to some interesting applications, efficiency improvements allows to gain new insights into existing constructions.

Algorithmic Problems in Polycyclic Groups

Delaram Kahrobaei
The City College of New York, United States of America

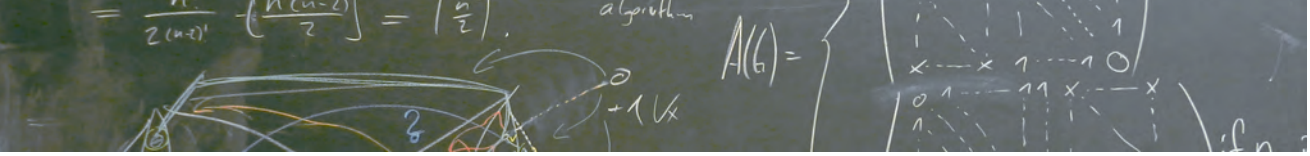
I shall talk about some algorithmic problems in polycyclic groups and analyze the complexity of them.

Exploring the solution space and improving the run-time of the BDHCP-algorithm

Christian Kell
University of Passau, Germany

In 2003 Cheon and Jun invented a polynomial-time algorithm, which solves the braid group-based Diffie-Hellman Conjugacy Problem (BDHCP). The algorithm was presented in their article "A polynomial time algorithm for the braid Diffie-Hellman conjugacy problem" (in: Advances in Cryptology—CRYPTO 2003, Springer). The algorithm makes use of the Lawrence-Krammer representation which is an injective group homomorphism between the braid group B_n and the general linear group of degree $\binom{n}{2}$ over the two-variable Laurent-ring $\mathbb{Z}[t^{\pm 1}, q^{\pm 1}]$. The algorithm searches for a matrix $\mathcal{A} \in \mathrm{GL}_{\binom{n}{2}}(\mathbb{Z}[t]/(p, f))$ (p (large) prime, f an irreducible polynomial (of large degree in t)) which is a solution to several matrix equations. A part of the structure of the possible solutions $\mathcal{A}$ is already known by Cheon and Jun. During our research on the algorithm we were able to find the complete structure, which improves the run-time complexity ($\mathcal{O}(\ell^3 n^{13,2} \log n)$) of the algorithm by a constant factor.

Since the powers in the complexity are large, a reduction by a constant factor is not of much use. So our next aim is a clever implementation of the algorithm using interpolation methods and



the Chinese remainder theorem, in order to do the calculations over small finite fields instead of doing them over the large field $\mathbb{Z}[t]/(p, f)$. If we can reduce the run-time of the algorithm enough, then also the knowledge about the structure of the possible solutions should be of greater use.

Algebraische Fehlerangriffe

Martin Kreuzer
University of Passau, Germany

Bei Seitenkanalangriffen versucht man nicht den mathematischen Algorithmus eines Kryptosystems sondern seine Implementierung in Soft- und Hardware anzugreifen. Eine wichtige Klasse solcher Angriffe sind Fehlerangriffe, bei denen durch gezielte physikalische Manipulationen (z.B. Manipulation der Spannungsversorgung, Beschuss mit Lasern oder anderen Strahlungen) bestimmte Fehlberechnungen induziert werden. Bei algebraischen Fehlerangriffen wird die erhaltene Information in polynomiale Gleichungen über endlichen Körpern umgewandelt und dann versucht, diese mit symbolischen Verfahren zu lösen. Wir führen verschiedene Arten und Beispiele algebraischer Fehlerangriffe vor und diskutieren auch mögliche Verteidigungsstrategien.

Variants of the Burrows-Wheeler Transform

Manfred Kufleitner
University of Stuttgart, Germany

We give an overview of several variants of the Burrows-Wheeler Transform (BWT). This includes the sort transform (ST), bijective versions of the BWT and the ST, and generalizations by using permutations on the alphabet. The setting of the BWT with permutations (BWTP) is as follows. Let G be a group acting on an ordered alphabet Σ. We write a^g for the letter obtained by applying the element $g \in G$ to $a \in \Sigma$. For $u = a_1 \cdots a_n$ we let $u^g = a_1^g \cdots a_n^g$ be the homomorphic extension to words $u \in \Sigma^*$. Let $\tilde{u}$ denote the lexicographically minimal element in $\{u^g \mid g \in G\}$. Let $(\tilde{v}_1, \ldots, \tilde{v}_n)$ be the sorted list of the conjugates v_i of u. The BWT with permutations (BWTP) of u is $\mathrm{BWTP}_G(u) = (w, i, g)$ where w is the sequence of the last letters in the sorted list of the words $\tilde{v}_i$, the number i is an index with $\tilde{u} = \tilde{v}_i$, and $g \in G$ satisfies $\tilde{u} = u^g$.

Cryptographic protocols based on Nielsen transformations

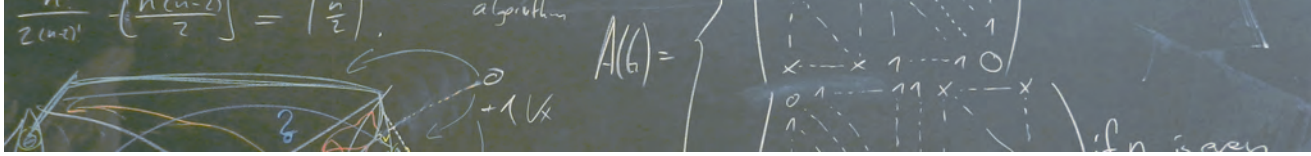
Anja Moldenhauer
University of Hamburg, Germany

We present and analyze cryptographic protocols which are based on Nielsen transformations.

Model Theory and Complexity of Free Solvable Groups with applications to cryptography

Alexei Myasnikov
Stevens Institute of Technology, United States of America

We discuss the complexity of algorithms and decision problems for free solvable groups and describe some applications in cryptography.



Homomorphic encryption of group elements

Vladimir Shpilrain
The City College of New York, United States of America

We offer a secure homomorphic encryption of elements of a finite nonabelian simple group. According to a result of Khamsemanan-Ostrovsky-Skeith, this entails a construction of a secure fully homomorphic encryption scheme.

Resource estimates for quantum cryptanalysis

Rainer Steinwandt
Florida Atlantic University, United States of America

Asymptotically efficient quantum algorithms that render some classical computational hardness assumptions invalid are widely known, and the availability of these algorithms motivates research in post-quantum cryptography. A more fine-grained resource analysis of such quantum algorithms is desirable in order to understand their cryptanalytic impact. How many qubits and how many gates of which type do we need to attack actually deployed schemes, and what is the depth of such a quantum circuit?

MS#3: Algebraic Quantum Field Theory on Lorentzian Manifolds

Organisatoren: Christian Bär, Potsdam; Klaus Fredenhagen, Hamburg; Rainer Verch, Leipzig

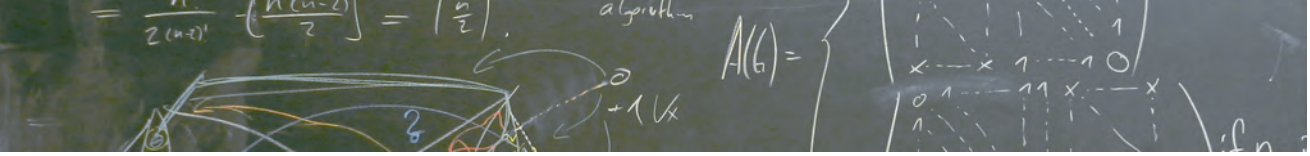
After some decades of work a satisfactory theory of quantum gravity is still not available; moreover, there are indications that the original field theoretical approach may be better suited than originally expected. There, to first approximation, one is left with the problem of quantum field theory on Lorentzian manifolds. This approach leads to far reaching conceptual and mathematical problems and to spectacular predictions, the most famous one being the Hawking radiation of black holes.

Ingredients of this approach are the formulation of quantum physics in terms of C*-algebras, the geometry of Lorentzian manifolds, in particular their causal structure, and hyperbolic partial differential equations, as well as more recently the insights from suitable concepts such as microlocal analysis.

On Analysis of Hyperbolic PDO and AQFT

Zhirayr Avetisyan
University College London, England

Hyperbolic PDO on Lorentzian manifolds appear naturally as field operators in QFT in CST, and their analysis yields directly to the field content. We shall start from the separation of variables in a hyperbolic field equation by means of Fourier analysis, and the resulting mode decomposition of quantum states. Then we shall go on to Paley-Wiener theorems and see how they translate the Hadamard property of a quasifree quantum state to the dual (momentum) space. Finally we shall discuss more subtle topics on hyperbolic PDO and how they relate to Lorentzian geometry. Everywhere both available results and ongoing work will be presented.



Global observables for Abelian gauge theories via homotopy colimits

Marco Benini
Heriot-Watt University, Scotland
Universität Potsdam, Germany

The question of how to glue local observables for an Abelian gauge theory to global ones is addressed at the kinematic level using the framework of homotopy theory. Starting from functors providing chain complexes that describe configurations and observables for an Abelian gauge theory on contractible manifolds, we present a procedure to extend those functors to non-contractible manifolds by means of homotopy (co)limits. This approach turns out to be flexible enough to encode also the relevant topological information (non-trivial principal bundles, flat connections, ...). Furthermore, on contractible manifolds, the extended functors are shown to agree with the original ones up to natural quasi-isomorphisms. Joint work with A. Schenkel and R. J. Szabo (arXiv:1503.08839).

Complex powers of analytic functions and meromorphic regularization in QFT

Nguyen Viet Dang
Université Lille 1, laboratoire Paul Painlevé, France

My talk is motivated by the problem of renormalization of QFT on real analytic spacetimes. In a first part, I shall explain how we are let to study and regularize families of complex powers of analytic functions of the form

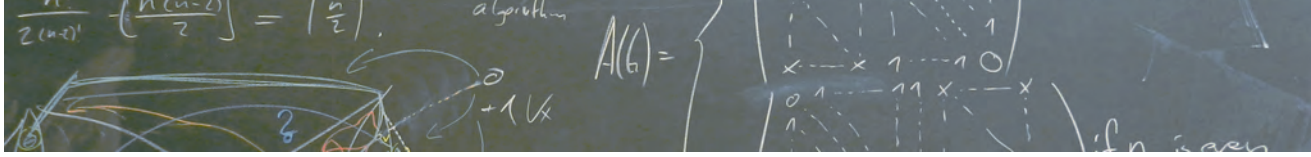
$$\prod_{i=1}^{p}(f_j+i0)^{\lambda_j}$$

where f_j are real analytic functions and λ_j are complex powers. I shall show that $\prod_{i=1}^{p}(f_j+i0)^{\lambda_j}$ is a distribution valued in meromorphic functions with linear poles, the proof relies on Hironaka's resolution of singularities and recent results (2015) of Guo–Paycha–Zhang. This allows me to regularize $\prod_{i=1}^{p}(f_j+i0)^{\lambda_j}$ at integer values for λ_j. Then I shall show how a detailed functional analytic study of the family $\prod_{i=1}^{p}(f_j+i0)^{\lambda_j}$ allows to renormalize QFT on analytic spacetimes following the Epstein–Glaser method generalizing the work of Dütsch-Fredenhagen-Keller-Rejzner.

Constructing Isometry Invariant Hadamard States via a Novel Deformation Argument

Claudio Dappiaggi
University of Pavia, Italy

Existence of Hadamard states for a free field theory on a globally hyperbolic spacetime has been proven via a metric deformation argument, proposed by Fulling, Narkowich and Wald in the eighties. The main deficiency of this scheme is the complete loss of any control on the invariance of the state under the action of the background isometries. In order to account for them, one needs to resort to specific construction schemes which are often valid for a given free field with a fixed value of the mass and, if present, of the coupling to scalar curvature. Via an extended version of the Møller operator, we show that, these isometry invariant Hadamard states can be deformed to Hadamard states for any value of the mass and of the coupling to scalar curvature. Furthermore the invariance under any spacelike isometry is preserved, while, for the timelike ones, a kind of adiabatic procedure is necessary. (Joint work with Nicoló Drago, Genoa; arXiv:1506.09122.)



The split property for QFT in curved spacetimes

Christopher J. Fewster
University of York, England

The split property expresses the way in which local regions of spacetime define subsystems of a quantum field theory. It is known to hold for general theories in Minkowski space under the hypothesis of nuclearity. In this talk, the split property will be discussed for general locally covariant quantum field theories in arbitrary globally hyperbolic curved spacetimes, using a spacetime deformation argument to transport the split property from one spacetime to another. It is also shown how states obeying both the split and (partial) Reeh–Schlieder properties can be constructed, providing standard split inclusions of certain local von Neumann algebras. Sufficient conditions are given for the theory to admit such states in ultrastatic spacetimes, from which the general case follows. A number of consequences are described, including the existence of local generators for global gauge transformations, and the classification of certain local von Neumann algebras. I shall also show that, in the locally covariant context, theories with a finite splitting distance (distal split property) must in fact obey the split property. The interpretation of this last result is that theories that obey the distal split property, but not the split property, either fail to obey the timeslice axiom, or do not admit locally quasiequivalent state spaces.

The generalised principle of perturbative agreement and the thermal mass

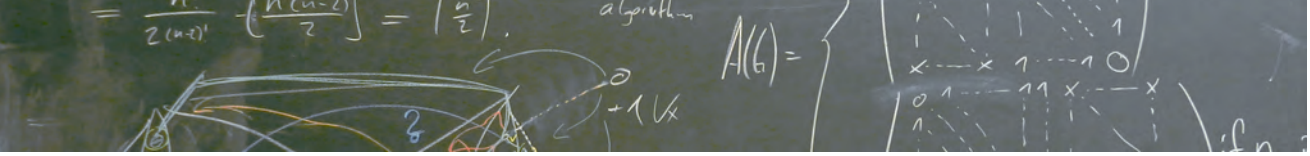
Thomas-Paul Hack
University of Leipzig, Germany

The Principle of Perturbative Agreement, as introduced by Hollands & Wald, is a renormalisation condition in quantum field theory on curved spacetimes. This principle states that the perturbative and exact constructions of a field theoretic model given by the sum of a free and an exactly tractable interaction Lagrangean should agree. We develop an alternative proof of the validity of this principle in the case of scalar fields and quadratic interactions without derivatives. Afterwards, we prove a generalisation of the Principle of Perturbative Agreement and show that considering an arbitrary quadratic contribution of a general interaction either as part of the free theory or as part of the perturbation gives equivalent results. Motivated by the thermal mass idea, we use our findings in order to extend the construction of massive interacting thermal equilibrium states in Minkowski spacetime developed by Fredenhagen & Lindner to the massless case.

Supergeometry in classical field theory

Igor Khavkine
University of Trento, Italy

Ordinary (bosonic) classical field theory consists of a "field" bundle on a spacetime manifold, a variational PDE on the field sections, its space of solutions (the "phase space", an infinite dimensional manifold), and the algebra of smooth functions ("observables") on the phase space, with an induced Poisson bracket. Fermionic field theory is defined analogously, except that the fibers of the field bundle are allowed to be supermanifolds instead of ordinary manifolds. In the physics literature, fermionic field theories are usually treated in an essentially algebraic way, at the level of the super-Poisson algebra of observables, with its interpretation as the algebra of functions on a phase space supermanifold lost. I shall discuss how a modern, functorial formulation of supergeometry allows us to describe the fermionic phase space as a geometric object and to apply tools from analysis and PDE theory to answer some questions about fermionic theories that were difficult to study or even formulate in the algebraic treatment.



An analytic regularization scheme for time-ordered products on curved spacetime

Nicola Pinamonti
University of Genova, Italy

During this talk we shall discuss the implementation of an analytic regularization scheme for time ordered products of quantum field theory on curved backgrounds. After discussing the general method and the ideas on which the method is based we shall present some concrete computations for analyzing interacting quantum field theory on cosmological spacetimes.

BV algebras in causal approach to renormalization

Kasia Rejzner
University of York, England

The causal perturbation theory approach to renormalization, based on the seminal paper of Epstein and Glaser from 1973, is a mathematically rigorous framework which allows to study foundations of perturbative QFT. In this talk I shall explain how BV algebras arise naturally in this construction. The physical motivation is the study of gauge theories. Mathematically, the construction which I present allows to obtain interesting examples of BV algebras from a class of differential Gerstenhaber algebras.

Ground states for radiating static black holes

Ko Sanders
Universität Leipzig, Germany

The phenomenon of black hole radiation (Hawking, 1975), which is still only partially understood, provides an interesting connection between the behaviour of quantum matter and the classical geometry of a background spacetime.

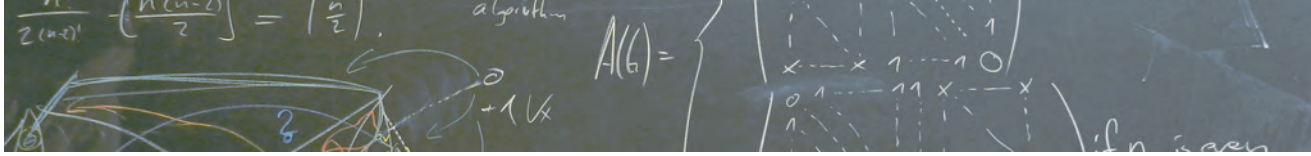
For a simplified description at late times, where the black hole has settled down to a stationary state, one conjectures that the quantum matter is in a kind of ground state, which is well-behaved across the black hole horizon. Restricting this state to the region outside the black hole yields a thermal (KMS) state at the Hawking temperature (Hartle and Hawking, 1976; Israel, 1976).

The conjectured existence of the ground state was argued to be false for certain stationary black holes by Kay and Wald (1991). However, we shall discuss some aspects of the first general existence proof (2015), which concerns free scalar fields in a class of static spacetimes with a bifurcate Killing horizon (including the Schwarzschild black holes). The proof combines detailed methods from geometry and analysis (local and global).

An index theorem for Lorentzian spacetimes

Alexander Strohmaier
University of Loughborough, England

I shall explain an analogue of the Atiyah-Patodi-Singer index theorem for the (Loretzian) Dirac operator on a globally hyperbolic spacetime with boundary. Since this operator is not elliptic this does not fall into the framework of classical index theory. I shall also discuss some consequences of this theorem for quantum field theory on curved spacetimes. (Joint work with C. Bär.)



The classical phase space in the BRST formalism on curved spacetimes.
Michał Wrochna
Université Grenoble 1, France

One of the well-known features of the BRST formalism is that the physical space is obtained as the cohomology of the BRST differential. On the other hand, standard approaches to linear quantum fields on curved spacetime use a description of the classical phase space in terms of space-compact solutions of a hyperbolic differential operator. To make those two aspects work together, one needs a good understanding of the interplay of the BRST differential with the equations of motion. I shall explain the resulting issues on the level of differential operators and give a rigorous definition of the classical phase space in the BRST formalism, proposed recently in joint work with J. Zahn, then point towards new challenges in the construction of physical states for higher-spin fields.

MS#4: Applied and Computational Harmonic Analysis

Organisatoren: Gitta Kutyniok, Berlin; Jakob Lemvig, Kungens Lyngby

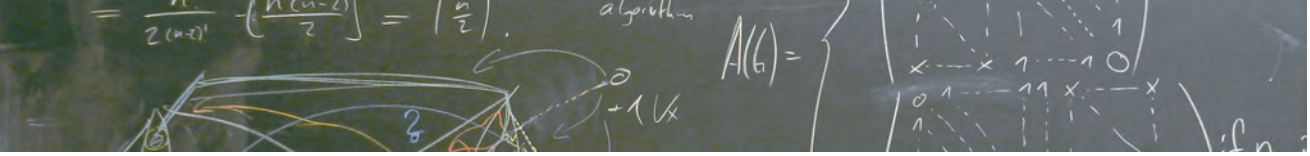
Recent advances in modern technology have created a new world of enormous, multivariate data structures. In biomedical imaging, seismic imaging, astronomical imaging, computer vision, and video processing, the capabilities of modern computers and highprecision measuring devices have generated 2D, 3D, and even higher dimensional data sets of sizes that were infeasible just a few years ago. We need to efficiently handle such data has initiated an intense study in developing efficient multivariate (directional) representation systems in the applied harmonic analysis research community.

From a computational point of view one searches for transforms which, in particular, provide compressible approximations, resolve wavefront sets, possess fast decomposition algorithms, and allow for a unified treatment of continuum and discrete data. From an abstract point of view one seeks to understand the underlining principles of such "successful" transforms; where "successful" is measured in terms of the above listed desirable properties. Which classes of transforms will have the desirable properties? From a representation-theoretic viewpoint one can ask for a characterization of groups which through their associated transforms lead to desirable properties.

This workshop will explore diverse topics within this area with presentations from both Danish and German researchers.

On Grassmannian designs and applications
Martin Ehler
University of Vienna, Austria

Many high-dimensional data analysis problems require some dimension reduction process before sophisticated analysis tools can be used. Standard approaches design one single projector of some predefined rank. One may ask what to do if several projectors can be chosen. We study the choice of collections of projectors of varying ranks that be used simultaneously.



On the use of highly directional representations in incomplete data tomography

Jürgen Frikel
Danmarks Tekniske Universitet, Denmark

Tomographic reconstruction from incomplete data plays an important role in many practical applications (due to technical restrictions), and is utilized as a technique for dose reduction, e.g., in x-ray imaging. The underlying mathematical problem is known to be severely ill-posed, i.e., even small measurement errors can cause huge reconstruction errors. As a result, some features of the original object cannot be reconstructed reliably (invisible singularities) if a significant portion of the data is missing and additional artifacts (added singularities) can be generated that can degrade the reconstruction quality even further. Both phenomena can be mathematically characterized in terms of their orientations by using microlocal analysis. To integrate this type of information into practical reconstruction algorithms, sophisticated tools are needed that can make this directional information practically accessible. In this talk, we shall discuss that highly directional systems can be used for the implementation of microlocal characterizations into practical algorithms. In addition to that, we also show that by using directional systems an orientation sensitive and edge preserving regularization can be achieved.

Continuous wavelet analysis in higher dimensions

Hartmut Führ
RWTH Aachen University, Germany

The generalized continuous wavelet transforms that this talk is about are constructed by choosing a suitable matrix group, the so-called dilation group H. Wavelet systems associated to this group then arise by picking a suitable wavelet, dilating it by elements of H, and translating arbitrariily. The wavelet transform of a signal (a function or tempered distribution) then arises by taking scalar product with the elements of the wavelet system.

In higher dimensions, there is a large variety of suitable matrix groups to choose from. One of the pertinent questions in connection with the associated transforms is whether they are able to efficiently encode important properties of the analyzed functions, specifically smoothness behaviour. So far, these questions have only been studied for a few isolated groups.

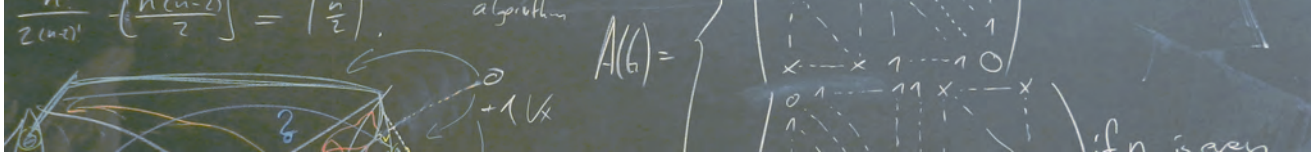
For example, it is well-known that the homogeneous Besov spaces in any dimension are related to the continuous wavelet transform associated to the similitude group. Another, celebrated, example is the shearlet group and its associated systems of wavelets, called shearlets. Shearlet coorbit space norms, obtained by imposing weighted mixed L^p norms on the shearlet coefficients, can be understood as a quantification of (directional) global smoothness, whereas local directional smoothness (or roughness) features such as the wavefront set are captured by local decay behaviour of the shearlet coefficients.

In this talk I shall give an overview of recently developed methods that allow to study the above-mentioned properties of wavelet systems in a unified and comprehensive framework, for a large variety of dilation groups. The new techniques provide far-reaching extensions of the above-mentioned results for shearlets.

A stochastic convergence analysis for Tikhonov regularization with sparsity constraints

Daniel Gerth
Johannes Kepler University Linz, Austria

In recent years, regularization methods for linear ill-posed problems with sparsity constraints have been discussed widely in literature. One specific approach is regularization with a Besov space



penalty, which, under certain conditions, can be described in a simple way using a wavelet basis. Convergence of the solutions has been analysed assuming deterministic worst-case error bounds of the error between the noisy measurements and the true data. In the talk we shall exchange this with an explicit stochastic noise model, i.e., allow arbitrarily large measurement errors, but with low probability. We use a specific metric to lift deterministic results into the stochastic setting. We shall prove convergence of the solutions with respect to the variance of the error and, using a new parameter choice rule, derive convergence rates. The theoretical results are illustrated in one dimensional and two dimensional examples.

Regular Gabor systems on locally compact abelian groups.

Mads Sielemann Jakobsen
Technical University of Denmark, Denmark

This talk will be concerned with recent results on Gabor systems in locally compact abelian groups with tranlsation and modulation along an arbitrary closed subgroup in the phase space. In particular, the famous Wexler-Raz relations and the duality principle for Gabor frames will be extended to this setting. Moreover, a new form of density result for Gabor frames will be presented. The results are not based on the usual assumption that the translation and modulation are along discrete subgroups. Moreover, the results include the non-separable (and possibly non-symplectic) case and the results are new, even in $\mathbb{R}^n$.

Algebraic and geometric spread in finite frames

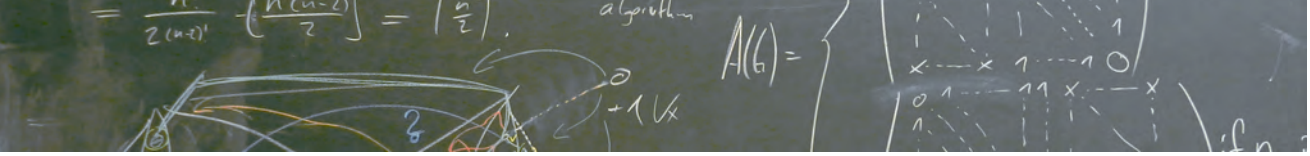
Emily J. King
University of Bremen, Germany

When searching for finite unit norm tight frames (FUNTFs) of M vectors in $\mathbb{F}^N$ which yield robust representations, one is concerned with finding frames consisting of frame vectors which are in some sense as spread apart as possible. Algebraic spread and geometric spread are the two most commonly used measures of spread. A frame with optimal algebraic spread is called full spark and is such that any subcollection of N frame vectors is a basis for $\mathbb{F}^N$. A Grassmannian frame is a FUNTF which satisfies the Grassmannian packing problem; that is, the frame vectors are optimally geometrically spread given fixed M and N. A particular example of a Grassmannian frame is an equiangular frame, which is such that the absolute value of all inner products of distinct vectors is equal. The relationship between these two types of optimal spread is complicated. The folk knowledge for many years was that equiangular frames were full spark; however, this is now known not to hold for an infinite class of equiangular frames. The exact relationship between these types of spread will be further explored in this talk, as well as Plücker coordinates and mutual coherence, which are measures of how much a frame misses being optimally algebraically or geometrically spread.

Optimal Compressive Imaging for Fourier Data

Gitta Kutyniok
Technische Universität Berlin, Germany

One fundamental problem in applied mathematics is the issue of recovery of continuous data from specific samples. Of particular importance is the case of pointwise samples of the associated Fourier transform, which are, for instance, collected in Magnetic Resonance Imaging (MRI). Strategies to reduce the number of samples required for reconstruction with a prescribed accuracy have thus a direct impact on such applications—which in the case of MRI will, for instance, shorten the time a patient is forced to lie in the scanner.



In this talk, we shall present a sparse subsampling strategy of Fourier samples which can be shown to perform optimally for multivariate functions, which are typically governed by anisotropic features. For this, we shall introduce a dualizable shearlet frame for reconstruction, which provides provably optimally sparse approximations of cartoon-like images, a class typically regarded as a suitable model for images. The sampling scheme will be based on compressed sensing ideas combined with a coherence-adaptive sampling density considering the coherence between the Fourier basis and the shearlet frame. This is joint work with W.-Q. Lim (Technische Universität Berlin).

Wavelets for non-expanding dilations

Jakob Lemvig
Technical University of Denmark, Denmark

The study of wavelets in higher dimensions is generally restricted to the class of expanding dilations A, i.e., all eigenvalues λ of A satisfy $|\lambda| > 1$. In contrast, much less attention has been devoted to the study of wavelets associated with general invertible dilations. In this talk we show that problems of existence and characterization of wavelets for non-expanding dilations are intimately connected with the geometry of numbers; more specifically, with the estimate on the number of lattice points inside dilates of balls by the powers of a dilation $A \in GL_n(\mathbb{R})$. This connection is not visible for the well-studied class of expanding dilations since the desired lattice counting estimate holds automatically.

We show that the lattice counting estimate holds for all dilations A with $|\det A| \neq 1$ and for almost every lattice Γ with respect to invariant measure on the set of lattice. As a consequence, we deduce the existence of minimally supported frequency (MSF) wavelets associated with such dilations for almost every choice of a lattice. Likewise, we show that MSF wavelets exist for all lattices and and almost every choice of a dilation A with respect to the Haar measure on $GL_n(\mathbb{R})$. This is joint work with Marcin Bownik.

Recoverable supports in sparse reconstruction

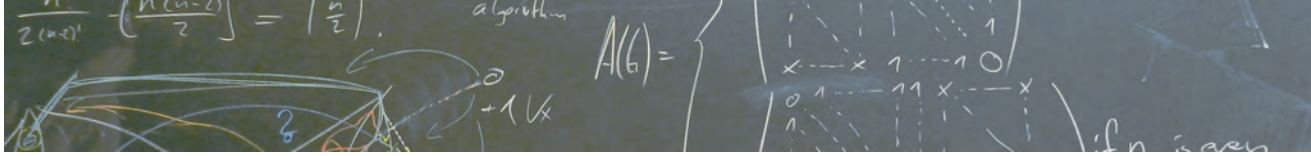
Dirk Lorenz
Technische Universität Braunschweig, Germany

Sparse reconstruction aims to recover a sparse vector for underdetermined linear measurements. We introduce the notion of recoverable support (recoverable sign-pattern, to be precise) for such problems and analyze recoverable supports for the so-called basis pursuit method. Unlike many previous studies we do not consider any asymptotic regime but try to answer questions like "How many different recoverable supports can a matrix of a given size have?" or "How can one determine the largest recoverable support for a given matrix?". We show that answers to such questions can be given with the help of the geometry of certain convex polytopes.

Directional Anisotropic Multiscale Systems on Bounded Domains

Philipp Petersen
Technische Universität Berlin, Germany

Driven by an overwhelming amount of applications numerical approximation of partial differential equations has established itself as one of the core areas in applied mathematics. During the last decades a trend for the solution of PDEs emerged, that focuses on employing systems from applied harmonic analysis for the adaptive solution of these equations. Most notably wavelet bases and also frames have been used and led for instance to provably optimal solvers for elliptic PDEs. Inspired by this success story also other systems with various advantages in different directions are



currently beeing investigated in various discretization problems of PDEs. For instance, ridgelets where recently successfully used in the discretization of linear transport equations.

Maybe the most widely used anisotropic system today is that of shearlets, which admits optimally sparse representations of functions which are governed by discontinuities along smooth curves—so called cartoon like functions. This system constitutes a frame for $L^2(\mathbb{R}^2)$. However, in order to apply such systems in adaptive discretization algorithms it is necessary to have a system on a bounded domain, which still yields a frame, is able to incorporate boundary conditions, and characterizes Sobolev spaces. Although there have been first approaches to construct shearlet systems for the solution of PDEs on bounded domains they fail to satisfy all the desiderata above. In this talk we shall introduce a novel shearlet system that meets all the requirements mentioned above and admits optimal approximation rates for cartoon-like functions.

Gabor spaces and the Balian-Low Theorem

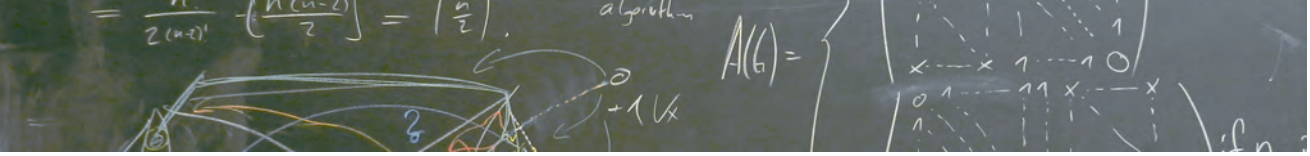
Götz Pfander
Jacobs University, Germany

We establish Balian-Low type theorems for Gabor spaces, that is, for spaces generated by a discrete set of time-frequency shifted copies of a single window function. Our results characterize windows that generate Gabor spaces which are invariant under time-frequency shifts that are not member of the space generating discrete set. Further, we observe that additional time-frequency invariance and good time-frequency decay of the window function are mutually exclusive properties. As generating sets, we consider symplectic lattices of rational density. (Joint work with Carlos Cabrelli and Ursula Molter.)

Different faces of the shearlet group

Gerd Teschke
Hochschule Neubrandenburg, Germany

Recently, shearlet groups have received much attention in connection with shearlet transforms applied for orientation sensitive image analysis and restoration. The square integrable representations of the shearlet groups provide not only the basis for the shearlet transforms but also for a very natural definition of scales of smoothness spaces, called shearlet coorbit spaces. The aim of this talk is twofold: first we discover isomorphisms between shearlet groups and other well-known groups, namely extended Heisenberg groups and subgroups of the symplectic group. Interestingly, the connected shearlet group with positive dilations has an isomorphic copy in the symplectic group, while this is not true for the full shearlet group with all nonzero dilations. Having understood the various group isomorphisms it is natural to ask for the relations between coorbit spaces of isomorphic groups with equivalent representations. These connections are discussed in the second part of the talk. We describe how isomorphic groups with equivalent representations lead to isomorphic coorbit spaces. In particular we apply this result to square integrable representations of the connected shearlet groups and metaplectic representations of subgroups of the symplectic group. This implies the definition of metaplectic coorbit spaces. This is joint work with Stephan Dahlke, Filippo De Mari, Ernesto De Vito, Sören Häuser, and Gabriele Steidl.



MS#5: Computer Algebra and Applications

Organisatoren: Mohamed Barakat, Kaiserslautern; Janko Böhm, Kaiserslautern; Claus Fieker, Kaiserslautern

Increasingly complex structures arise in various areas of pure mathematics. Exploring and understanding such structures is often indispensable for theoretical progress. This elevates the interest in constructive aspects and their algorithmic treatment. Computer algebra provides a framework for such algorithmic explorations. It profits from the rapid development of hard and software technology. This mini-symposium will highlight recent achievements in and supported by computer algebra.

Multi-threaded Singular

Reimer Behrends
Technische Universität Kaiserslautern, Germany

Singular is a computer algebra system with a focus on polynomial computations; it depends on an existing codebase of several hundreds of thousands lines of code written in efficient, but low-level C/C++. In this talk, we describe how we transformed this codebase to make it thread-safe and discuss the mechanisms we introduced to facilitate multi-threaded programming in Singular.

Ein Zufallszahlengenerator auf Basis elliptischer Kurven

Claus Diem
Universität Leipzig, Germany

Es ist wohlbekannt, dass man ein diskretes Logarithmusproblem als Basis für einen Pseudozufallsgenerator benutzen kann. Die ursprüngliche Konstruktion von Blum und Micali ist allerdings vom praktischen Standpunkt aus recht ineffizient.

Der „Dual Elliptic Curve Deterministic Random Bit Generator“ ist ein von NIST standardisierter Generator ähnlicher Art, dessen Sicherheit auf dem ersten Blick auf dem diskreten Logarithmenproblem in elliptischen Kurven beruht. Dieser Generator ist allerdings unsicher. Außerdem enthält der Standard, wenn man ihn wörtlich nimmt, eine offensichtliche „Hintertür“. Letzteres wurde im Jahr 2013 im Zuge der Enthüllungen von Edward Snowden bekannt.

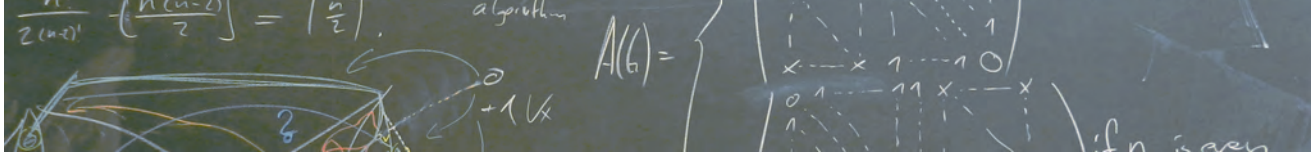
Aufgrund dieser Gegebenheiten liegt die Konklusion nahe, dass man das diskrete Logarithmenproblem in elliptischen Kurven nicht als Basis für einen Generator verwenden sollte.

In dem Vortrag wird aufgezeigt, dass dieser Schluss allerdings voreilig ist. In der Tat ist es möglich, einen recht effizienten Generator zu erhalten, dessen Sicherheit auf einer Standardannahme über die Schwierigkeit des bekannten Diffie-Hellman-Problems beruht. Der Vortrag beruht auf einer Zusammenarbeit mit Domingo Gomez in Santander.

Betti numbers for determinantal singularities

Anne Frühbis-Krüger
Leibniz Universität Hannover, Germany

The topology of the Milnor fibre of an isolated singularity holds important information about the singularity. For hypersurface singularities and complete intersections, it is well understood. But for the slightly more complicated case of Cohen-Macaulay codimension 2 singularities, systematic studies have only started recently. In this talk, I shall present an approach to computing the Betti numbers of the Milnor fibre (in the range of good dimensions). Applying this to the list of simple 3-fold singularities within this class, certain patterns are revealed, which I am also going to explain in the talk (joint work with Matthias Zach).



Categories, algorithms, and programming

Sebastian Gutsche
Technische Universität Kaiserslautern, Germany
Sebastian Posur
RWTH Aachen University, Germany

In the talk we present CAP, which is a realization of categorical programming written in GAP. CAP makes it possible to compute complicated mathematical structures, e.g., spectral sequences. This can be achieved using only a small set of basic algorithms given by the existential quantifiers of ABELian categories, e.g., composition, kernel, direct sum. In the talk we shall explain the concepts of categorical programming and give a demonstration of the functionalities of CAP.

Nemo: A computer algebra package for Julia

William Hart
Technische Universität Kaiserslautern, Germany

We shall demonstrate a new computer algebra package written in the programming language Julia.

Nemo is designed to provide generic algorithms for a variety of different generic rings which are constructed over base rings provided by various computer algebra libraries, such as Singular, Flint, Antic and others.

We shall discuss what is currently available in Nemo, compare Nemo with various other systems and outline our current plans for the future of Nemo.

F-Überlagerungen von endlichen auflösbaren Gruppen

Max Horn
Justus-Liebig-Universität Giessen, Germany

Sei G eine endliche auflösbare Gruppe und $\nu_0(G) := F(G)$ die Fitting-Untergruppe von G, also der maximale nilpotenten Normalteiler von G. Für $i \geq 0$ sei $\nu_{i+1}(G)$ der kleinste Normalteiler von $F(G)$, so dass $\nu_i(G)/\nu_{i+1}(G)$ ein direktes Produkt elementar-abelscher Gruppen ist, welche von $F(G)$ zentralisiert werden. Dann ist $G \geq \nu_0(G) \geq \nu_1(G) \ldots$ die *F-Zentralreihe* von G. Die Länge c dieser Reihe ist die *F-Klasse* von G. Ein *F-Nachfolger von G* ist eine Gruppe H, so dass $H/\nu_c(H) \cong G$ und $\nu_c(H) \neq 1 = \nu_{c+1}(H)$ gelten.

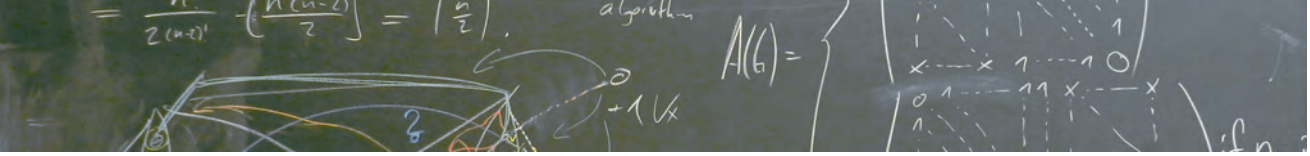
Man kann nun die Isomorphietypen endlicher auflösbarer Gruppen einer festen Ordnung $N \in \mathbb{N}$ algorithmisch klassifizieren, in dem man sukzessive F-Nachfolger einiger geeigneter (bekannter) endlicher auflösbarere Gruppen bestimmt, wobei die Ordnungen der Ausgangsgruppe alle kleiner N sind (siehe "The construction of finite solvable groups revisited" (B. Eick und M. Horn, J. Algebra 408, 2014).

Hierbei ist ein Schlüsselschritt die Bestimmung von *F-Überlagerungsgruppen von G*; dies sind Gruppen mit u. A. der Eigenschaft, dass jeder Nachfolger von G ein Quotient von K ist. Wir stellen einen neuen Algorithmus hierfür vor, welcher wesentlich effizienter arbeitet als der bisher eingesetzte naive Algorithmus.

Moduli of Tropical Plane Curves

Michael Joswig
Technischen Universität Berlin, Germany

We study the moduli space of metric graphs that arise from tropical plane curves. There are far fewer such graphs than tropicalizations of classical plane curves. For fixed genus g, our moduli



space is a stacky fan whose cones are indexed by regular unimodular triangulations of Newton polygons with g interior lattice points. It has dimension $2g+1$ unless $g \leq 3$ or $g = 7$. We compute these spaces explicitly for $g \leq 5$. The computations are based on TOPCOM and polymake. (Joint work with Sarah Brodsky, Ralph Morrison and Bernd Sturmfels.)

Generalizing the Taylor resolution for toric rings

Lars Kastner
Freie Universität Berlin, Germany

For a monomial ideal in a polynomial ring the Taylor resolution is the best understood free resolution. It has been used in many proofs and already been generalized in many different directions: For example the Scarf complex gives a complex that arises in the same fashion. The minimal resolution of the monomial ideal then sits between the Taylor resolution and the Scarf complex. We want to generalize the construction for toric rings, i.e., semigroup rings with the semigroup coming from a cone intersected with a lattice. The resulting complex is not necessarily free, but applying the construction repeatedly we can get a free resolution up to any desired point. Additionally we can derive some results on the support of Ext modules of divisorial monomial ideals.

Computing automorphisms of graded algebras and Mori dream spaces

Simon Keicher
Universität Tübingen, Germany

We present algorithms to compute the automorphism group of integral, finitely generated algebras that are graded by a finitely generated abelian group. We apply our methods to compute automorphism groups of Mori dream spaces. As an example, we compute automorphism groups of Fano varieties in the computer algebra system Singular.

On terminal Fano 3-folds with 2-torus action

Michele Nicolussi
Universität Tübingen, Germany

We present the state of the art in the classification of terminal Q-factorial Fano threefolds that come with an effective action of a two-dimensional torus. To any such variety we associate its "anticanonical complex". The lattice points inside this complex control the discrepancies. This leads, amongst other, to simple characterizations of terminality and singularity. The explicit description of the anticanonical complex allows us to apply combinatorial and computational methods to the classification.

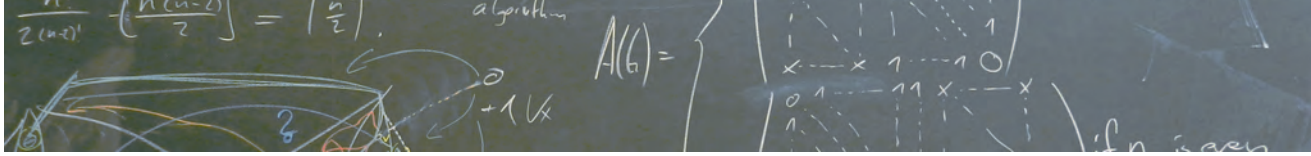
Maximally symmetric p-groups

Alice Niemeyer
University of Ireland, Ireland

In 1978, R. M. Bryant and L. G. Kovács showed that for every subgroup H of the group $\mathrm{GL}(d, q)$ of invertible $d \times d$ matrices with entries in a finite field of order p, for a prime p, there is a finite p-group P such that the automorphism group of P induces a subgroup isomorphic to H on a certain quotient of P.

Their proof demonstrates the existence of such a p-group by considering sufficiently large quotients of a free group F on d generators.

In joint work with J. Bamberg, S. Glasby and L. Morgan we consider maximal subgroups of $\mathrm{GL}(d, p)$ for odd primes p and d at least 4. Guided by explicit computations of such groups in



GAP and MAGMA we are able to prove the existence of the required p-groups and construct them algorithmically.

Algorithmic Computation of Direct Images of D-Modules

Cornelia Rottner
Technische Universität Kaiserslautern, Germany

D-modules are algebraic counterparts of systems of linear differential equations and play an important role in algebraic geometry, singularity theory and representation theory. The foundations of the theory were laid by Kashiwara and others. Mebkhout described the formalism of Grothendieck's six operations for D-modules. One of them, the direct image, corresponds in some sense to integration of differential forms. In this talk we describe an algorithmic approach to the D-module direct image extending ideas of Oaku/Takayama and Walther.

MS#6: DGVFM-Minisymposium in Financial and Insurance Mathematics

Organisatoren: Alexander Szimayer, Hamburg; Christian Hilpert, Hamburg

The DGVFM-Minisymposium will bring together leading researchers in the field of financial and insurance mathematics and will be organized in cooperation with the *Deutsche Gesellschaft für Versicherungs- und Finanzmathematik* (DGVFM, German Association for Financial and Insurance Mathematics). Topics include derivative pricing, quantitative risk management, risk measures and issues related to regulation of the financial sector (Basel III and Solvency II).

Risk-shifting & optimal asset allocation in life insurance: The impact of regulation

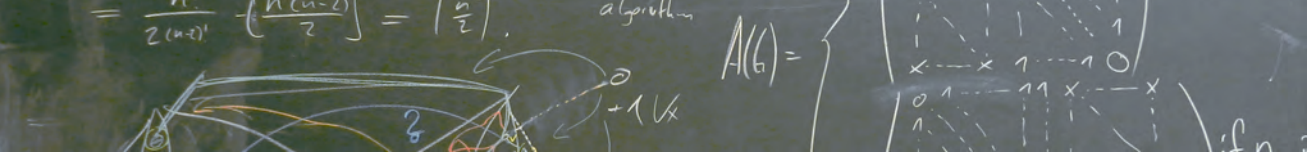
An Chen
University of Ulm, Germany

In a typical participating life insurance contract, the insurance company is entitled to a share of the return surplus as compensation for the return guarantee granted to policyholders. This call-option-like stake gives the insurance company an incentive to increase the riskiness of its investments at the expense of the policyholders. This conflict of interests can partially be solved by regulation deterring the insurance company from taking excessive risk. In a utility-based framework where default is modeled continuously by a structural approach, we show that a flexible design of regulatory supervision can be beneficial for both the policyholder and the insurance company.

Optimal Investment with Illiquid Assets

Sascha Desmettre
University of Kaiserslautern, Germany

We study asset allocation decisions of an investor that has the opportunity to invest in an illiquid asset that is only traded at time 0. We use a generalized martingale approach to find the optimal terminal wealth and to determine the optimal amount invested in the illiquid asset. We also characterize optimal trading strategies via Clark's formula and provide a simple representation in terms of a liquidity-related derivative. As an application, we study optimal asset allocation with fixed-term deposits and fixed-term defaultable investments. We demonstrate that the presence of such investment opportunities can have a significant impact on asset allocation: CRRA agents



with realistic values of relative risk aversion optimally allocate more than 40% of their wealth to illiquid assets if these yield a moderate excess return of 100 basis points over the money market account.

Are American options European after all?

Jan Kallsen
Christian-Albrechts-Universität zu Kiel, Germany

Christensen (Mathematical Finance 24, 2014, 156–172) has introduced an efficient numerical approach for obtaining upper bounds of American option prices in diffusion models. It relies on approximating the value of the option by European options with a larger payoff. In this talk we discuss the question whether or to what extent the value of an American option actually coincides on the continuation region with that of a properly chosen European payoff. In analytical terms this boils down to the question whether the harmonic function solving a free boundary problem can be extended to a harmonic function on the whole space.

Modeling capital gains taxes in continuous time

Christoph Kühn
Goethe Universität Frankfurt am Main, Germany

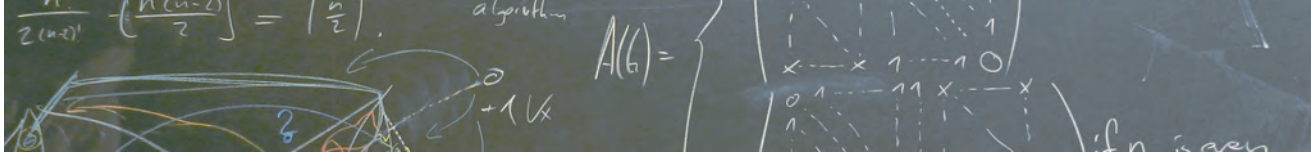
In most countries, trading gains have to be taxed. The modeling is complicated by the rule that gains on assets are taxed when assets are sold and not when gains actually occur. This means that an investor can influence the timing of her tax payments, i.e., she holds a timing option. In this talk, it is shown how the tax payment stream can be constructed beyond trading strategies of finite variation.

In addition, we analyze Constant Proportion Portfolio Insurance (CPPI) strategies in models with capital gains taxes and an Itô asset price process. CPPI strategies invest a constant fraction of some cushion in a risky asset (or index). For a fraction bigger than one, this leads to a superlinear participation in upward price movements while guaranteeing a given part of the invested capital, even if the cushion gets completely lost. It turns out that the associated tax payment stream is of finite variation if the tax-adjusted fraction is bigger or equal to one and of infinite variation otherwise. (Parts of the talk are based on joint work with Björn Ulbricht)

Measures of Systemic Risk

Stefan Weber
Leibniz-Universität Hannover, Germany

Systemic risk refers to the risk that the financial system is susceptible to failures due to the characteristics of the system itself. The tremendous cost of this type of risk requires the design and implementation of tools for the efficient macroprudential regulation of financial institutions. We propose a novel approach to measuring systemic risk. Key to our construction is a rigorous derivation of systemic risk measures from the structure of the underlying system and the objectives of a financial regulator. The suggested systemic risk measures express systemic risk in terms of capital endowments of the financial firms. Their definition requires two ingredients: first, a random field that assigns to the capital allocations of the entities in the system a relevant stochastic outcome. The second ingredient is an acceptability criterion, i.e., a set of random variables that identifies those outcomes that are acceptable from the point of view of a regulatory authority. Systemic risk is measured by the set of allocations of additional capital that lead to acceptable outcomes. The resulting systemic risk measures are set-valued and can be studied using methods from set-valued convex analysis. At the same time, they can easily be applied to the regulation of



financial institutions in practice. We explain the conceptual framework and the definition of systemic risk measures, provide an algorithm for their computation, and illustrate their application in numerical case studies. We apply our methodology to systemic risk aggregation as described in Chen, Iyengar & Moallemi (2013) and to network models as suggested in the seminal paper of Eisenberg & Noe (2001), cf. also Cifuentes, Shin & Ferrucci (2005), Rogers & Veraart (2013), and Awiszus & Weber (2015). This is joint work with Zachary G. Feinstein and Birgit Rudloff.

Pricing of Variable Annuities—Incorporation of Policyholder Behavior

Rudi Zagst
Technische Universität München, Germany

Variable annuities represent certain unit-linked life insurance products offering different types of protection commonly referred to as guaranteed minimum benefits (GMXBs). They are designed for the increasing demand of the customers for private pension provision. We propose a framework for the pricing of variable annuities with guaranteed minimum repayments at maturity and in case of the insured's death. If the policyholder prematurely surrenders this contract, his right of refund is restriced to the current value of the fund account reduced by the prevailing surrender fee. For the financial market and the mortality model an affine linear setting is chosen. For the surrender model a Cox process is deployed whose intensity is given by a deterministic function (s-curve) with stochastic inputs of the financial market. Hence, the policyholders' surrender behavior depends on the performance of the financial market and is stochastic. The presented pricing framework allows for an incorporation of the so-called interest-rate, moneyness, and emergency-fund hypothesis and is based on suitable closed-form approximations.

MS#7: Didactical aspects and functions of graphical representations

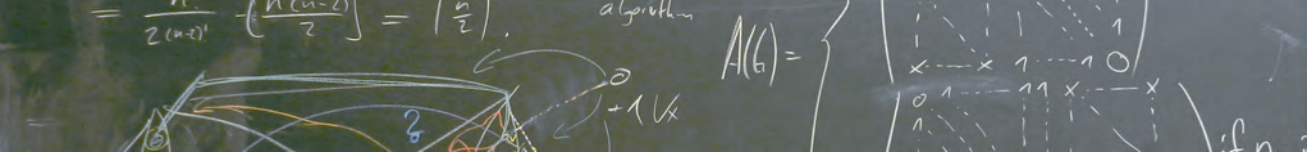
Organisatoren: Eva Müller-Hill, Köln

The symposium focuses on aspects and functions of graphical representations relevant to mathematics education. It combines different perspectives on the issue of graphical representations in teaching and learning of mathematics that are developed and discussed rather separately in existing literature.

Well-investigated and already quite strongly related core areas regarding the didactics of graphical representations are "ideas, *Grundvorstellungen*, cognition", "concept formation", "problem solving" and "dynamical representations" (CAS, DGS). In addition, there are research perspectives in mathematics education focussing more specifically on one of the following issues:

1. the role of graphical representations for mathematical proof and explanation in classroom;
2. the special importance of graphical, esp. geometrical, interpretations for the teaching and learning of algebra;
3. semiotic and discursive aspects of graphical representations in mathematics classroom;
4. the historical development of the role of graphical representations and its relevance for mathematics education;
5. the relation between usage of graphical representations in classroom, teachers (esp. epistemological) beliefs and overarching conceptions of mathematics, and the development of learners' mathematical beliefs and conceptions of mathematics.

Questions regarding the conditions and potential of multi-perspective considerations will connect individual contributions from these different perspectives.



Aspekte dynamischer Visualisierungen im Mathematikunterricht

Hans-Jürgen Elschenbroich
Marie-Curie-Gymnasium in Neuss, Studienseminar S II Neuss, LVR Medienzentrum Rheinland, Germany

Kurze Charakterisierung digitaler Werkzeuge (DGS, TK, F-Plotter, CAS) und Lernumgebungen im MU. Dynamische Visualisierungen durch dynamische Software (z.B. GeoGebra), hier vorzugsweise DGS und Funktionenplotter.

Hauptteil. Beispiele aus

Geometrie Euler-Gerade, Parabel aus Brennpunkt-Leitlinie;

Algebra Binomische Formel, Pythagoras indisch oder Stuhl der Braut, Heron-Verfahren;

Funktionen Elementare Optimierung, Funktionenlupe Differenzialrechnung.

Bei den Geometrie-Beispielen steht der Aspekt der Dynamisierung im Vordergrund, eine visuelle Repräsentation ist durch eine Zeichnung oder Konstruktion ja schon gegeben.

Bei den beiden ersten Algebra-Beispielen geht es darum, einen abstrakten, formelmäßigen Sachverhalt graphisch zu repräsentieren (visualisieren) und zu erleben, welche Vorteile eine Dynamisierung dabei noch bringt. Beim Heron kann man erleben, wie man mit einer geeigneten Lernumgebung aus einer völlig einfachen Idee einen Algorithmus entwickeln kann.

Bei den Funktionen steht im Vordergrund, wie man aus einem anschaulichen Herangehen Funktionsgraphen erzeugen bzw.untersuchen kann. Dies ist ein schülernaher Ansatz, der durchaus konträr zum üblichen Vorgehen im MU ist (mit Vorrang von Algebra & Kalkül).

Abschließend seien noch (vorwiegend für die Diskussion) Gefahren und offene Fragen genannt, die der weiteren Erforschung wert sind.

Gefahren. Ersetzt die Visualisierung die Mathematik? Visualisiert die Visualisierung das, was sie visualisieren soll? Oder schafft sie neue Vorstellungen, die sich dazwischen schieben? Wird die Visualisierung vielleicht selbst zum eigenen Gegenstand?

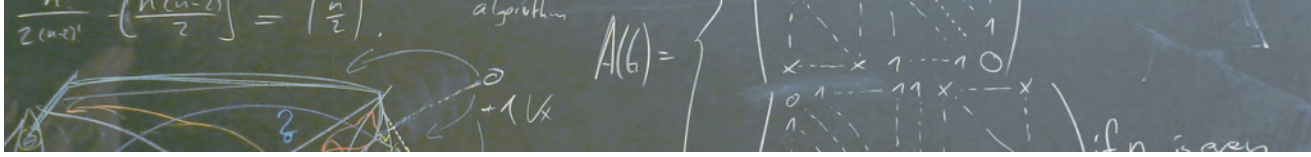
Fragen. Was ändert sich durch den Einsatz dynamischer Software und dynamischer Lernumgebungen beim Lernen von Mathematik? Lernen die Schüler mehr, besser? Gibt es durch dynamische Software & Visualisierungen andere Vorstellungen und Bilder von Mathematik bei den Schülern? Welche Fehler sind zu vermeiden?

Lösungsgraph und Zweispaltenbeweis als Hilfsmittel der Beweisfindung und -darstellung

Thomas Gawlick
Leibniz Universität Hannover, Germany

Das schlechte Abschneiden deutscher Schülerinnen bei TIMSS-Beweisaufgaben K10 und K18 beruht nach Reiss & Heinze (2004) nicht auf einem Mangel an Faktenwissen—vielmehr mangelt es an der Fähigkeit, Argumente korrekt zu begründen und zu einer Beweiskette zu verknüpfen. Beweisfindung und -darstellung sind Phasen im Boeroschen Beweismodell, die nach Heinze & Reiss (2004) unterrichtlich zu wenig praktiziert und von den Lernern daher nur unzureichend beherrscht werden. Wir betrachten hierzu zwei heuristische Hilfsmittel, die an Schulbuchinhalte Thema Beweisen anknüpfen.

Im Schulbuch „Neue Wege“ (Lergenmüller & Schmidt, 2007, S. 72) wird zur Beweisorganisation erläutert, wie man Beweise im Zweispaltenformat aufschreibt, so dass Argumente verkettet und Begründungen ausgewiesen werden können—versehen mit dem Hinweis „Die Beweisfigur und die übersichtliche Darstellung der Beweisschritte stehen meist nicht am Anfang des Beweisens, sie entwickeln sich oft erst nach vielen Ansätzen mit Versuch und Irrtum.“ Eine über dieses heuristische Basisprogramm hinausgehende Hilfestellung zur Beweisfindung wird indes nicht gegeben.



Im Schulbuch „Elemente der Mathematik“ (Griesel et al. 2008, S.145) wird die Beweisfindung an Hand der Metapher „Flussüberquerung“ als Überbrückung der Kluft von Voraussetzung und Behauptung durch sukzessive Interpolation von Zwischenaussagen dargestellt. Hieran knüpft der Lösungsgraph nach Pólya und Kőnig an—er ist ein heuristisches Hilfsmittel, das Beweise in einem ikonisch-symbolischen Format repräsentiert. Stärker als im Zweispaltenbeweis werden so die Gliederung der Argumentation, der Zusammenhang, der einzelnen Argumente und der Beweisfluss insgesamt deutlich. Während die lineare Anordnung der Argumente im Zweispaltenformat Reihenfolgeentscheidungen erzwingt, die naturgemäß teilweise willkürlich sind, hebt der relationale Charakter des Graphen stärker die logische Struktur hervor. Der Lösungsgraph eignet sich daher dazu, in der Rückschauphase dem Beweisaufbau zu veranschaulichen und den Nutzen heuristischer Impulse für die Lösungsfindung hervorzuheben. Zudem ist er für den Prozess des Verallgemeinerns nutzbar.

Wir konkretisieren unsere Überlegungen am Satz des Thales und seiner Verallgemeinerung zum Umfangswinkelsatz.

[1] Griesel, H.; Postel, H. & Suhr, F. (Hrsg., 2008): Elemente der Mathematik 8, Braunschweig: Schroedel.

[2] Heinze, A. & Reiss, K. (2004): The teaching of proof at lower secondary level—a video study. ZDM—International Journal on Mathematics Education 36(3), 98–104.

[3] Lergenmüller, A & Schmidt, G. (2007): Mathematik Neue Wege 8, Arbeitsbuch für Gymnasien Nds., Braunschweig: Westermann

[4] Reiss, K. & Heinze, A. (2004) Knowledge acquisition in students' argumentation and proof processes. In G. Törner, R. Bruder, N. Neill, A. Peter-Koop & B. Wollring (Eds.), Developments in Mathematics Education in German-Speaking Countries. Selected Papers from the Annual Conference on Didactics of Mathematics, Ludwigsburg 2001 (pp. 107–115). Hildesheim: Franzbecker.

Dynamik bringt die Mathematiklehre voran

Dörte Haftendorn
Leuphana Universität Lüneburg, Germany

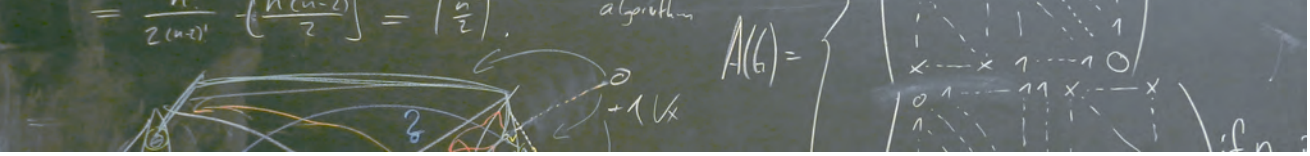
Es geht in diesem Vortrag um die „vorwärts treibende Kraft“, mit der bewegliche Darstellungen der DMS (Dynamischen Mathematik-Systeme) das Verstehen von Mathematik fördern. Damit muss auch die Lehre von Mathematik die allzu statische Sicht überwinden und wirklich „vorankommen“, in eine gute Zukunft gehen.

In drei Themen sollen Beispiele diesen Mehrwert von „Dynamik“ zeigen. Zu einem frei beweglichen Polynom entsteht als Ortslinie die Ableitung, die dann aber auf dynamische Änderungen des Polynoms zwangläufig in der ihr eigenen Weise antworten muss. Wer die Antwort voraussagen kann, hat etwas verstanden. Zwei weitere Beispiele aus der Analysis zeigen eine dynamische Hinführung zur *e*-Funktion und zum „Hauptsatz“.

Mit der polar-kartesisch-gekoppelten Darstellung wird mit zwei synchronen Graphikfenstern ein vertieftes Verständnis von Polarkoordinaten vorgestellt. Das Problem des Durchlaufs eines Kurvenpunktes kann durch vergleichendes Argumentieren gelöst werden.

Auf geometrische Weise wird die Reflexion achsenparalleler Strahlen an einer Parabel realisiert. Eine verblüffende Dynamisierung lässt dann die Leitgerade „aus dem Nichts“ erscheinen.

Die dynamische Betrachtung visualisiert nicht nur schon vorhandene mathematische Aussagen, sondern bringt neue Erkenntnisse—bei den Lernenden—hervor. Darum muss die Mathematiklehre sich nun auch selbst bewegen.



MS#8: Discontinuous Galerkin methods for the unsteady compressible Navier-Stokes equations

Organisatoren: Jochen Schütz, Aachen; Andrea Beck, Stuttgart

The fundamental physical behavior of compressible fluid flows can be described by what are called the *compressible* Navier-Stokes equations. Due to their importance in, e.g., engineering applications, but also due to their complicated, yet fascinating mathematical structure, these equations have attracted much research in the past centuries.

The minisymposium will deal with the approximation of solutions to the time-dependent compressible Navier-Stokes equations using (variants of) the discontinuous Galerkin (DG) method. This method has been developed independently for elliptic and hyperbolic equations in the 70s, and has since received lots of attention in both mathematical and engineering communities. At the root of the method lies the approximation of unknown quantities (e.g., density, momentum...) using cell-wise polynomial approximations. Evolving methods differ, for example, in the choice of supported element types, basis and flux functions and temporal integration. All ingredients have been recognized to be extremely sensitive to the quality of an approximate solution and the stability and efficiency of an algorithm.

Using the DG method for solutions to the Navier-Stokes equations is a highly active field of research. Therefore, in the minisymposium, we aim at bringing together researchers from both mathematics and engineering to discuss new concepts, such as hybrid DG, nodal DG, non-standard temporal integrators, efficient implementation, e.g., with respect to parallelization and many more.

De-Aliasing Strategies for High Order Discontinuous Galerkin Methods

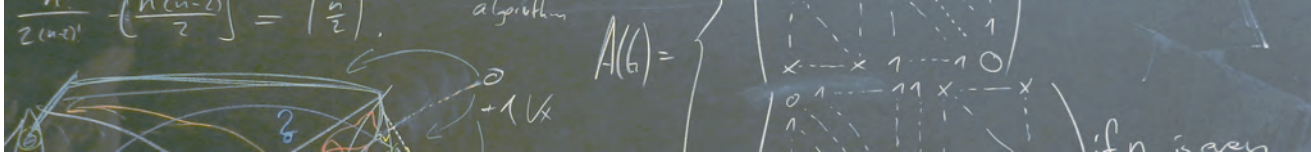
Andrea Beck
University of Stuttgart, Germany

The numerical approximation of multi-scale problems like hydrodynamic turbulence requires approximation schemes that not only offer fast convergence rates for smooth solutions and well-resolved cases, but also controllable approximations errors and inherent stability for under-resolved flows. One family of approximation methods that combines accuracy and robustness for convection-dominated problems with excellent parallelization efficiency are high order discontinuous Galerkin schemes, based on an element-wise variational formulation with local testfunctions. The implementation of the associated projection operators demands particular attention, as inexact integration of non-linearities (of flux functions and transformation metrics) leads to an efficient implementation, but can cause aliasing instabilities.
In this talk, we shall present a highly efficient discontinuous Galerkin framework for solving the compressible Navier-Stokes equations in complex domains. We shall focus on the non-linear instabilities through inexact projection and discuss different remedial strategies in terms of accuracy, stability and implementation efficiency. We shall conclude by presenting a novel, spatially and temporally adaptive de-aliasing strategy suitable for both continuous and discontinuous Finite Element formulations.

Multiwavelet-based grid adaptation

Nils Gerhard
RWTH Aachen University, Germany

We present an adaptive strategy for solving unsteady compressible flows by a discontinuous Galerkin method. The underlying idea of our adaptive strategy is to perform a multiresolution analysis using multiwavelets on a hierarchy of nested grids. This provides information on the



difference between successive refinement levels that may become negligibly small in regions where the solution is smooth. Applying thresholding, the data is compressed thereby triggering local grid adaptation. Furthermore, this information is used as an additional indicator for limiting.

An IMEX-DG method for low-Mach flows

Klaus Kaiser
RWTH Aachen University, Germany

Given relatively slow fluid velocities, Navier-Stokes equations depend on a small Mach number, which renders the development of stable high-order numerical methods quite challenging.

In this talk we present recent developments on creating a high-order DG scheme coupled to an IMEX time discretization.

Hybridizable discontinuous Galerkin methods for incompressible flow

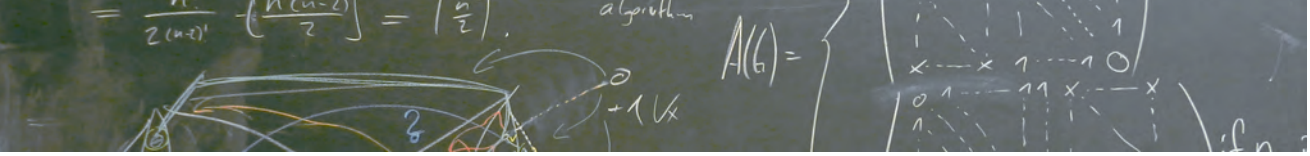
Martin Kronbichler
Technische Universität München, Germany

High order discontinuous Galerkin methods have emerged as ideal candidates for next-generation solvers of convection-dominated problems as they combine high accuracy with robustness. Hybridized discontinuous Galerkin discretizations (HDG) are special representatives mainly targeting implicit time stepping schemes with a considerably reduced the number of unknowns in the final linear systems: By suitable numerical traces, all element-related velocity degrees of freedom can be statically condensed into contributions for the velocities on the mesh skeleton only, while also offering favorable convergence behavior. In this talk we present our progress on taking HDG methods from a concept mostly used in theoretical works towards the practical application in large eddy simulation of incompressible turbulent flow. This includes the efficient implementation on high-performance parallel computers as well as iterative solvers for the final system in trace velocities and discontinuous pressures using block-triangular preconditioners. We shall show comparisons of our new HDG solvers with established methods based on finite elements. Finally, turbulent-specific methodologies such as scale separation and subgrid scale models in the HDG context will be presented.

High-order accurate implicit schemes applied to the discontinuous Galerkin discretized Navier-Stokes equations

Alessandra Nigro
University of Calabria, Italy

Implicit multistep/multistage approaches to a high-order accurate time integration seem well suited to be coupled with high-order DG space discretization of the unsteady compressible Navier-Stokes equa- tions. Implicit schemes, if accurate enough, can be very efficient and precise on highly-stretched grids even using large time step sizes. In this talk a short review of very accurate implicit methods is given and some issues of their implementation in the context of a matrix-free DG approach will be addressed. Furthermore, the influence of some physical (low Mach) and space discretization (anisotropic mesh) aspects on the performance of these schemes is discussed. The talk is completed by the presentation of recent numerical results of inviscid and viscous computations.



Efficient time integration for the HDG method

Jochen Schütz
RWTH Aachen University, Germany

In this talk, we present recent results on efficient time integration for the hybridized discontinuous Galerkin method. As this method necessitates implicit time-stepping, it is desirable to keep the effort per time-step as low as possible, while retaining a given order of temporal accuracy. The class of multiderivative ODE integrators in general yields higher accuracy while retaining less internal stages in comparison to standard Runge-Kutta methods. Coupling those integrators to the HDG method locally increases the number of spatial unknowns. These, however, can be accounted for quite efficiently within this framework.

MS#9: Dynamics of Patterns

Organisatoren: Christian Kuehn, Vienna; Jens Rademacher, Bremen

The analysis of patterns as emergent phenomena in evolutionary equations is a topic undergoing rapid development. This minisymposium aims to capture recent trends in the analytical and numerical study of nonlinear waves and other coherent structures. Key themes are existence, stability, dynamics and numerical computation: Does a wave exist? If so, is it stable? How does it interact with other patterns? Can we efficiently compute it and/or its properties? These questions apply to any other form of pattern and it is the aim of this minisymposium to communicate current challenges in the broad area of pattern formation.

A Geometric Approach to Stationary Defect Solutions

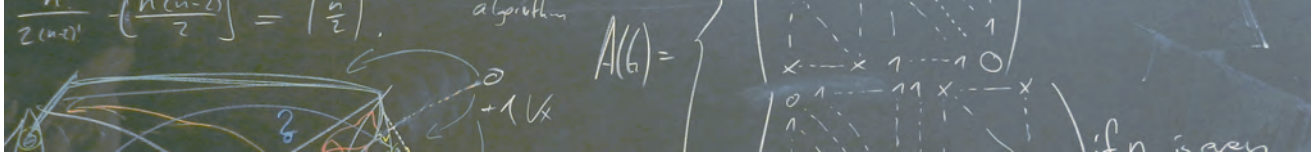
Arjen Doelman
Leiden University, The Netherlands

In this talk we consider the impact of a very simple and small spatial heterogeneity on the existence of localized patterns in a system of PDEs in one spatial dimension. The existence problem for a 'localized defect pattern' reduces to the problem of finding a heteroclinic orbit in an ODE in 'time' x, for which the vector field for $x > 0$ differs slightly from that for $x < 0$, under the assumption that there is such an orbit in the unperturbed problem. We show that both the dimension of the problem as well as the nature of the linearized system near the endpoints of the heteroclinic orbit has a remarkably rich impact on the existence these defect solutions.

Reaction-Diffusion Equations with Spatially Distributed Hysteresis

Pavel Gurevich
Free University of Berlin, Germany

We consider continuous and discrete reaction-diffusion equations with hysteresis which is given at every spatial point. Such equations arise when one describes hysteretic interaction between several diffusive and nondiffusive substances. In the talk, we shall discuss mechanisms of appearing global and local spatio-temporal patterns due to hysteresis as well as their interconnection. This is joint work with Sergey Tikhomirov (Max Planck Institute for Mathematics in the Science, Leipzig, Germany).



Asymptotic wave patterns in Hamiltonian lattices

Michael Herrmann
Westfälische Wilhelms-Universität Münster, Germany

Many dynamical patterns in Hamiltonian lattices can be described by (nonlinear) traveling waves. In this talk we present a refined asymptotic analysis for the high-energy limit of such waves. (Joint work with Karsten Matthies, University of Bath.)

Dynamics of topological defects in magnetism

Christof Melcher
RWTH Aachen University, Germany

Variational theories of ferromagnetism accommodates a variety of topologically non-trivial field configurations (domain wall, vortices, skyrmions). We shall discuss the effective dynamics of these particle-like structures based on localization principles for Landau-Lifshitz-Gilbert equations.

Using symmetries for numerical long-time simulations and approximation of similarity solutions

Jens Rottmann-Matthes
Karlsruhe Institute of Technology, Germany

Symmetries are abundant in PDEs from applications. In this talk we show how symmetries can be used to approximate similarity solutions to PDEs by direct long-time simulations. The basic approach is to separate the behavior of the solution into two parts, one describing the evolution of the solutions shape and the other describing the movement of the solution in a symmetry-group, that is related to the problem. This approach leads to a partial differential algebraic equation that has to be solved numerically.

As a simple example we consider the viscous and inviscid Burgers' equation and generalizations of it to more than one spatial dimension. In this case the symmetry includes spatial shifts and scalings of space and time and can be described by (non-)abelian Lie-groups.

Dynamics at the Eckhaus boundary

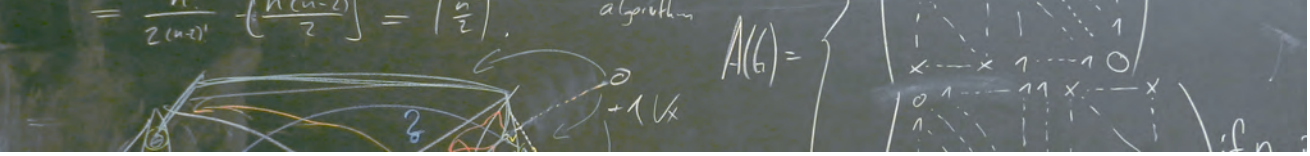
Guido Schneider
Universität Stuttgart, Germany

We consider spatially periodic pattern at the Eckhaus boundary. We explain the occurrence of a waiting time phenomenon for solutions which are pinned for $x \to -\infty$ at an Eckhaus stable equilibrium and for $x \to -\infty$ at the equilibrium at the Eckhaus boundary. Secondly, we prove the nonlinear diffusive stability of the equilibrium at the Eckhaus boundary.

Optimal harvesting and other spatial patterns in distributed optimal control problems

Hannes Uecker
Carl-von-Ossietzky Universität Oldenburg, Deutschland

We present a framework to numerically treat spatially distributed optimal control problems with an infinite time horizon, illustrating the approach by some examples. The basic idea is to consider the associated canonical systems in two steps. First we perform a bifurcation analysis of the steady state canonical system, yielding branches of patterned canonical steady states. In a second step we compute time dependent canonical system paths to steady states having the so called saddle point property. It turns out that often patterned canonical steady states are optimal.



Transient growth phenomenon in a parabolic-elliptic chemotaxis system

Michael Winkler
Universität Paderborn, Germany

We consider variants of the Keller-Segel system of chemotaxis which contain logistic-type source terms and thereby account for proliferation and death of cells. We briefly review results and open problems with regard to the fundamental question whether solutions exist globally in time or blow up. The primary focus will then be on the prototypical parabolic-elliptic system

$$u_t = \varepsilon u_{xx} - (uv_x)_x + ru - \mu u^2, 0 = v_{xx} - v + u,$$

in bounded real intervals. The corresponding Neumann initial-boundary value problem, though known to possess global bounded solutions for any reasonably smooth initial data, is shown to have the property that the so-called *carrying capacity* $\frac{r}{\mu}$ can be exceeded dynamically to an arbitrary extent during evolution in an appropriate sense, provided that $\mu < 1$ and that $\varepsilon > 0$ is sufficiently small. To achieve this, an analysis of the hyperbolic-elliptic problem obtained on taking $\varepsilon \to 0$ is carried out; indeed, it turns out that the latter limit problem possesses some solutions which blow up in finite time with respect to their spatial L^∞ norm.

This result is in stark contrast to the case of the corresponding Fisher-type equation obtained upon dropping the term $-(uv_x)_x$, and hence reflects a drastic peculiarity of destabilizing action due to chemotactic cross-diffusion, observable even in the simple spatially one-dimensional setting. Numerical simulations underline the challenge in the analytical derivation of this result by indicating that the phenomenon in question occurs at intermediate time scales only, and disappears in the large time asymptotics.

MS#10: Experimental mathematics

Organisatoren: Søren Eilers, Copenhagen; Frank Lutz, Berlin

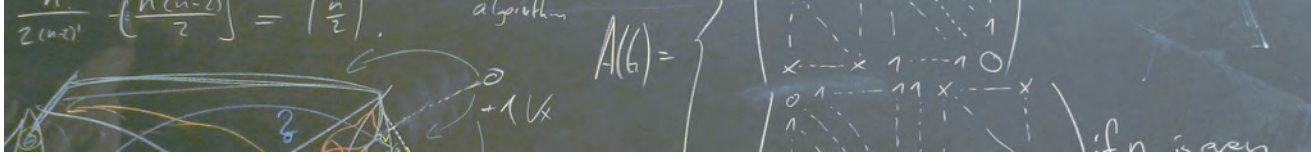
The modus operandi of using computer experiments to generate conjectures or even (hints for) proofs in pure mathematics is rapidly gaining ground these years, and German and Danish experimental mathematics has intersected nontrivially over the last years due in part to targeted funding at Copenhagen and Odense. The strong German presence at the recent conference "Discrete, Computational and Algebraic Topology" in Copenhagen bears witness to this.

Our aim is to further the interaction between mathematicians working systematically with experimentation in the two countries, and to offer inspiration to all mathematicians interested in expanding their experimental repertoire. We intend to focus on topics arising in operator algebras, number theory, and topology, and combinatorial methods are ubiquitous in the area.

Vietoris–Rips dynamics on the circle

Michal Adamaszek
University of Copenhagen, Denmark

For a finite subset X of the unit circle and a fixed angle α we consider the map $f_\alpha : X \to X$ which takes every point x to the clockwise furthest element of X which is still in angular distance at most α from x. We are interested in the discrete dynamical system on X generated by f_α, and especially in its expected behaviour when X is a large random set. The first indication of how the model depends on α was obtained through computer experiments. This setup is motivated by topological considerations. The number of periodic points and the lengths of orbits of f_α determine the homotopy type of the so-called Vietoris–Rips complex of X at distance α, a



geometric construction used commonly in computational topology. Joint work with Henry Adams and Francis Motta (Duke University).

On computations of the homology of moduli spaces of Riemann surfaces

Felix Jonathan Boes
MPIM Bonn, Germany

A topological surface F_g admits a unique smooth structure, but there is a whole space of complex structures. This space is the moduli space $\mathfrak{M}_g$. Riemann started the study of these spaces, but they are far from beeing completely understood. One approach to detect the homology of $\mathfrak{M}_g$ is to find a suitable triangulation C translating its geometry into combinatorial data. In my talk, I shall sketch one of these models which allows computer aided computations.

Realizing polytopes with nonlinear programming

Moritz Firsching
Freie Universität Berlin, Germany

Given a simplicial sphere or an oriented matroid we can ask if those objects are polytopal and if this is the case are they inscribable? This question can be rephrased as "is a certain semialgebraic set empty?". In many cases we can answer this question numerically with the help of nonlinear optimization and then obtain exact solutions from the numerical solutions. As application of this method we present a description of all 3-spheres with small valence, and an attempt to find the exact number of simplicial 4-polytopes with 10 vertices.

Visualizing and finding automorphisms of graph algebras

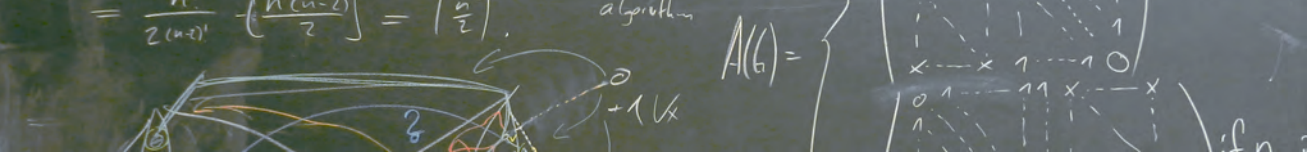
Rune Johansen
University of Copenhagen, Denmark

Given a directed graph and a fixed $k \in \mathbb{N}$, any endpoint-fixing permutation of the paths of length k induces an endomorphism of the corresponding graph C*-algebra. The goal of this experimental project has been to find exhaustive collections of such permutative automorphisms for various graph C*-algebras (including the Cuntz-algebras), and to search for automorphisms with interesting properties among these. The number of endomorphisms grows violently with the length k, necessitating new efficient representations and algorithms in order to make seemingly intractable problems accessible to computer experimentation. The talk will highlight how this search resulted in a mathematical framework that allows the visualization of the involved automorphisms.

The amenability problem of the Thompson group F

Maria Ramirez-Solano
Universidade Federal de Santa Catarina, Brasil

It is a long standing open problem whether the Thompson group F is amenable. In this talk I shall give a brief introduction to the three Thompson groups F, T and V and their C*-algebras and Von Neumann algebras. Then I shall discuss the paper "A computational approach to the Thompson group F", which I wrote in collaboration with Uffe Haagerup and Soren Haagerup. Here we estimate the norms of certain elements of the reduced C*-algebra of F, that suggest that F might not be amenable.



Reductions of eigenforms modulo prime powers

Nadim Rustom
University of Copenhagen, Denmark

It is a classical result that for any fixed N and any prime p, there are only finitely many congruence classes of eigenforms level N modulo p, and these occur in weights bounded by a constant depending only on p. The situation modulo higher prime powers is however unclear. In this talk, I shall explain the problem, and state results on the existence of weight bounds recently obtained in joint work with Ian Kiming and Gabor Wiese. I shall also discuss computer experiments that may shed light on the nature of these bounds.

On the homology of Sullivan diagrams

Daniela Egas Santander
Max Planck Institue for Mathematics, Germany

In string topology one studies the algebraic structures of the chains of the free loop space of a manifold by defining operations on them. Recent results show that these operations are parametrized by certain graph complexes that compute the homology of compatifications of the Moduli space of Riemann surfaces. Finding non-trivial homology classes of these compactifications is related to finding non-trivial string operations. However, the homology of these complexes is largely unknown.

In this talk I shall describe one of these complexes: the chain complex of Sullivan diagrams. In the genus zero case, I shall give a reinterpretation of it in terms of weighted partitions, give some computational results, connectivity results and some conjectures and open problems. This talk is based on joint work with F. Lutz.

Computations in tropical geometry

Kristin Shaw
Technischen Universität Berlin, Germany

Tropical geometry provides polyhedral models of algebraic varieties over fields. Often invariants of the classical geometric objects are translated to the combinatorics of these models.

We shall look at how a computational approach has aided in specific problems surrounding moduli spaces of tropical and classical curves and surfaces.

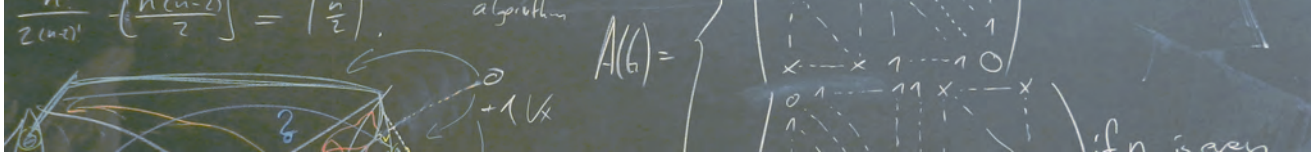
MS#11: Geometric Variational Problems

Organisatoren: Bernd Kawohl, Köln; Carlo Nitsch, Naples

This minisymposium will deal with quantitative forms of isoperimetric inequalities and best constants in various geometric estimates. In recent years there has been a surge of investigations surrounding isoperimetric conjectures. To give examples, [1] answered a long standing conjecture of Pólya and [2] deals with Faber-Krahn-type inequalities for nonlinear eigenvalue problems under Neumann boundary conditions. Entire conferences in Oberwolfach, Banff and Luminy have been dedicated to such subjects.

[1] L. Esposito, V. Ferone, B. Kawohl, C. Nitsch and C. Trombetti: The longest shortest fence and sharp Poincaré Sobolev inequalities, Arch. Ration. Mech. Anal. 206 (2012), pp. 821–851.

[2] L. Esposito, C. Nitsch, B. Kawohl and C. Trombetti: The Neumann eigenvalue problem for the ∞-Laplacian, Atti Accad. Naz. Lincei Rend. Lincei Mat. Appl. 26 (2015), pp. 119–134.



On the minimizers of trace inequalities in BV

Vincenzo Ferone
Universita di Napoli Federico II, Italy

It is well known that, for any given bounded domain Ω with a "nice" boundary, $\mathrm{BV}(\Omega)$ embeds in $\mathrm{L}^1(\partial\Omega)$, in the sense that the total variation of a function u bounds the L^1 norm of $(u-c)$ through a constants K which depends on Ω. For c, various choices can be made. We consider the cases where c is the median or the mean value of the trace of u over the boundary of Ω. We prove that balls achieve the least embedding constant K in both inequalities. Uniqueness of such minimizers is also discussed in details. Some of the tools used in the proof are: modified Cauchy area formula, characterization of sets of constant brightness, characterization of sets of constant projection. This is joint work with A. Cianchi, C. Nitsch, and C. Trombetti.

Some new inequalities for elasticae

Antoine Henrot
Université de Lorraine, France

In this talk we shall review some new inequalities obtained for the *elastic energy* defined, for any regular closed curve γ in the plane by $E(\gamma) = \frac{1}{2}\int_\gamma C^2\,ds$ where C is the curvature and s the curvilinear abscissa. We denote by Ω the bounded domain whose boundary is γ. We prove, in particular, that the disk minimizes $E(\gamma)$ among sets of given area. On the contrary, if we consider a constraint on the inradius, the disk is no longer the minimizer. We also consider a Blaschke-Santalò diagram for convex domains involving area, inradius and elastic energy.

The longest shortest fence and the stability of floating trees

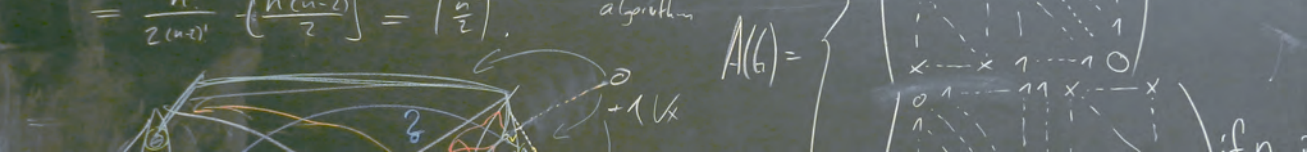
Bernd Kawohl
Universität zu Köln, Germany

Over 50 years ago Pólya stated the following problem. Given a plane convex set K find the shortest curve that bisects it into two pieces of equal area. Is it true that this curve is never longer than the diameter of a disk of the same area? Under the additional assumption that K is centrosymmetric (i.e., $K = -K$) he gave a simple proof that this is indeed the case. Without this assumption the proof is much harder, and I report on a joint paper with L. Esposito, V. Ferone, C. Nitsch and C. Trombetti containing the proof. It is remarkable that the answer to Pólya's question is negative if only straight cuts are allowed. In that case N. Fusco and A. Pratelli were able to show that the Auerbach triangle and not the disc provides "the longest shortest cut". A related result states that a cylindrical bar of specific weight 0.5 does not need to have circular cross section to float in a metastable way in any horizontal orientation.

The Neumann eigenvalue problem for the ∞-Laplacian.

Carlo Nitsch
Universita di Napoli Federico II, Italy

The first nontrivial eigenfunction of the Neumann eigenvalue problem for the p-Laplacian converges, as p goes to ∞, to a viscosity solution of a suitable eigenvalue problem for the ∞-Laplacian. We show among other things that the limiting eigenvalue is in fact the first nonzero eigenvalue, and derive a number consequences, which are nonlinear analogues of well-known inequalities for the linear (2-)Laplacian. This is joint work with L. Esposito, B. Kawohl and C. Trombetti.



Power concavity in weakly coupled elliptic and parabolic systems

Paolo Salani
Universita di Firenze, Italy

I shall describe the results of a joint paper with K. Ishige and K. Nakagawa. In this paper we start the investigation of concavity properties of solutions to systems of PDE's in convex domains. In particular we prove that suitable powers of solutions to some weakly coupled elliptic and parabolic systems are concave.

On a conjecture for the $3G$-function.

Guido Sweers
Universität zu Köln, Germany

Let $\Omega \subset \mathbb{R}^n$ be a bounded domain and let $G : \bar{\Omega} \times \bar{\Omega} \to [0, \infty]$ be the Green function for $-\Delta u = f$ in Ω under zero Dirichlet boundary conditions. What can one say about the supremum of the so-called $3G$-function

$$G_3(x, y) := G(x, y)^{-1} \int_\Omega G(x, z)\, G(z, y)\, dz?$$

It is conjectured that for simply connected domains the essential supremum is reached at some (opposite) boundary points:

$$\operatorname*{ess\,sup}_{x,y\in\Omega} G_3(x, y) = \operatorname*{ess\,sup}_{x,y\in\partial\Omega} G_3(x, y).$$

Indeed for Ω being a ball, this conjecture has been confirmed. For $n = 2$ this conjecture remains open but in higher dimensions one may construct a domain Ω that gives a counterexample. This $3G$-function is related with the expected lifetime of a certain conditioned Brownian motion. The main part will focus on joint work with Matthias Erven.

MS#12: Heteroclinic Dynamics: Theory and Applications

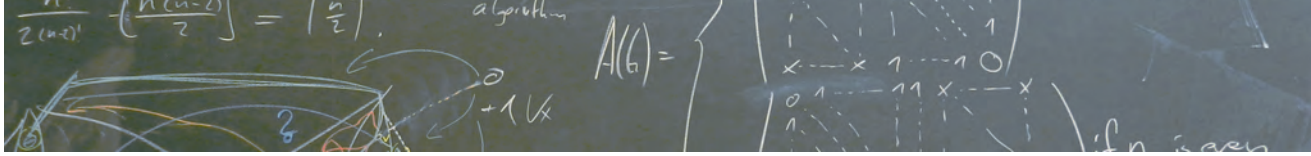
Organisatoren: Alexander Lohse, Hamburg, Porto; Sofia Castro, Porto

Heteroclinic cycles and networks are a useful tool for modelling stop-and-go dynamics in various applications, ranging from geophysics to neuroscience. They display complex forms of non-asymptotic stability, possibly attracting and repelling sets of positive measure at the same time. Recently, different approaches have been taken to improve our understanding of heteroclinic dynamics and stability of networks and of cycles in networks. In this minisymposium we aim to discuss current ideas and developments on aspects of both purely theoretical and more application-oriented nature.

Heteroclinic cycles in Hopfield networks

Pascal Chossat
Université de Nice Sophia-Antipolis, France

Learning or memory formation are associated with the strengthening of the synaptic connections between neurons according to a pattern reflected by the input. According to this theory a retained memory sequence is associated to a dynamic pattern of the associated neural circuit. In this work M. Krupa and myself have considered a class of network neuron models, known as Hopfield



networks, with a learning rule which consists of transforming an information string to a coupling pattern in the form of a robust heteroclinic cycle for an approximate system. I shall explain this idea and present results which show a tight connection between existence of the heteroclinic cycles and the structure of the coupling.

Codimension one D_{4m}-symmetric homoclinic cycles

Maria Kellner
Technische Universität Ilmenau, Germany

Considering the dynamics near codimension one homoclinic cycles in flows that are equivariant under the action of the group D_n one finds an open problem in case that n is a multiple of 4. We present an explicit construction of families of D_{4m}-symmetric polynomial vectorfields in $\mathbb{R}^4$ possessing such a codimension one homoclinic cycle. Based on this example we discuss problems that occur in bifurcation analysis of these cycles.

Reversible non-elementary T-points

Jürgen Knobloch
Technische Universität Ilmenau, Germany

Heteroclinic cycles connecting equilibria with different saddle indices, where one of the heteroclinic orbits is transverse and isolated, are referred to as *T-points*. In this talk we study the unfolding of a symmetric saddle-node of T-points in the context of reversible systems. We assume that the leading eigenvalues of the equilibria are real. We focus on the existence of shift dynamics and its creation or annihilation, respectively.

Singularities of front dynamics in FitzHugh-Nagumo type systems

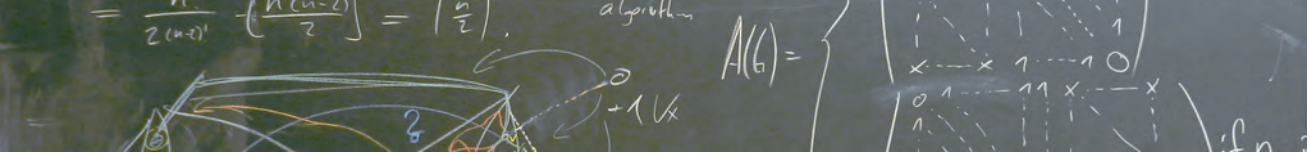
Jens D. M. Rademacher
Universität Bremen, Germany

As a simple model for phase separation, the Allen-Cahn equation possesses stable front-type interface solutions that are heteroclinic orbits in the planar spatial ODE. The coupling to a second reaction-diffusion equation is known to generate cusp singularities of fronts and to produce oscillatory front bifurcations. We focus on weak coupling to one or more linear equation, similar to the FitzHugh-Nagumo system, which allows for explicit analyses of the heteroclinic bifurcations and the PDE-stability. In particular, linear coupling to two equations produces a butterfly singularity and nonlinear coupling allows for the imbedding of arbitrary singularities in the dynamics of the front velocity. This is joint work with Martina Chirilus-Bruckner, Arjen Doelman and Peter van Heijster.

Dynamics near a homoclinic network with a bifocus

Alexandre A.P. Rodrigues
Centro de Matemática da Universidade do Porto, Portugal

In dimension three, the Shilnikov model of a homoclinic cycle to a saddle-focus is one of the most famous and rich examples in the dynamical systems theory, in which a simple configuration generates a very complicated behaviour around the neighbourhood of the cycle. Concerning the study of chaos arising from the presence of rotating nodes, the next big challenge is the study of cycles involving a bifocus in dimension four. In a homoclinic network associated to a non-resonant hyperbolic bifocus, we prove that the rotation combined with a non-degeneracy condition concerning the intersection of the two-dimensional invariant manifolds of the equilibrium, creates



switching behaviour. Trajectories that realize switching lie on suspended hyperbolic horseshoes that accumulate on the network. This is joint work with Santiago Ibanez from Oviedo University (Spain).

MS#13: History of Stochastics

Organisatoren: Wolfgang K. Härdle, Berlin; Annette Vogt, Berlin

Recent developments in modern science and technology have created an enormous set of data and data structures (big data as a synonym for this advancement). Looking back to history some problems and issues could be described as an evolution of certain methods and theories which were developed already in the 19th and 20th centuries. In the history the development of computer technology and of programming languages played an important role. In the minisymposium we shall discuss some theories, methods and aspects of the history of stochastics and history of statistics from this perspective with the aim of understanding modern developments and their problems deeper and better. We shall focus on the history of various stochastic theories, the introduction of certain statistical methods and their effects, the specific role computer technology and programming languages have played, the didactic uses of a bio-bibliographical database on leading mathematicians, statisticians and scholars in social sciences like economy or insurance science.

Collective biographies—the database *BBI–Biographical Background Information*

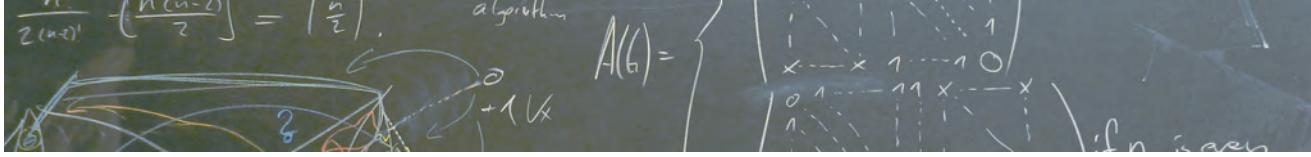
Wolfgang Karl Härdle
Humboldt-Universität zu Berlin, Germany
Lee Kong Chian School of Business, Singapore
Chen Huang
Humboldt-Universität zu Berlin, Germany
Andrija Mihoci
Humboldt-Universität zu Berlin, Germany
Alla Petukhina
Humboldt-Universität zu Berlin, Germany
Annette B. Vogt
Humboldt-Universität zu Berlin, Germany

Our database represents basic biographic information and scientific contributions of more than 100 statisticians and mathematicians. It covers the period from the 16th century until current time and the number of biographies is constantly growing, whereas the information on scientific contributions is updated regularly. Different criteria and principles for database creation are explained, and applications in teaching are demonstrated. The current BBI interface allows the connection between different scientists as well as their contributions in a modern style suitable for teaching purposes.

Ladislaus von Bortkiewicz and his contribution to the popularisation of statistics

Annette B. Vogt
Humboldt-Universität zu Berlin, Germany

L. von Bortkiewicz (1868–1931) was an outstanding statistician, less known is his major contribution to the popularisation of statistiscs in the mid 1920s. He became the editor of a series of popular books on statistics (“Serie populärer statistischer Bücher”) which were published by Rudolf Mosse publishing house (Rudolf Mosse Buchverlag Berlin) in Berlin between 1925 and 1929. The



seven volumes *The world in figures* (Die Welt in Zahlen) became a role model of this kind of publications. In the talk we'll describe the collaboration between the couple Woytinsky (Wladimir S. Woytinsky, 1885–1960, and Emma S. Woytinsky, 1893–1968) and L. von Bortkiewicz producing these volumes. Furthermore, we shall discuss the motivations of the latter to participate in this project.

MS#14: Homotopy Type Theory and Univalent Foundations

Organisatoren: Benedikt Ahrens, Toulouse; Bas Spitters, Aarhus; Thomas Streicher, Darmstadt

Homotopy Type Theory refers to a new interpretation of Martin-Löf's system of intensional, constructive type theory into abstract homotopy theory. Propositional equality is interpreted as homotopy and type isomorphism as homotopy equivalence. Logical constructions in type theory then correspond to homotopy-invariant constructions on spaces, while theorems and even proofs in the logical system inherit a homotopical meaning. As the natural logic of homotopy, constructive type theory is also related to higher category theory as it is used, e.g., in the notion of a higher topos. Voevodsky's Univalent Foundations program aims to provide a comprehensive, computational foundation for mathematics based on the homotopical interpretation of type theory. The subtle Univalence Axiom, introduced by Voevodsky, relates propositional equality on the universe with homotopy equivalence of small types. The program is currently being implemented with the help of the interactive proof assistant Coq. The Univalent Foundations program is closely tied to homotopy type theory and is being pursued in parallel by many of the same researchers.

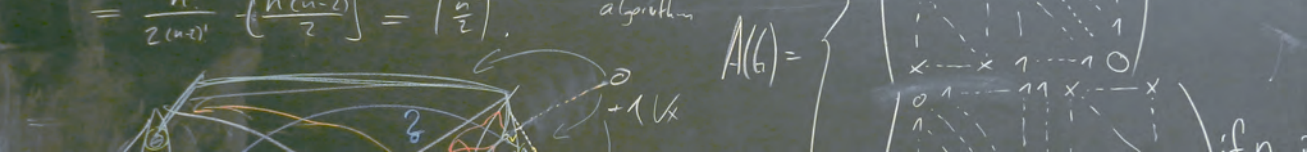
Research on Homotopy Type Theory (HoTT) takes place at the intersection of three domains: type theory and proof assistants, category theory and homotopy theory. Indeed, in the course of the development of HoTT, exciting connections have been discovered between these fields of research. Through these connections, the ideas, languages and methods of either of those fields are available for understanding HoTT. The goal of the mini-symposium is to present the underlying ideas of HoTT to researchers in these fields from the perspectives of logic, category theory and homotopy theory, thus enabling mathematicians from a wide variety of research areas to understand the problems HoTT tries to solve and the difficulties that need to be overcome in this undertaking.

This mini-symposium is supported by the *Deutsche Vereinigung für Mathematische Logik und für Grundlagenforschung der exakten Wissenschaften* (DVMLG).

The coherence problem in HoTT

Thorsten Altenkirch
University of Nottingham

All attempts to internalise semisimplicial types in HoTT have failed, due to a coherence problem: how do we make precise the notion of an omega functor? This is not the only instance of such a problem. We suggest a two level system, which introduces pre types with a notion of strict equality and a universe of types with an extensional, univalent equality. This is inspired by Voevodsky's HTS but unlike HTS our approach is an extension of intensional type theory and can be easily formalised within existing systems like Agda. Our approach works for type valued presheaves over a Reedy category. This relies on the assumption that the basic types like natural numbers agree with their pre type.



On the cubical model of HoTT

Steve Awodey
Carnegie Mellon University, United States of America

In this work-in-progress talk, I shall analyse the cubical model of homotopy type theory of Coquand et al. in functorial terms, making a few adjustments along the way. The basic category of cubical sets used is presheaves on the free cartesian category on a bipointed object, i.e., the Lawvere theory of bipointed objects. The presheaf category is the classifying topos for strictly bipointed objects. The Kan extension property familiar from algebraic topology is shown to be exactly what is required to model the Identity-elimination rule of Martin-Löf, and the closure of Kan objects under function spaces is ensured constructively by Coquand's uniformity condition, re-analysed as the existence of a certain natural transformation making natural choices of Kan fillers. A universe of Kan objects is given in the style of the recent "natural models" construction, based on ideas of Lumsdaine-Warren and Voevodsky.

Weak universes and homotopy exact completion.

Benno van den Berg
University of Amsterdam, The Netherlands

In this talk I shall discuss weak universes, with any small type only being weakly equivalent to something inside the universe. The motivation is that it turns out to be much easier to construct models of homotopy type theory with weak univalent universes and that such weak universes are just as well-behaved as ordinary universes. For example, they also lead to models of CZF: to give a nice categorical proof of this fact we introduce a new categorical construction which we call a *homotopy exact completion*. This is ongoing joint work with Ieke Moerdijk.

Aspects of univalence

Nicola Gambino
University of Leeds, England

I shall review and discuss some aspects of Voevodsky's univalence axiom. First, I shall illustrate how recent work of Cisinski provides a streamlined proof of the validity of the univalence axiom in the simplicial model. Secondly, I shall describe how, in analogy with the notion of a univalent fibration, it is possible to define a notion of univalent dependent type, giving some examples.

Models of homotopy type theory

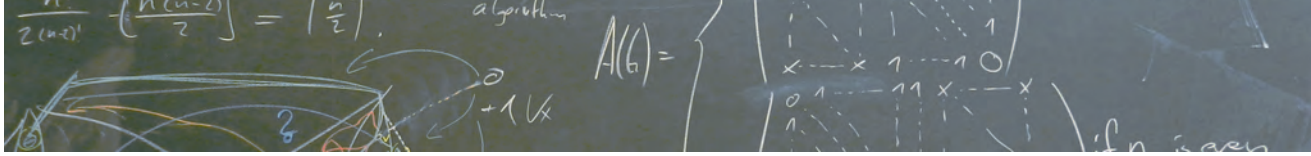
Tamara von Glehn
University of Cambridge, England

In this talk I shall consider various constructions of categorical models of dependent type theory, and look at how the fibrations involved interact with the structure required for identity types and enrichment.

The groupoid interpretation of type theory, a personal retrospective

Martin Hofmann
Ludwig-Maximilians University, Germany

Back in 1994, Thomas Streicher and myself discovered the groupoid interpretation of Martin-Löf's type theory which is now seen as a precursor of Homotopy Type Theory and in fact anticipated



some simple cases of important ideas of Homotopy Type Theory, notably a special case of the univalence axiom. I shall explain how and why we found the groupoid interpretation, our motivations and results. I shall also present some less well-known results about *extensional* Martin-Löf type theory and speculate how this might relate to homotopy type theory.

A Cubical Type Theory

Simon Huber
University of Gothenburg, Sweden

We present a type theory in which the user can directly manipulate n-dimensional cubes (points, lines, squares, cubes, etc.) based on a model of type theory in cubical sets with connections. The identity type is defined as a type of paths and all properties of intensional equality are provable, with the usual definitional equalities. The fact that the user can directly manipulate n-dimensional cubes enables new ways to reason about identity types, for instance, function extensionality is directly provable in the system. Further, the system also supports transforming any isomorphism into an equality and some higher inductive types like the circle and suspensions. This is joint work with Cyril Cohen, Thierry Coquand, and Anders Mörtberg.

Formalising the categorical semantics of type theory, in type theory.

Peter LeFanu Lumsdaine
Stockholm University, Sweden

I shall report on work in progress with Håkon Gylterud and Erik Palmgren: a formalisation, in Coq, of the basic algebraic semantics of dependent type theory. Specifically, we aim to show the initiality of the syntactic category with attributes, for a small-ish dependent type theory. To minimise meta-theoretic assumptions, we use a setoid-based notion of categories with attributes, rather than categories or pre-categories in the sense of HoTT; however, due to the interaction between the set(oid)s of types and the (E-)category of contexts, a HoTT-like worldview inevitably pervades the work.

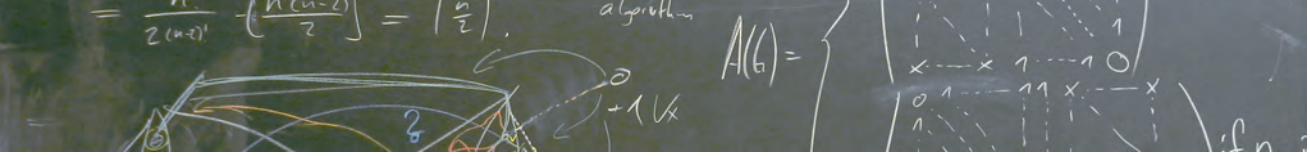
A related question is whether Homotopy Type Theory can eat itself—that is, whether one can construct in HoTT an interpretation function from some small fragment of its syntax into the actual universe of types. This has proven difficult, perhaps surprisingly so. The present project does not attempt to do this, but it perhaps sheds some light on the difficulties that arise.

Towards guarded recursion in HoTT

Rasmus Ejlers Møgelberg
IT University of Copenhagen, Denmark

Guarded recursion is a form of recursion where the recursion variable is only allowed to appear guarded by a time step. The notion of time step is encoded in type theory by a modal type operator. Guarded recursion allows one to solve guarded variants of otherwise unsolvable type equations, and these have proved useful for modelling programming languages with advanced features inside type theory. Guarded recursion can also be used for constructing guarded variants of coinductive types, such as streams, and these can be used when constructing and reasoning about elements of coinductive types. In particular they can be used to encode the notion of productivity in types.

In the talk I shall outline the use of guarded recursion in type theory and show how guarded recursion can be proved consistent with the univalence principles by constructing a presheaf model.



Some thoughts on the future of modal homotopy type theory

Urs Schreiber
Charles University Prague, Czech Republic

In 1991, Lawvere suggested (a) that the future of category theory revolves around toposes equippped with an adjoint system of idempotent (co-)monads [1] and that (b) this is formalization of what the ancients had called the *objective logic* [2]. While for 1-toposes this seems inconclusive, one finds [3] that internal to infinity-toposes equipped with such adjoint systems much of higher differential geometry and of modern physics has a succinct and useful synthetic formalization. But here the syntax of this internal language is modal homotopy type theory [4]. In this talk I survey the immensely rich semantics and the potential prospects of its full syntactic formalization, in the hope to motivate the type theory community to further look into this fascinating but under-explored aspect of their theory.

Cubical sets as a classifying topos

Bas Spitters
Aarhus University, Denmark

Coquand's cubical set model for homotopy type theory provides the basis for a computational interpretation of the univalence axiom and some higher inductive types, as implemented in the cubical proof assistant. We show that the underlying cube category is the opposite of the Lawvere theory of De Morgan algebras. The topos of cubical sets itself classifies the theory of "free De Morgan algebras". We shall relate this to Johnstone's topological topos and the nerve construction. This provides us with a topos with an internal "interval". Using this interval we construct a model of type theory following van den Berg and Garner. We are currently investigating the precise relation with Coquand's model. We do not exclude that the interval can also be used to construct other models.

Various ways of splitting and equality of objects

Thomas Streicher
Technische Universität Darmstadt, Germany

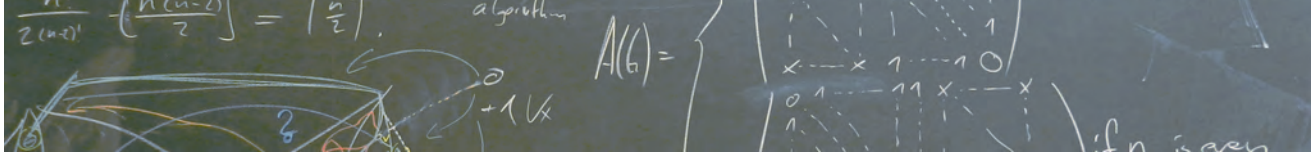
We recall various ways of splitting fibrations and discuss the role equality of objects plays in there.

MS#15: Jump processes and related topics

Organisatoren: Alexander Lindner, Ulm; Steen Thorbjørnsen, Aarhus

Lévy processes and more generally jump processes have constituted an active field of research during the last years. They have various applications in finance, insurance mathematics, engineering or physics, and are also interesting from a purely mathematical point of view. They have various connections to other disciplines such as Partial Differential Equations or Stochastic Analysis.

The aim of this minisymposium is to bring together various people working in this area, with an emphasis on young researchers. Topics of the minisymposium include distributional properties of processes derived from Lévy processes, fluctuation theory of jump processes, connections with analysis, and applications of Lévy processes.



Quantization of jump processes

Frank Aurzada
Technische Universität Darmstadt, Germany

We consider the question of encoding the trajectory of a stochastic process (lossy coding). Here, certain jump processes are considered, in particular Lévy processes, and we describe results concerning the rate of the coding error (quantization error). Further, we outline extensions to the coding of objects from stochastic geometry with some interesting open questions.

Stationarity and ergodicity for an affine two-factor model

Mátyás Barczy
University of Debrecen, Hungary

Affine processes are common generalizations of continuous state and continuous time branching processes with immigration and Ornstein-Uhlenbeck type processes. Roughly speaking, the affine property means that the logarithm of the characteristic function of the process at any time is affine with respect to the initial state. Let us consider an affine two-factor model given by the jump-type SDE

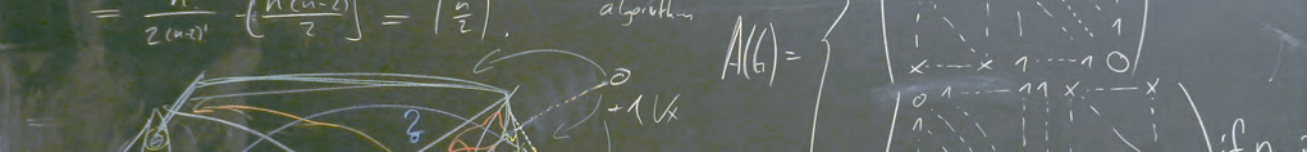
$$\mathrm{d}Y_t = (a - bY_t)\,\mathrm{d}t + \sqrt[p]{Y_{t-}}\,\mathrm{d}L_t, \qquad t \geq 0, \mathrm{d}X_t = (\alpha - \gamma X_t)\,\mathrm{d}t + \sqrt{Y_t}\,\mathrm{d}B_t, \qquad t \geq 0,$$

where $a > 0$, $b, \alpha, \gamma \in \mathbb{R}$, $p \in (1, 2]$, $(L_t)_{t\geq 0}$ is a spectrally positive p-stable process with Lévy measure $C_p z^{-1-p}\mathbf{1}_{\{z>0\}}$, where $C_p := (p\Gamma(-p))^{-1}$ (Γ denotes the Gamma function) if $p \in (1, 2)$, and a standard Wiener process if $p = 2$, and $(B_t)_{t\geq 0}$ is an independent standard Wiener process. Note that the first coordinate is nothing else but a so-called p-root process with $p \in (1, 2]$, which, in case of $p = 2$, is also called a CIR process. Provided that $a > 0$, $b > 0$ and $\gamma > 0$, we prove that the affine model above has a unique strictly stationary solution in both cases $p \in (1, 2)$ and $p = 2$. Further, in case of $p = 2$, supposing that $a > 0$, $b > 0$ and $\gamma > 0$, the ergodicity is also shown together with the fact that the unique strictly stationary solution is absolutely continuous having finite mixed moments. In case of $p \in (1, 2)$, the question of ergodicity remains open, however, we shall briefly describe a possible approach for proving such a result.

On Φ-variation of stochastic processes with exponential moments.

Andreas Basse-O'Connor
Aarhus University, Denmark

The Φ-variation of a stochastic process may be viewed as a measurement of its smoothness, and it plays an important role in integration theory, rough paths theory and Fourier analysis. The special cases of bounded variation and bounded p-variation were introduced by Jordan and Wiener respectively, and the general definition of Φ-variation goes back to Young. A classical result by Lévy states that the sample paths of a Brownian motion are of bounded p-variation if and only if $p > 2$. This result has been improved by Taylor who showed that the "correct" Φ-variation of the Brownian motion is $\Phi(x) = x^2/\log(\log(1/x))$. Furthermore, Dudley and Norvaisa has characterized the correct Φ-variation of the fractional Brownian motion. On the other hand, there does not exists a correct Φ-variation function for a stable non-Gaussian Lévy process. In this talk we shall, in particular, derive the correct Φ-variation of a class of self-similar Gaussian chaos processes with stationary increments called Hermite processes. This class includes the fractional Brownian motion and Rosenblatt process as special cases. Our technique relies on metric entropy methods for stochastic processes with exponential moments. This talk is based on joint work with Michel Weber, IRMA, Université de Strasbourg.



Exponential functionals of Lévy processes with jumps

Anita Behme
Technische Universität München, Germany

In this talk, we consider exponential functionals of two one-dimensional independent Lévy processes, as they appear as stationary distributions of generalized Ornstein-Uhlenbeck processes. Hereby the integrating Lévy process will be assumed to be a subordinator. In particular, we present an integro-differential equation for the density of the exponential functional whenever it exists. Further, we consider the mapping, which maps the law of the integrating Lévy process to the law of the corresponding exponential functional, where the other Lévy process remains fixed. We study the behaviour of the range of this mapping for varying characteristics of the Lévy process in the integrand. Moreover, we derive conditions for selfdecomposable distributions and generalized Gamma convolutions to be in the range.

Markov chain approximations to jump processes

Björn Böttcher
Technische Universität Dresden, Germany

We give an overview of the four Skorokhod topologies. Each topology naturally suggests a particular embedding of discrete time processes into continuous time. Within this framework we compare the convergence of embedded Markov chain approximations.

Exchangeability and infinite divisibility

Martin Drapatz
Universität Ulm, Germany

We characterize exchangeability of infinitely divisible distributions in terms of the characteristic triplet. This is applied to stable distributions and self-decomposable distributions, and a connection to Lévy copulas is made. We further study general mappings between classes of measures that preserve exchangeability and give various examples which arise from discrete time settings, such as stationary distributions of AR(1) processes, or from continuous time settings, such as Ornstein-Uhlenbeck processes or Upsilon-transforms.

High frequency statistic for Lévy semistationary processes

Claudio Heinrich
Aarhus University, Denmark

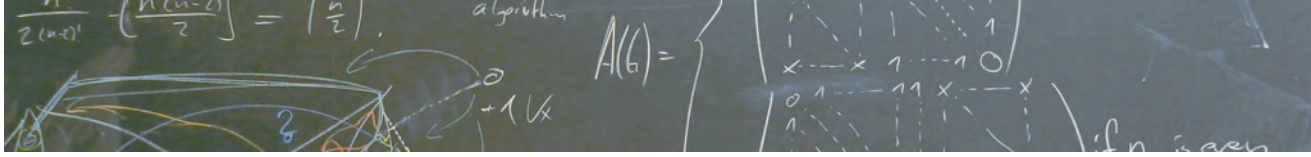
Lévy semistationary processes of the form

$$X_t = \int_{-\infty}^{t} g(t-s) b_s dL_s,$$

where g is a deterministic kernel and b is predictable, have been proposed for modeling the velocity in a turbulent flow in 2005. Since then, various properties of these processes have been successfully studied, amongst others the limiting behavior of the power variation

$$V(p)_n = \sum_{i=1}^{n} |X_{i/n} - X_{(i-1)/n}|^p,$$

for $n \to \infty$ for the case where L is a Brownian motion. We shall now present a limit theory for the case where the integrator is a pure jump Lévy process, leading to some surprising results.



Intrinsic scaling for Markov processes

Moritz Kaßmann
Universiät Bielefeld, Germany

In recent years, the interplay between Markov jump processes and integrodifferential operators was the subject of many research activities. Several results have been obtained for solutions to nonlocal equations where the integrodifferential operator is of a (fractional) differentiability order less than 2. Scaling properties are essentially used in these approaches. In the talk we explain the use of scaling in these works and address limit cases where standard scaling fails. The objects that we study are closely related to geometric stable processes. The talk is based on joint work with A. Mimica.

Order selection criteria for CARMA processes

Sebastian Kimmig
Karlsruhe Institute of Technology, Germany

Continuous-time ARMA(p, q) (CARMA(p, q)) processes are the continuous-time analog of the well-known ARMA(p, q) processes. They have attracted interest over the last years. Methods to estimate the parameters of a CARMA process require an identifiable parametrization. Such an identifiable parametrization particularly requires the degree p of the autoregressive polynomial to be fixed. Thus, the degree p has to be known for parameter estimation. When this is not the case information criteria can be used to estimate p as well as q. In this talk we investigate information criteria for CARMA processes based on quasi maximum likelihood estimation. Therefore, we first derive the asymptotic properties of quasi maximum likelihood estimators for CARMA processes in a misspecified parameter space. Then, we present necessary and sufficient conditions for information criteria to be strongly and weakly consistent, respectively. In particular, we study the well-known Akaike Information Criterion (AIC) and the Bayesian Information Criterion (BIC) as special cases. The results can be generalized to multivariate CARMA processes as well. The talk is based on joint work with Vicky Fasen.

On the class of distributions of subordinated Lévy processes

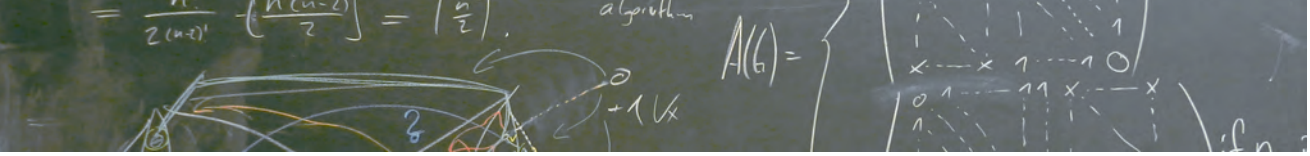
Orimar Sauri
Aarhus University, Denmark

In this talk we derive some basic properties of a certain mapping obtained via Lévy mixing. Using this, we study the class of infinitely divisible distributions obtained by subordinating a Lévy process through a subordinator. We show that this class is closed under convolutions and it is in a bijection with the family of infinitely divisible distributions whose support is contained in $(0, \infty)$ (subordinators). In particular, we use our results to solve the so-called recovery problem for Lévy bases as well as moving average processes which are driven by subordinated Lévy processes. This talk is based on joint work with Almut Veraart.

Computing harmonic measures for the Lévy stable process

Thomas Simon
Université Lille 1, France

Using classical hypergeometric identities, we compute the harmonic measure of finite intervals and their complementaries for the Lévy stable process on the line. This gives a simple and unified proof of several results by Blumenthal-Getoor-Ray, Rogozin, and Kyprianou-Pardo-Watson. We



deduce several explicit computations on the related Green function and Martin kernel. (Joint work with Christophe Profeta, Evry.)

Geometric Ergodicity of the Multivariate Continuous-time GARCH(1,1) Process

Robert Stelzer
Universität Ulm, Germany

In this talk we consider the multivariate continuous-time GARCH(1,1) process driven by a Lévy process emphasising stationarity properties. The focus is on the volatility process which takes values in the positive semi-definite matrices.

In the univariate model existence and uniqueness of the stationary distribution as well as geometric ergodicity are well-understood, whereas for the multivariate model only an existence criterion is known as far as strict stationarity is concerned. We shall first review the multivariate COGARCH(1,1) model and its properties focussing on strict and weak stationarity. Thereafter, the main part of the talk is devoted to establishing sufficient conditions for geometric ergodicity and thereby for uniqueness of the stationary distribution and exponential strong mixing.

We follow a classical Markov/Feller process approach based on a Foster-Lyapunov drift condition on the generator. Apart from finding an appropriate test function for the drift criterion, the main challenge is to prove an appropriate irreducibility condition due to the degenerate structure of the jumps of the volatility process, which are all rank one matrices. We present a sufficient condition for irreducibility in the case of the driving Lévy process being compound Poisson.

MS#16: Mathematical and Computational methods for Earth System Sciences

Organisatoren: Jörn Behrens, Hamburg; Thomas Slawig, Kiel

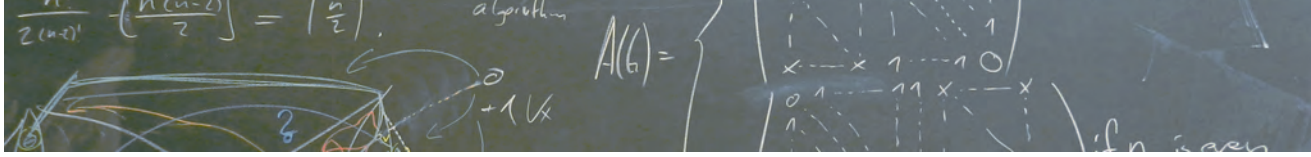
Complex multi-scale phenomena on earth and the more and more demanding societal pressure on resources and security call for simulation-based mathematical descriptions of natural systems. This is particularly visible in the earth system sciences, which have a great impact on societal decision making. Mathematical models play an important role in knowledge gaining in earth system sciences. However, transferring the insights in mathematical developments to complex real-life settings is often a hard task. The opposite transfer of problems in applied sciences like the geosciences into challenging mathematical research questions has traditionally generated fruitful developments in applied mathematics.

This minisymposium aims at presenting current work and achievements in this field by demonstrating interesting problem settings in earth system sciences and their mathematical and computational solution in an interdisciplinary work environment.

Discontinuous Galerkin finite element modeling system for coastal and regional ocean

Vadym Aizinger
Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany

We present an application of the discontinuous Galerkin finite element method to the simulation of flow and transport processes in regional and coastal ocean. The talk discusses a number of discretization issues, numerical techniques for various physical parametrizations, and illustrates the performance of the method using several real-life problems.



Adaptive Simulation of Flooding and Drying Events with Discontinuous Galerkin Schemes

Nicole Beisiegel
University of Hamburg, Germany
Stefan Vater
University of Hamburg, Germany

Discontinuous Galerkin models have recently been used to produce accurate and ro- bust solutions of the shallow water equations for various geo-scientific applications. They can be easily formulated to be mass-conservative, are extendable to higher-order accuracy and have a local stencil, the latter being advantageous for parallelization. On the other hand, certain aspects are still under heavy development, such as the accurate treatment of wetting and drying events. The presented inundation scheme utilizes slope-limiting techniques that do not influence the stability of the scheme and are free from additional parameters. It can be shown to be mass-conservative, positivity-preserving and well-balanced for the still water state at rest.

To reduce the computational effort for complex flow situations a dynamically adaptive mesh is used, and problem-dependent refinement indicators are introduced to resolve local features of interest. Furthermore, the patch-wise mesh manipulation strategy that we employ, keeps the mesh conforming throughout the simulation, which further simplifies the computations. We shall discuss the efficiency of our adaption strategy and its effects on the overall accuracy of the simulation. Numerical test cases demonstrate the applicability of our model to quasi-realistic scenarios.

High-order WENO finite volume methods for Cartesian grids

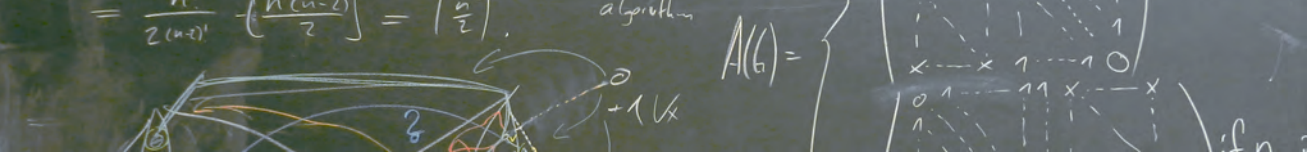
Christiane Helzel
Heinrich-Heine-University Düsseldorf, Germany

High-order WENO (i.e., weighted essentially non-oscillatory) methods are widely used for the approximation of hyperbolic partial differential equations. A common approach to use WENO methods on multidimensional Cartesian grids consists in applying a one-dimensional WENO method in each direction. This spatial discretization is typically combined with a Runge-Kutta method in time, i.e., during each stage of a Runge-Kutta method one-dimensional WENO schemes are used in a dimension-by-dimension fashion.

However, it is known that finite volume WENO methods based on a dimension-by-dimension approach retain the full order of accuracy (of the one-dimensional method) for linear multidimensional problems, but they are only second order accurate for the approximation of nonlinear multidimensional problems.

In my talk, I shall present a simple modification of finite volume WENO methods, which leads to the full spatial order of accuracy by using only one-dimensional polynomial reconstructions in a dimension-by-dimension approach.

Furthermore, I shall discuss the use of this method on adaptively refined grids. This is recent joint work with Pawel Buchmüller and Jürgen Dreher.



An efficient parallel solver for sparse linear equation systems arising in non-hydrostatic tsunami simulations

Wolfgang Hiller
Alfred Wegener Institute, Germany
Sven Harig
Alfred Wegener Institute, Germany
Annika Fuchs
Alfred Wegener Institute, Germany
Natalja Rakowsky
Alfred Wegener Institute, Germany

In the framework of the German-Indonesian Tsunami Early Warning System, the tsunami modeling group at AWI developped the simulation code TsunAWI which discretises the non-linear shallow water equations on an unstructured finite element mesh. A modular extension including a non-hydrostatic correction of the pressure term can be invoked to improve the simulation, e.g., in regions with steep bathymetry. However, the non-hydrostatic pressure term requires the solution of a large sparse system of linear equations in each time step. In this talk, we investigate several numerical solver techniques, e.g., sequential and parallel preconditioning methods applied to the Krylov subspace method FGMRES(m), domain decomposition techniques, and resorting algorithms. An emphasis will be put on the parallel Schur and restrictive additive Schwarz preconditioner that proved to provide very good convergence and computational efficiency for non-hydrostatic TsunAWI as well as for the sparse linear system arising in the ocean model FESOM. The correspondend solver components were also implemented in the framework of the pARMS solver library.

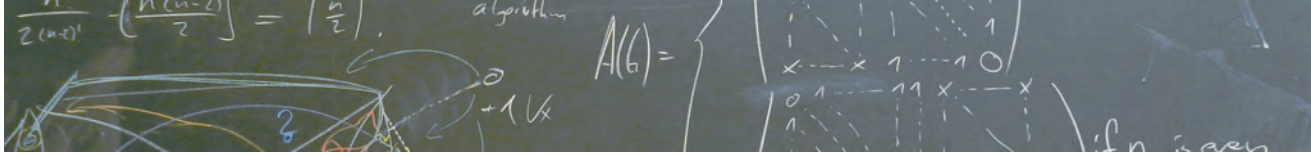
Causality or correlation? Multiscale inference and applications to geoscience

Illia Horenko
Università della Svizzera Italiana, Switzerland

One of the challenges in analysis of geophysical systems is to learn about the causality relations in the considered systems on a certain level of resolution—and to distinguish between the true causality from simple statistical correlations. Proper inference of such causality relations, besides giving an additional insight into such processes, can allow improving the respective mathematical and computational models. However, inferring such relations directly from geophysical equations/models is hampered by the multiscale character of the underlying processes and the presence of unresolved/sub-grid scales.

Implications of missing/unresolved scales for this problem will be discussed and an overview of methods for data-driven causality inference will be given. Recently-introduced data-driven multiscale causality inference framework for discrete/Boolean data will be explained and illustrated on analysis of historical climate teleconnection series and on inference of their mutual influences on monthly scale.

The talk will be based on the recently published paper S. Gerber and I. Horenko. *On inference of causality for discrete state models in a multiscale context*, Proceedings of the National Academy of Sciences of the United States of America, 111 (41), 14651-14656, 2014.



Compressible atmospheric modelling on unstructured grids

Oswald Knoth
Leibniz-Institut für Troposphärenforschung e.V., Germany

Unstructured grids are in common for the next generation of global models for numerical weather prediction. In the first part of the talk I would like to give an overview of new efforts in this active area of code development and numerical research. The overview will focus on model formulation, grid structure as well as spatial discretization and time integration methods. The models include OLAM, ICON, MPAS, HOMME, the GungHo project, NUMA., and others.

In the second I shall report on my own experiences in this area, where I tried to have different grid structures and numerical methods in one code coupled with the same physical parameterizations like surface fluxes, turbulence and phase transfer processes between different water types in the atmosphere. In the code ASAMunstructured the conservative form of the compressible equations are discretized in space by a mixture of finite volumes and finite differences coupled with a zoo of temporal integration methods. Numerical examples from the DCMIP case suite will illustrate the benefits and shortcomings of the actual implementation.

Mimetic Discretization Methods for Numerical Modeling of Atmosphere and Ocean

Peter Korn
Max Planck Institute for Meteorology, Germany

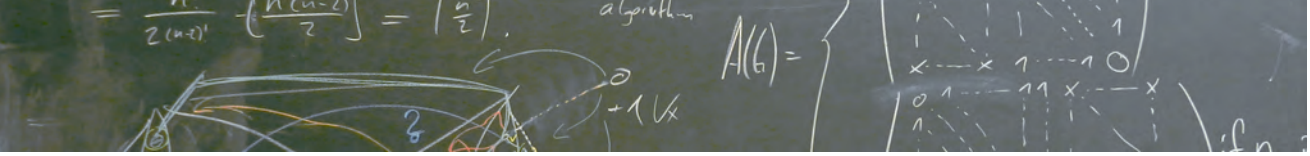
Mimetic discretization methods for integrating the dynamical equations of Atmosphere and Ocean models on unstructured grids have recently gained much attraction. We review mimetic methods in view of their applications in numerical geophysical fluid dynamics. As a specific example we describe ICON-O a new general circulation model of the global ocean. ICON-O based on the Ocean Primitive Equations: the incompressible Navier-Stokes Equations on the sphere, in vector invariant form with a free surface plus the hydrostatic and the Boussinesq approximation.

The model solves the ocean primitive equations on a triangular icosahedral grid. The models dynamical core as well as its subgrid scale closure use a coherent discretization that is based on a mimetic discretization approach. We describe the mimetic disretization and some of its properties. A sequence of simulations is presented that range from idealized process studies to long-term global ocean simulations.

Higher order locally adaptive discontinuous Galerkin approach for atmospheric simulations and surface flows

Dietmar Kröner
University of Freiburg, Germany

In this talk we shall give some recent results about atmospheric flows which were obtained within the DFG Schwerpunktprogramm 1276 *MetStroem*. In particular we shall consider the numerical simulation of the gravity waves and some Benchmark problems which were designed within this DFG Schwerpunktprogramm. The simulation is based on the compressible Navier Stokes equation and for the numerical discretization we use discontinuous Galerkin methods within the DUNE context. Furthermore we shall discuss the numerical simulation of surface flows modelled by shallow water equations including the wetting and drying process. Also in this case the numerical approximation is based on discontinuous Galerkin methods.



Developing parametrizations for multiscale systems using non equilibrium statistical mechanics

Valerio Lucarini
University of Hamburg, Germany
University of Reading, England

We consider the problem of deriving approximate autonomous dynamics for a number of variables of a dynamical system, which are weakly coupled to the remaining variables. We have used the Ruelle response theory on such a weakly coupled system to construct a surrogate dynamics, such that the expectation value of any observable agrees, up to second order in the coupling strength, to its expectation evaluated on the full dynamics. We show here that such surrogate dynamics agree up to second order to an expansion of the Mori-Zwanzig projected dynamics. This implies that the parametrizations of unresolved processes suited for prediction and for the representation of long term statistical properties are closely related, if one takes into account, in addition to the widely adopted stochastic forcing, the often neglected memory effects.

Asymptotic preserving IMEX FV-methods for singular limit atmospheric flows

Maria Lukacova-Medvidova
Johannes Gutenberg-University Mainz, Germany

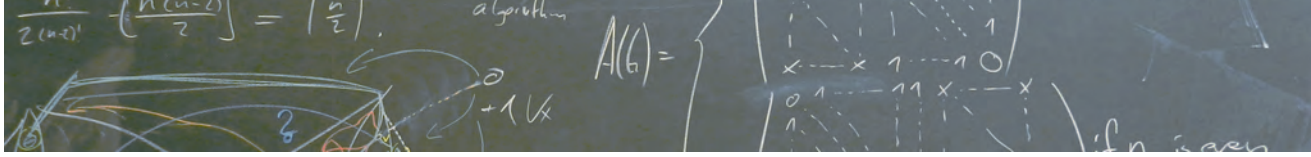
We shall present some recent results on the asymptotic preserving FV schemes for the shallow water and/or Euler equations.

We shall show theoretically as well as by numerical experiments that the resulting methods yield consistent approximations with respect to a singular parameter. The main idea is to use a suitable splittting of the whole nonlinear problem into a linear singular operator (describing fast linear waves) and a nonlinear nonsingular one (describing slow nonlinear waves). Moreover, suitable approximation of the source terms will yield a well-balanced method uniformly with respect to the singular parameter, as well. The present work has been done in cooperation with G. Bispen and L. Yelash (University of Mainz).

Simulation of hydraulic fracturing using XFEM

Insa Neuweiler
University of Hannover, Germany
Alina Ramirez
University of Hannover, Germany

Modeling of hydraulic fracturing (the injection of fluid at high pressures into the underground to create/widen fractures in the rock) requires the coupling of different physical processes, like rock deformation, fluid flow in the matrix and the open fracture. We present a 2D model that is described by the theory of poroelasticity and simulates the propagation of a single embedded fracture in a fully saturated, linear elastic, isotropic, porous material. Fluid flow within the matrix is given by Darcy's law and the open flow in the fracture is approximated by a parallel plate model. The used numerical method is the Extended Finite Element Method (XFEM). This way, no mesh-adapting step is needed when the geometry or location of the discontinuity changes. The coupling between the two domains is done via Lagrange multipliers. We discuss the implementation of the coupling during fracture growth and show examples of different fracture geometries and material properties.



Probability densities of ocean biogeochemical observations and model output: Hellinger distance as potential metric for optimisation of global ocean simulations

Markus Schartau
GEOMAR Helmholtz-Zentrum für Ozeanforschung Kiel, Germany
Iris Kriest
GEOMAR Helmholtz-Zentrum für Ozeanforschung Kiel, Germany

The distribution of ocean measurements, in particular of biogeochemical properties, exhibits spatial variability, which complicates the comparison of simulation results with data. But data-model comparisons are essential to evaluate the credibility of simulation results. Typically, assessments of global biogeochemical ocean models are approached with summary statistics, e.g., by considering spatial means of measured nutrient concentrations. Comparisons of temporal and regional means mask information about a model's ability to resolve observed variations within ocean regions defined for averaging. This limitation hinders the assessment of model results with respect to events that can occur on smaller regional scales, e.g., a shift from nitrogen to phosphate limitation of algal growth. In our presentation we introduce an alternative approach where simulated and observed probability distributions of specific ocean regions are compared. We shall discuss advantages and limitations of applying the Hellinger distance as a metric for ocean biogeochemical model assessment and for model parameter optimisation.

MS#17: Mathematical General Relativity

Organisatoren: Oliver Rinne, Potsdam; Lars Andersson, Potsdam

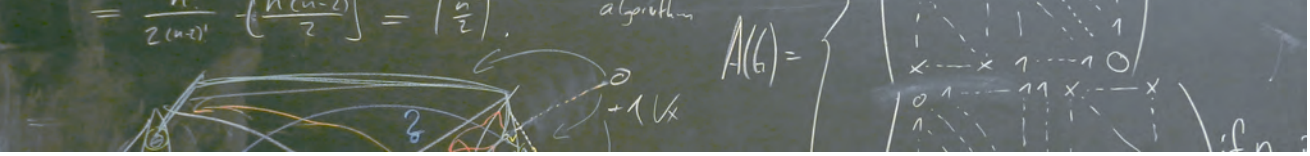
Mathematical general relativity is a broad research field spanning differential geometry, partial differential equations, dynamical systems and scientific computing, among others. Much progress has been made in recent years. The problems of black hole stability and cosmic censorship have led to important advances in nonlinear hyperbolic PDEs. The study of initial data for the Einstein equations has motivated important problems in Riemannian geometry such as the Penrose inequality. Cosmological models provide rich dynamical systems and have led to insights into the structure of singularities. Numerical simulations have become a reliable tool both to model astrophysical processes and to investigate more fundamental aspects of the theory.

The mini-symposium is intended to present a broad overview of current research directions and to attract a general mathematical audience to this fascinating subject. With the 100th anniversary of the genesis of general relativity, 2015 is a fitting time for such a mini-symposium.

High-accuracy methods for black-hole perturbations: quasi-normal-modes filtering

Marcus Ansorg
Universität Jena, Germany

In this talk I shall present a spectral decomposition of solutions to relativistic wave equations on a given Schwarzschild-black-hole background. To this end, the wave equation is Laplace-transformed which leads to a spatial differential equation with a complex parameter. This equation is treated in terms of a sophisticated Taylor series analysis. Thereby, all ingredients of the desired spectral decomposition arise explicitly, including quasi normal modes, quasi normal mode amplitudes and the jump along the branch cut. Finally, all contributions are put together to obtain via the inverse Laplace transformation the spectral decomposition in question.



Uniqueness of photon spheres in static vacuum isolated systems

Carla Cederbaum
Universität Tübingen, Germany

We show that the Schwarzschild spacetime is the only static vacuum asymptotically flat general relativistic spacetime that possesses a suitably geometrically defined photon sphere. We shall present two proofs, both extending classical static black hole uniqueness results. Part of this work is joint with Gregory Galloway.

Blowup results for nonlinear wave equations

Roland Donninger
Universität Bonn, Germany

A stunning feature of Einstein's equations of general relativity is the onset of singularities in finite time from perfectly regular initial data. This happens, for instance, in the dynamical formation of black holes. In most cases, however, a rigorous treatment of this phenomenon is hopeless at the present stage of research. Consequently, one resorts to simpler model problems. In the last decade there was tremendous progress in the study of singularity formation for nonlinear wave equations and I shall report on some of the most important results.

Some global results and problems for Einstein's field equations

Helmut Friedrich
Max-Planck-Institut für Gravitationsphysik, Germany

We discuss results and open questions on the stability and the asymptotic behaviour of solutions to Einstein's field equations with positive cosmological constant and discuss their role in the context of the recently proposed conformal cyclic cosmological model.

Aspects of 3-manifold theory in general relativity

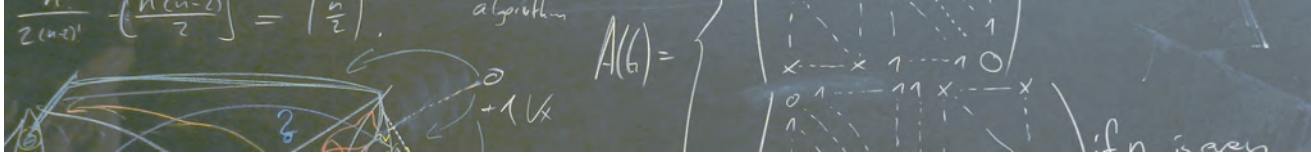
Domenico Giulini
Universität Hannover, Germany
Universität Bremen, Germany

As is well known, Einstein's field equations of General Relativity impose no topological obstruction on the Cauchy hypersurface. Hence there is generally some topological freedom in modelling initial data corresponding to a specific physical situation, like, e.g., a collection of black holes momentarily at rest. This gives rise to interesting topological considerations connected with the physically motivated question concerning the structure of configuration spaces in General Relativity. A simple 2-hole example serves to illustrate the somewhat surprising richness of structure and allows to speculate about its possible physical implications.

Critical phenomena in gravitational collapse

Carsten Gundlach
University of Southampton, England

How easy is it to generate a naked singularity from analytic initial data in general relativity with well-behaved matter (such as a scalar field or perfect fluid)? The surprise answer is that one only needs to fine-tune any one generic parameter of the initial data to the collapse threshold. In this sense, naked singularities are codimension-1 generic. The underlying theory involves self-



similar spacetimes that have only one growing perturbation, and dynamical systems theory. Open questions concern vacuum relativity and the role of angular momentum.

Chaotic heteroclinic structure for extreme gravity models

Juliette Hell
Freie Universität Berlin, Germany

The Bianchi IX cosmological model is homogeneous but anisotropic. The dynamics on the Ringström's attractor is a network of heteroclinic orbits that supports the Belinsky-Khalatnikov-Lifschitz conjecture: a universe tumbling from one Kasner state to the next in a specific chaotic manner. We introduce a parameter in this model, whose variation from the critical value corresponding to Bianchi IX changes the dynamics dramatically. Below the critical value, heteroclinic chains generically end up after finally many iterations, while chaos of BKL type survives only on a fractal Cantor set of measure zero. Above the critical value, chaos is in some sense generic, but not of BKL-type because the concept of era loses its meaning. We shall give interpretations of the parameter introduced and explain how the methods of symbolic dynamics used here can be applied also for FLRW models with scalar fields.

Recent progress in the black hole stability problem

Gustav Holzegel
Imperial College London, England

I shall review some recent progress in the black hole stability problem including a proof of the linear stability of the Schwarzschild spacetime under gravitational perturbations (joint work with Dafermos and Rodnianski).

Hairy black holes

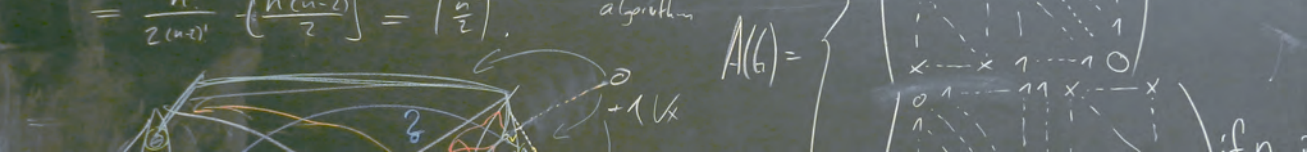
Jutta Kunz
Universität Oldenburg, Germany

In Einstein-Maxwell theory a number of theorems hold for black holes. For instance, black holes are uniquely specified by their global charges; a static horizon implies a spherically symmetric spacetime as well as vanishing total angular momentum. However, these theorems do not generalize to theories with other types of fields. Yang-Mills fields violate uniqueness and allow for static non-spherically symmetric black hole spacetimes. The presence of a dilaton yields stationary black holes with static horizons as well as counterrotating black holes. Complex scalar fields produce hair on rotating black holes.

The tumbling universe: cosmological models in the big-bang limit

Stefan Liebscher
Freie Universität Berlin, Germany

We consider cosmological models of Bianchi type. They yield spatially homogeneous, anisotropic solutions of the Einstein field equations. In particular, we are interested in the alpha-limit dynamics of the Bianchi model corresponding to the big-bang singular limit of the Einstein equations. Emphasis is on transient behaviour of solutions near the (backward) Bianchi attractor composed of the Kasner circle of equilibria and attached heteroclinic connections. The heteroclinic orbits in the Bianchi attractor form formal sequences of shift type. We prove the existence of unstable manifolds to heteroclinic sequences. This relates alpha-limit transients of cosmologies of Bianchi type to formal sequences of Kasner heteroclinics: a tumbling universe.



Constructive proof of the no-hair theorem

Reinhard Meinel
Universität Jena, Germany

According to the no-hair theorem, the Kerr-Newman black hole solution represents the most general asymptotically flat, stationary (electro-)vacuum black hole solution in general relativity. The talk shows how this solution can indeed be constructed as the unique solution to the corresponding boundary value problem of the axially symmetric Einstein-Maxwell equations in a straightforward manner.

Test body motion in gravity

Dirk Pützfeld
Universität Bremen, Germany

We present a unified covariant multipolar framework for the description of test bodies in gravity. The framework covers a very large class of gravitational theories, and one can use it as a theoretical basis for systematic tests of gravity by means of extended deformable test bodies. The classes of theories covered range from simple generalizations of General Relativity, e.g., encompassing additional scalar fields, to theories with additional geometrical structures, which are needed for the description of microstructured matter. Furthermore, we discuss the impact of nonstandard couplings between matter and gravity on the resulting test body equations of motion.

MS#18: Mathematical Methods for Magnetic Particle Imaging

Organisatoren: Wolfgang Erb, Lübeck; Andreas Weinmann, München

Magnetic particle imaging (MPI) is a novel imaging modality that determines the spatial distribution of magnetic nanoparticles by measuring the non-linear magnetization response of the particles to an applied magnetic field. Due to its high spatial and temporal resolution as well as the fact that, in contrast to other tomographic methods such as PET or SPECT, no radioactive substances are needed, MPI is a very promising imaging modality for biomedical diagnostics such as blood flow imaging and cancer detection.

The mathematical problem of MPI is to reconstruct the particle density function from the measured voltage signal induced in the receive coils. The intrinsic relation between particle distribution and measured signal is described by the so-called system function. The mathematical modelling and analysis of the system function is one of the major challenges in MPI. Since the reconstruction is ill-posed, appropriate regularization techniques which are also suitable for clinical purposes have to be included. Further, to improve the reconstruction quality, stable and efficient numerical algorithms have to be developed.

In this Minisymposium, we bring together researchers working in MPI shedding light on both theoretic and practical aspects. There will be talks that give introductions as well as talks focusing on different mathematical aspects of MPI. Further, we want to address open problems and challenges related to this novel imaging modality.

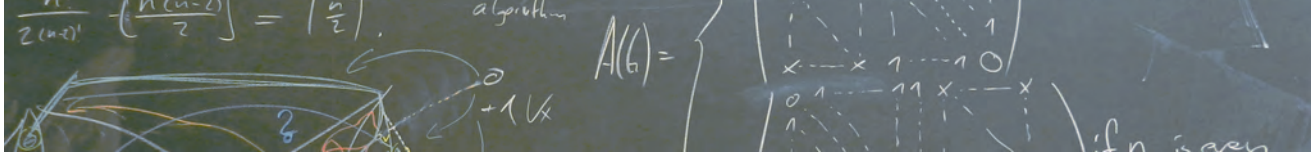


Image Reconstruction in Magnetic Particle Imaging within the Scope of Imaging Sequences

Mandy Ahlborg
Universität zu Lübeck, Germany

The imaging technology Magnetic Particle Imaging (MPI) develops rapidly regarding specific hardware designs. As a result, different imaging sequences have been established each favoring different reconstruction methods. In this talk an overview of realized MPI sequences and published image reconstruction algorithms is given. Furthermore, the mathematical similarities and differences between the reconstruction methods will be investigated with respect to the applied imaging sequence. Since the increase of field of view size is an important topic a brief discussion on the resulting consequences for the reconstruction will be given to emphasize current research topics.

Sparse image reconstruction for magnetic particle imaging

Christina Brandt
University of Osnabrück, Germany

The image reconstruction problem of magnetic particle imaging consists of the determination of the magnetic particle density function from the measured voltage signal induced by an applied magnetic field. The relation between the particle distribution and the measured signal is described by the system function which contains information about particle dynamics, experimental setup, and the measurement parameters. In practice, a discrete version of the system function is determined experimentally.

Since the image reconstruction is sensitive to noise, regularization methods are necessary. Currently, regularization strategies such as classical Tikhonov regularization, truncated singular value decompositions as well as iterative methods such as Kaczmarz method or conjugate gradient algorithm are applied. We shall focus on variational regularization methods with sparsity constraints for MPI which incorporate more adequate a priori information on the solution such as total variation norm for preserving edges in the image or sparsity promoting L^1-norms of shearlet coefficients. We shall present numerical results both for simulations as well as real data.

Trivariate polynomial approximation on Lissajous curves

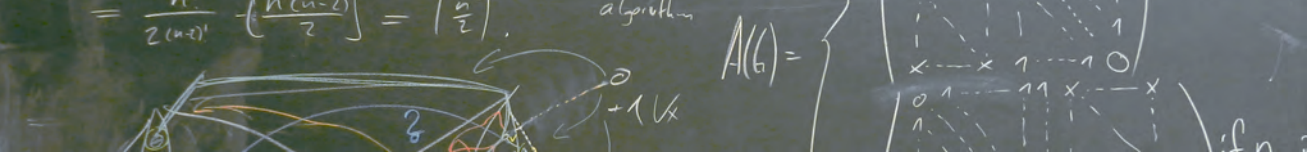
Stefano De Marchi
University of Padova, Italy

We study Lissajous curves in the 3-cube, that generate algebraic cubature formulas on a special family of rank-1 Chebyshev lattices. These formulas are used to construct trivariate hyperinterpolation polynomials via a single 1D Fast Chebyshev Transform (by using the well-known Chebfun package), and to compute discrete extremal sets of Fekete and Leja type for trivariate polynomial interpolation. Typical applications are in the framework of Lissajous sampling for MPI (Magnetic Particle Imaging). (Joint work with L. Bos, University of Verona, Italy, and M. Vianello, University of Padova, Italy.)

Reconstructions in Magnetic Particle Imaging using curved field free lines

Jürgen Frikel
Technical University of Denmark, Denmark

Magnetic Particle Imaging (MPI) is an emerging imaging modality that measures the magnetization response of paramagnetic nanoparticles to determine its spatial distribution. In this



talk, we consider a 2D situation in which the data is generated by using a constantly rotated and shifted field free line (FFL). In this imaging setup, the measured signals incorporate an averaging along these FFL's, leading to a mathematical formulation of the reconstruction problem that is a combination of a 2D Radon transform and a 1D MPI model. Therefore, one of the main steps in the reconstruction algorithms is the inversion of the Radon transform. However, in most practical situations, the generated field free lines are not ideal and appear to be rather curved. In this talk, we present a reconstruction approach which takes into account the curved nature of the FFL's and investigate the effectiveness of this method in numerical experiments.

Introduction to the Principles of Magnetic Particle Imaging

Tobias Knopp
Universitätsklinikum Hamburg-Eppendorf, Germany

Magnetic Particle Imaging (MPI) is a tomographic medical imaging technique that uses iron-oxide based tracers in order to follow their spatial distribution when, e.g., flowing through the cardiovascular system. In this talk the basic principles of MPI are introduced. Starting with the physical foundations involving static and dynamic magnetic fields responsible for spatial encoding we give an overview of the MPI signal chain. The later can be described by a forward model mathematically relating the particle concentration to the measurement signal that is detected in receive coils. In order to determine the particle concentration the inverse problem has to be solved. Due to the ill-conditioning of the MPI system matrix one has to apply regularization techniques that are described in this talk.

Computational Regularization of Inverse Problems

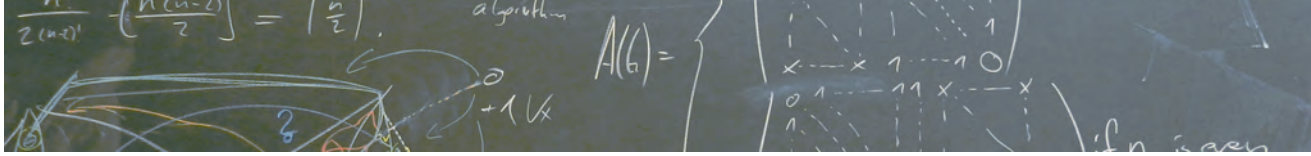
Dirk Lorenz
Technische Universität Braunschweig, Germany

Inverse problems often suffer from ill-posedness, e.g., in the sense that the problems are underdetermined and/or the solution does not depend continuously on the given data. We study variational regularization methods, i.e., methods that minimize certain functionals. Noise models and prior information can be modelled via that approach. We touch upon regularizing properties of such functionals and also computational methods to solve the resulting convex minimization problems. The algorithms are build in a way that the scalable to large problems and produce mildly accurate minimizers quickly.

Joint Image Reconstruction and Segmentation in Magnetic Particle Imaging

Martin Storath
EPFL, Switzerland

We present a new algorithmic approach to the non-smooth and non-convex Potts problem (also called piecewise-constant Mumford-Shah problem) for inverse imaging problems. We derive a suitable splitting into specific subproblems that can all be solved efficiently. Our method does not require a priori knowledge on the gray levels nor on the number of segments of the reconstruction. Further, it avoids anisotropic artifacts such as geometric staircasing. We demonstrate the suitability of our method for the joint image reconstruction and segmentation in magnetic particle imaging.



Dynamisches Verhalten der magnetischen Teilchen in MPI

Jürgen Weizenecker
Hochschule Karlsruhe—Technik und Wirtschaft, Germany

In den letzten Jahren gab es beträchtliche Fortschritte auf dem Gebiet der tomographischen Bildgebung in der Medizintechnik mittels der Methode MPI (Magnetic Particle Imaging). Da es sich um eine vergleichsweise junge Methode handelt sind die aktuellen Aktivitäten äußerst vielfältig. Im Gegensatz zu anderen Modalitäten wird zur Signalerzeugung ein Kontrastmittel zwingend benötigt. Die Leistungsfähigkeit dieser nanometergroßen Magnete beeinflusst in hohem Maße die Bildqualität und hat großen Einfluss auf das Design der Signalkette. Im Vortrag wird nach einer kurzen Einleitung gezeigt, wie sich mittels stochastischer Differentialgleichungen (Langevin-Gleichung) oder partieller Differentialgleichungen (Fokker-Planck-Gleichung) die zeitlichen Ummagnetisierungsprozesse (Néel und Brown-Rotation) modellieren lassen und welche Auswirkung das auf die Signalqualität hat.

MS#19: Mathematical Methods in Image and Signal Processing

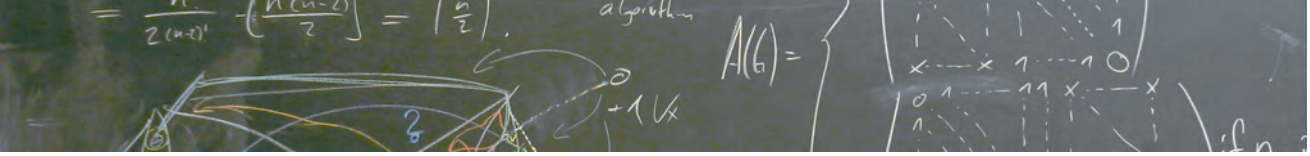
Organisatoren: Ole Christensen, Kungens Lyngby; Armin Iske, Hamburg

This mini-symposium brings together experts within mathematical methods in image and signal processing. The aim is to exchange recent advances in sampling theory, computational harmonic analysis and their relevant applications. Topics include wavelets and frames, compressed sensing, sparse representations and coding, dimensionality reduction, kernel-based approximation, medical image reconstruction, and other related topics.

Consistency of probability measure quantization by means of power repulsion-attraction potentials

Massimo Fornasier
Technische Universität München, Germany

In this talk we present the study of the consistency of a variational method for probability measure quantization, deterministically realized by means of a minimizing principle, balancing power repulsion and attraction potentials. The proof of consistency is based on the construction of a target energy functional whose unique minimizer is actually the given probability measure ω to be quantized. Then we show that the discrete functionals, defining the discrete quantizers as their minimizers, actually Γ-converge to the target energy with respect to the narrow topology on the space of probability measures. A key ingredient is the reformulation of the target functional by means of a Fourier representation, which extends the characterization of conditionally positive semi-definite functions from points in generic position to probability measures. As a byproduct of the Fourier representation, we also obtain compactness of sublevels of the target energy in terms of uniform moment bounds, which already found applications in the asymptotic analysis of corresponding gradient flows. To model situations where the given probability is affected by noise, we additionally consider a modified energy, with the addition of a regularizing total variation term and we investigate again its point mass approximations in terms of Γ-convergence. We show that such a discrete measure representation of the total variation can be interpreted as an additional nonlinear potential, repulsive at a short range, attractive at a medium range, and at a long range not having effect, promoting a uniform distribution of the point masses.



Sampling theory revisited: generalized Bernstein spaces and the way back to the real line

Brigitte Forster
University of Passau, Germany

We consider variations on the commutative diagram consisting of the Fourier transform, the Sampling Theorem and the Paley-Wiener Theorem. We start from a generalization of the Paley-Wiener theorem and consider entire functions with specific growth properties along half-lines. Our main result shows that the growth exponents are directly related to the shape of the corresponding indicator diagram, e.g., its side lengths. Since many results from sampling theory are derived with the help from a more general function theoretic point of view (the most prominent example for this is the Paley-Wiener Theorem itself), we motivate that a closer examination and understanding of the Bernstein spaces and the corresponding commutative diagrams can—via a a limiting process to the straightline interval $[-A, A]$—yield new insights into the $\mathrm{L}^p(\mathbb{R})$-sampling theory. This is joint work with Gunter Semmler, Technische Universität Bergakademie Freiberg, Germany.

Persistent homology, signal processing and noncommutative algebras

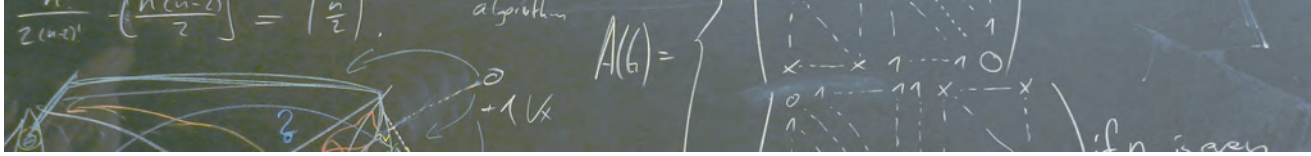
Mijail Guillemard
Technische Universität Berlin, Germany

The usage of topological and geometrical concepts in signal and data analysis has seen multiple developments in the last few years. In this talk, we present an overview of some selected topics in these fields. We begin with a basic review of ideas in signal processing using frame theory as a main tool that generalizes time-frequency analysis and wavelets transforms. We explain basic concepts on manifold learning and dimensionality reduction as modern tools for data analysis. A related topic is persistent homology, which provides new analysis strategies using concepts from homology. Noncommutative algebras provides a powerful machinery integrating topological and algebraic constructions. We illustrate the application of these tools using examples from both audio signal processing and image analysis.

Compressed sensing and matrix compression in magnetic particle imaging

Tobias Knopp
Universitätsklinikum Hamburg-Eppendorf, Germany

Magnetic Particle Imaging is a tomographic medical imaging technique that allows reconstructing the spatial distribution of magnetic nanoparticles. The relation between the measured voltage signal and the particle distribution is described by a linear system of equations. Due to the complex dynamic behavior of the magnetic nanoparticles the corresponding system matrix is not accurately known. For this reason the system matrix is usually measured column-by-column using a tedious calibration procedure involving a small delta sample and a robot. This measurement can last several days. In the talk it will be shown that the calibration measurement can be significantly accelerated using compressed sensing. Further the actual image reconstruction will be discussed. This involves regularization techniques due to the ill-conditioned system matrix. Using matrix compression in combination with iterative solvers the reconstruction time can be significantly reduced so that online reconstruction becomes feasible.



On the equivalence between k-means clustering and regularized matrix factorization with applications in hyperspectral imaging

Peter Maaß
University of Bremen, Germany

The basic equivalence between k-means clustering for the Euclidean metric and orthogonal non-negative matrix factorization (NMF) has attracted substantial interest in the last three years. We extend this approach to regularized NMF-methods with general p-norms and determine the equivalent k-means clustering algorithms. This gives rise to some algorithmically accessible non-standard k-means variants. We than apply this to MALDI Imaging data, which is a particular complex case of hyperspectral imaging data.

Fractional cone and hex splines

Peter Massopust
Technische Universität München, Germany

We introduce an extension of cone splines and box splines to fractional and complex orders. These new families of multivariate splines are defined in the Fourier domain along certain s-dimensional meshes and include as special cases the three-directional box splines and hex splines previously considered by Condat, Van De Ville et al. These cone and hex splines of fractional and complex order generalize the univariate fractional and complex B-splines in a natural way. Explicit time domain representations are derived for these splines on 3-directional meshes. We present some properties of these two multivariate spline families such as recurrence, decay and refinement. Finally it is shown that a bivariate hex spline and its integer lattice translates form a Riesz basis of its linear span. This is joint work with Pat Van Fleet, University of St. Thomas, St. Paul MN, United States of America.

Deterministic sparse FFT

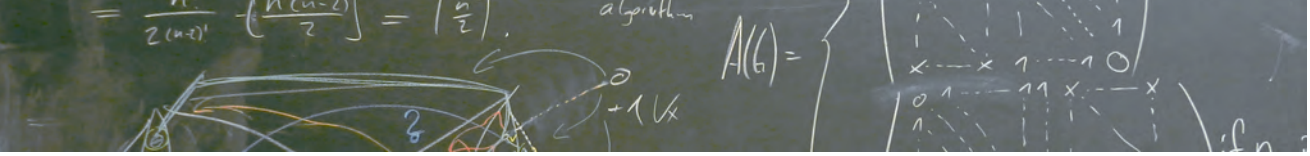
Gerlind Plonka
University of Göttingen, Germany

We consider some ideas to improve the well-known (inverse) FFT algorithm to compute a vector x from its Fourier transformed data. It is known that the FFT needs $\mathrm{O}(N \log N)$ arithmetical operations. However, if the resulting vector x is a priori known to be sparse, i.e., contains only a small number of non-zero components, the question arises, whether we can do this computation in an even faster way. In recent years, different sublinear algorithms for the sparse FFT have been proposed, most of them are randomized. We want to concentrate on deterministic sparse FFT algorithms and consider especially vectors with small support and sparse positive vectors. The talk is based on joint work with Katrin Wannenwetsch.

Prony's method in several variables

Tomas Sauer
University of Passau, Germany

In one variable, Prony's method is a well-known procedure to reconstruct sparse exponentials from integer data. The talk concerns its multivariate analog where ideal bases have to be computed from kernels of certain Hankel matrices. By means of homogeneous H-bases this can be done in a fairly fast and numerically quite stable way where it turns out that, though computationally more challenging, an increased number of variables stabilizes things significantly. This is a typical



behavior of polynomials where numerical issues often depend in a moderate way from the total degree and not the number of coefficients.

On inpainting with tensor product splines

Nada Sissouno
University of Passau, Germany

Motivated from art restoration, "inpainting" stands for methods for the reconstruction of damaged or missing parts of images. Such damage can be caused for example by degradation of the real image. On the basis of those data of the image which are not damaged, inpainting methods try to reconstruct the damaged parts in a suitable way. There exists a wide range of mathematical inpainting methods differing in the choice of the algorithm as well as in the space of the solutions, both strongly depending on the interpretation of what suitable means. Tensor product splines are, among other things, useful due to their simple structure and efficient implementability. In this talk we present an inpainting method that uses tensor product splines for the reconstruction. This is joint work with Tomas Sauer.

Real algebraic geometry for the construction of tight wavelet frames

Joachim Stöckler
Technische Universität Dortmund, Germany

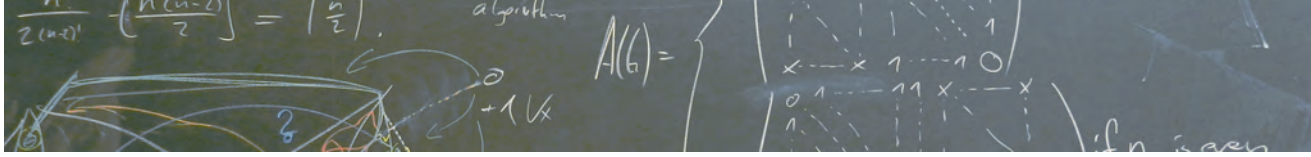
We combine methods of real algebraic geometry, linear system theory and harmonic analysis for the construction and for parameterization of classes of tight wavelet frames. Recent algebraic results guarantee that nonnegative trigonometric polynomials in two variables have a sum-of-squares decomposition. This result is useful in solving two matrix extension problems which occur in the construction of bivariate tight wavelet frames, namely the unitary and oblique extension principles. The masks of the wavelet frames are finite, if the constructions are based on the unitary extension principle, and infinite otherwise. For the oblique extension principle, a new and efficient method for the construction of tight wavelet frames with finite masks is presented. It uses the interpretation of certain rational trigonometric functions as transfer functions of a linear system. This is joint work with M. Charina, M. Putinar, and C. Scheiderer.

MS#20: Mathematics of Fluid Interfaces

Organisatoren: Helmut Abels, Regensburg; Harald Garcke, Regensburg

In many fluid dynamic problems either free surfaces or interfaces between different fluids or phases occur. Hence, the governing equations of fluid dynamics (e.g., the Navier-Stokes equations or the Euler equations) have to be solved on a domain which has to be determined as part of the problem. The arising mathematical equations are highly nonlinear and notoriously difficult to solve.

Recently several new ideas with respect to modelling and analysis of these phenomena were developed and need to be explored further. The aim of the mini-symposium is to present the state of the art of the field and focus on recent new developments. These include stability of fluid interfaces, diffuse interface models and their sharp interface limits, singularities for water waves, well-posedness results based on maximal regularity or new weak formulations, new models for complex phenomena at fluid interfaces (examples are transport phenomena and fluid-membrane interactions).



Diffuse Interface Models for Two-Phase Flows with Surfactants

Helmut Abels
University of Regensburg, Germany

We shall present a recent diffuse interface model for a two-phase flow of viscous incompressible fluids taking the effect of a surfactant into account, which diffuses through the bulk phases and along the interface. The model was developed by Garcke, Lam and Stinner. We shall discuss the existence of weak solutions for this model. This is joint work with Harald Garcke and Josef Weber.

Modeling of mass-transfer across contaminated fluid interfaces

Dieter Bothe
Technische Universität Darmstadt, Germany

The local rate of mass transfer of a gaseous component from a gas bubble rising in an ambient liquid, say, is strongly influenced by the presence of surface active substances, so-called surfactants. This is due to both a change of the local hydrodynamics due to Marangoni stresses because of inhomogeneous surface tension and a barrier effect resulting from the coverage of the interface by surfactant molecules. We give a thermodynamically consistent mathematical model for these phenomena, based on continuum thermodynamics employing sharp-interface balances and an appropriate form of the entropy principle. This is complemented by first numerical results on mass transfer under such conditions. This is joint work with Chiara Pesci and Holger Marschall (Darmstadt)

Existence and stability of weak solutions for a degenerate parabolic system of thin film type

Joachim Escher
Leibniz University Hannover, Germany

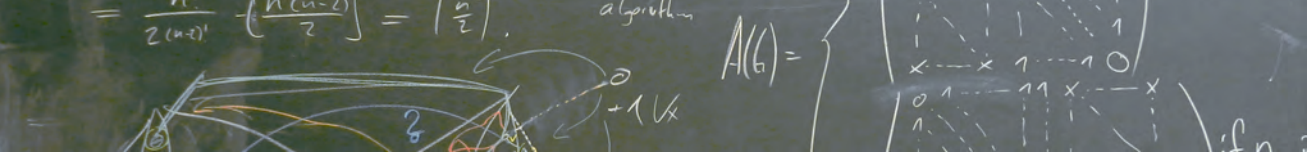
The evolution of two fluid phases in a porous medium is considered. The fluids are separated from each other and also the wetting phase from air by interfaces which evolve in time. It is shown that the problem can be reduced to an abstract evolution equation. A generalized Rayleigh–Taylor condition characterizes the parabolicity regime of the problem and allows to establish a general well-posedness result and to study stability properties of flat steady states. If surface tension effects on the interface between the fluids are included and if the more dense fluid lies above, bifurcating finger-shaped equilibria exist, which are however all unstable.

Relative entropy estimates for the Navier-Stokes-Korteweg model

Jan Giesselmann
University of Stuttgart, Germany

The isothermal Navier-Stokes-Korteweg (NSK) model is a well-known diffuse interface model describing compressible multi-phase flows. Its stability analysis is far from straightforward in case it derives from a non-convex energy density, which is standard in the modelling of multi-phase flows. We explain how the relative entropy method, a classical tool in the stability analysis of compressible fluid flows, can be modified as to provide a stability estimate for the NSK model with non-convex energy density.

We also outline how this result can be used to show convergence of solutions of a lower order model to solutions of the NSK model in some limit. Our interest in this limit arises from numerical considerations as solutions of the lower order model can be approximated much easier than solutions of the NSK model.



On micro-macro models for two-phase flow with dilute polymeric solutions—modeling and analysis

Günther Grün
University of Erlangen-Nürnberg, Germany

We suggest a diffuse-interface model for two-phase flow of incompressible fluids with dissolved non-interacting polymer chains. The polymer chains are modeled by dumbbells subjected to generic elastic spring-force potentials. Their density and orientation are described by a Fokker-Planck-type equation which is coupled to a Cahn-Hilliard and a momentum equation for phase-field and gross velocity/pressure. Henry-type energy functionals are used to describe different solubility properties of the polymers in the different phases or at the liquid-liquid interface.

Taking advantage of the underlying energetic/entropic structure of the system, we prove existence of a weak solution globally in time in the case of FENE-potentials. We discuss extensions of the model to take the interaction between polymer and fluid interface orientation into account ("amphiphilic surfactant") .

Finally, as a by-product of our general modeling approach, we suggest a two-phase visco-elastic model of Oldroyd-B-type. This is based on joint work with S. Metzger.

Modeling of fluid interfaces

Martin Heida
WIAS Berlin, Germany

We discuss a new approach to the derivation of sharp interface models for fluid-fluid interactions. The resulting models also describe the interaction between the fluid-fluid interface and a solid surface. This leads to a new perspective on the Dussan-Davis experiment and to Huh's and Scriven's paradox.

A diffuse interface model for tumour growth with chemotaxis and active transport.

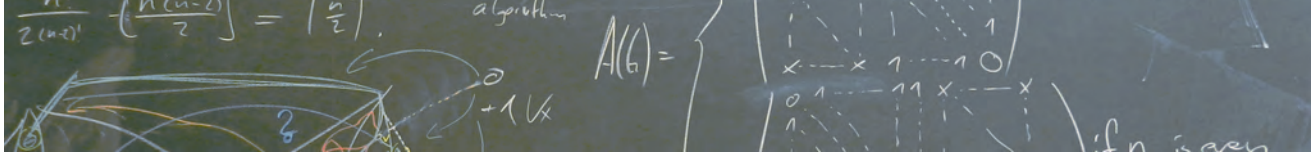
(Andrew) Kei Fong Lam
Universität Regensburg, Germany

We derive a thermodynamically consistent diffuse interface model for tumour growth with chemotaxis and active transport. We couple a Cahn-Hilliard-Darcy system for a two component mixture of healthy cells and tumour cells, and a reaction diffusion equation for a nutrient. Specific choices of the fluxes allow us to include the effects of chemotaxis and active transport. Via a formally matched asymptotic analysis, we recover some of the recent sharp interface models studied for tumour growth. If time permitting, we discuss some recent results regarding the well-posedness of the Cahn-Hilliard nutrient subsystem without fluid flow.

Thin-film equations with free boundaries

Dirk Peschka
Weierstrass Institut, Germany

Several approaches to treat thin-film type problems, i.e., degenerate fourth order parabolic equations, where the solution is only supported on part of the domain, will be reviewed. After discussing the effect of different degeneracies, an algorithm for this class of free boundary problems will be presented. The algorithm is used to compute solutions for different mobilities and for zero and non-zero contact angles in order to discuss the intricate behavior of the corresponding solutions (or their approximations) and as a validation for the algorithm, of course.



On some diffuse interface models of tumour growth

Elisabetta Rocca
WIAS, Germany

We consider a diffuse interface model for tumor growth proposed by Hawkins-Daarud, van der Zee and Oden. This model consists of the Cahn-Hilliard equation for the tumour cell fraction nonlinearly coupled with a reaction-diusion equation for the nutrient-rich extracellular water volume fraction. We shall first present a result on the existence of a weak solution, then we show that the weak solution is unique and continuously depends on the initial data. Furthermore, we shall give a result on the existence of a strong solution that allows to show that any weak solution regularizes in nite time. The last results will be on the existence of the global attractor in a phase space characterized by an a priori bounded energy and on some rigorous asymptotics. (Joint work with P. Colli, S. Frigeri, M. Grasselli, G. Gilardi, and J. Sprekels.)

Phase-field modelling of surfactants in multi-phase flow

Bjorn Stinner
University of Warwick, England

Recently, a phase field model for surfactant and two or more fluids has been presented. It generalises a Cahn-Hilliard-Navier-Stokes system which is coupled to an advection-diffusion equation for a soluble surfactant to multiple phases. In the interfaces and triple junctions, local chemical equilibrum with regards to the surfactant has been assumed. Using matched asymptotic expansions the approach could be shown to converge to the desired sharp interface problem which is supported by numerical simulation results. In the talk, extensions of the model will be discussed with a focus on non-equilibrum conditions both in the interfaces and the triple junctions.

Singularities in ElectroHydroDynamic Flows

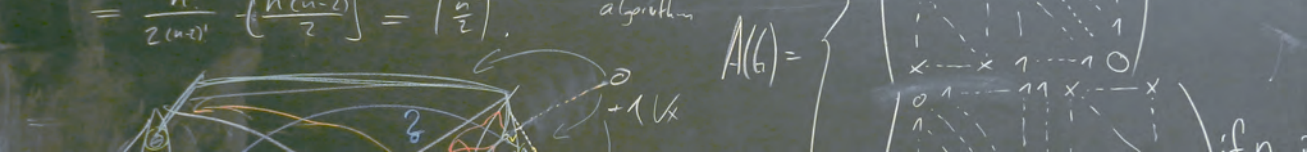
Georg S. Weiss
University of Duisburg-Essen, Germany

We consider axisymmetric solutions of the ElectroHydroDynamic equations in three dimensions. We analyze possible singularities and show in a certain regime convergence to a fluid cusp.

Rayleigh-Taylor instability for the two-phase Navier-Stokes equations with surface tension in cylindrical domains.

Mathias Wilke
Leibniz Universität Hannover, Germany

We consider the dynamic behaviour of two immiscible and incompressible fluids in a cylindrical domain, e.g., a capillary, which are separated by a sharp interface. The interface exhibits a contact angle with the fixed boundary. In case that the heavier fluid is located above the lighter fluid one expects that the upper phase sinks into the lower one; the effect being known as Rayleigh-Taylor instability. The main result yields the existence of a critical surface tension with the following property. In case that the surface tension of the interface between the two fluids is smaller than the critical surface tension, one has Rayleigh-Taylor-Instability. On the contrary, if the interface has a greater surface tension than the critical value, the instability effect does not occur and one has exponential stability of the interface. The last part of the talk is concerned with the bifurcation of nontrivial equilibria in multiple eigenvalues.



MS#21: Mathematics of Geophysical Flows

Organisatoren: Valerio Lucarini, Hamburg; Tobias Kuna, Reading

The fluid Earth is an excellent example of a forced, dissipative non-equilibrium system dominated by nonlinear processes and featuring multi-scale interactions, so that its understanding can be approached using the tools of dynamical systems theory, stochastic processes, and non-equilibrium statistical mechanics. The understanding of the statistical properties of a system under consideration is crucial per se and in a variety of applications, especially when considering large fluctuations, which may result into extreme events of relevant impact.

There is a close connection between core questions and problems of pure and applied mathematics and core questions of geophysical fluid dynamics relevant for the investigation of the climate system and of its component. These are closely linked to defining rigorously what is a good model for such a complex system like the Navier-Stokes equations and their many variants and reductions, multi-scale properties and the selection of appropriate random terms. The response to external forcing and the characterization of large deviations and extreme events are essential challenges. The differential equations that describe mathematically the fluid components, in particular the Navier-Stokes equations and their many variants and reductions, are at the core of the work of any analyst working in nonlinear PDEs. Many of the still open fundamental questions are at the heart of the link between analysts and geophysicists.

This minisymposium stems from the stimulation of the very successful international initiative *Mathematics for Planet Earth 2013* supported by mathematical societies and institutes around the world. The minisymposium gives an overview of four macro-themes of interest where the progress has been impressive on the mathematical side and its impact in terms of theoretical, model-assisted, and observational investigations of the planet Earth: a) Dynamical Systems and Statistical Mechanics; b) Extreme Events; c) Partial Differential Equations d) Stochastic Processes.

Geophysical Fluid Dynamics in Nambu Form

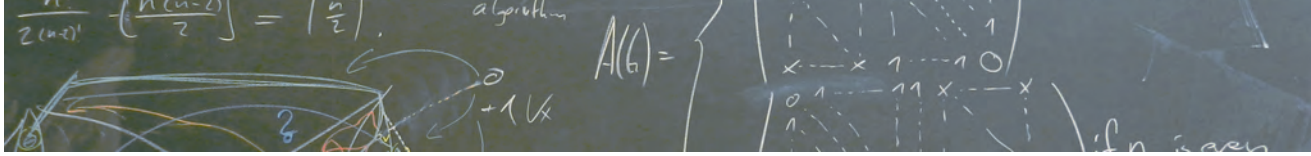
Richard Blender
Universität Hamburg, Germany

Nambu's (1973) extension of Hamiltonian mechanics is applied to Geophysical Fluid Dynamics by including several conservation laws in the dynamical equations. Ideal hydrodynamics is formulated in a Nambu representation in two and three dimensions using enstrophy and helicity as second conservation laws in addition to the total energy (Névir and Blender, 1993). Noncanonical Hamiltonian mechanics is embedded in Nambu mechanics if a Casimir function can be incorporated as a conservation law. The Nambu representations of the quasigeostrophic equations, the shallow water model, the Rayleigh-Bénard equations, and the baroclinic atmosphere are reviewed. Salmon (1995) suggested the design of conservative numerical codes based on a Nambu formulation. Gay-Balmaz and Holm (2013) have used the Nambu approach to parameterise the selective decay in 2D hydrodynamics. To derive the Nambu brackets for two-dimensional systems a geometric approach is suggested (Blender and Badin, 2015). As results, 2D hydrodynamics and Rayleigh-Bénard convection emerge. Approximations are obtained by the definition of constitutive conservation laws.

Dynamical Extremes of Mid-Latitude atmospheric circulation

Davide Faranda
LSCE—UMR 8212, Laboratoire des Sciences du Climat et de l'Environnement, France

Atmospheric mid-latitude circulation is dominated by a zonal, westerly flow. Such a flow is generally symmetric, but it can be occasionally broken up by blocking anticyclones. The subsequent



asymmetric flow can persist for several days. In this paper, we apply new mathematical tools in order to reexamine the dynamical mechanisms responsible for the transitions between zonal and blocked flows. By analyzing several blocking indices, we discard the general claim that mid-latitude circulation features two distinct stable equilibria or chaotic regimes, in favor of a simpler mechanism that is well understood in dynamical systems theory: we identify the blocked flow as an unstable fixed point (or saddle point) of a single basin chaotic attractor, dominated by the westerlies regime. We also analyze the North Atlantic Oscillation and the Arctic Oscillation atmospheric indices, whose behavior is often associated with the transition between the two circulation regimes, and investigate analogies and differences with the bidimensional blocking indices. We find that the Arctic Oscillation index, which is a proxy for a global average of the Tibaldi-Molteni blocking index, keeps track of the presence of unstable fixed points. On the other hand, the North Atlantic Oscillation index is representative only of local properties of the North Atlantic blocking dynamics.

Model selection for paleo-climatic time series: stable and fractional noise

Peter Imkeller
Humboldt-Universität zu Berlin, Germany

Dynamical systems of the reaction-diffusion type with small noise have been instrumental to explain basic features of the dynamics of paleo-climate data. For instance, a spectral analysis of Greenland ice time series performed at the end of the 1990s representing average temperatures during the last ice age suggest an α-stable noise component with an $\alpha \sim 1.75$. On the other hand, strong memory effects in the dynamics of global average temperatures are attributed to the global cryosphere. We model the time series as a dynamical system perturbed by α-stable and fractional Gaussian noise, and develop an efficient testing method for the best fitting α or Hurst coefficient. The method is based on the observed power variations of the residuals of the time series. Their asymptotic behavior in case of α-stable noise is described by $\frac{\alpha}{p}$-stable processes, while in the fractional Gaussian case normal asymptotic behavior is observed for suitably renormalized approximations of the quadratic variation. (Joint work with J. Gairing, C. Hein, and C. Tudor.)

Sound-proof approximations for atmospheric flows—a three-scale problem lacking a limit equation

Rupert Klein
Freie Universität Berlin, Germany

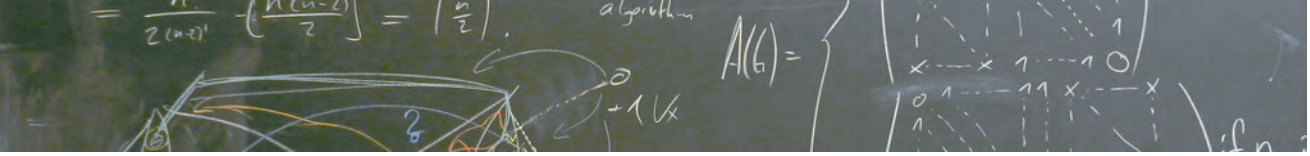
Air is a compressible medium. Yet, experience shows that sound waves play a negligible role in the vast majority of meteorologically relevant atmospheric processes. Nevertheless, the family of sound-proof flow models, which correspond to the incompressible or zero-Mach number approximations in engineering fluid mechanics, has met with severe scepticism from a large fraction of the meteorological community since they were first introduce many decades ago.

In this lecture I shall elucidate reasons for this scepticism, explain that a thorough analysis of nearly sound-free atmospheric flows involves a non-standard asymptotic three-scale problem, discuss formal estimates of the range of validity of available sound-proof models, and describe ongoing research aiming at an associated rigorous proof.

Extreme Value theory for dynamical systems

Tobias Kuna
University of Reading, England

In this talk we discuss the distribution of extreme events for dynamical systems for different classes of observables. In the last fifteen years the classical extreme value theory for stochastic



processes has been extended to dynamical systems. Extreme value theory is concerned with either the asymptotical distribution of running maxima or the asymptotic of over threshold events for large thresholds and the relation between these two. We shall review the aforementioned developments. Finally, we shall discuss the behaviour of high dimensional chaotic systems for observables which do not have their maximal value in the interior of the attractor. The latter is based on joint work with Valerio Lucarini, Davide Faranda and Jeroen Wouters.

Response and Fluctuations in Geophysical Fluid Dynamics

Valerio Lucarini
University of Hamburg, Germany
University of Reading, England

The climate is a complex, chaotic, non-equilibrium system featuring a limited horizon of predictability, variability on a vast range of temporal and spatial scales, instabilities resulting into energy transformations, and mixing and dissipative processes resulting into entropy production. Despite great progresses, we still do not have a complete theory of climate dynamics able to encompass instabilities, equilibration processes, and response to changing parameters of the system. We shall outline some possible applications of the response theory developed by Ruelle for non-equilibrium statistical mechanical systems, showing how it allows for setting on firm ground and on a coherent framework concepts like climate sensitivity, climate response, and climate tipping points. We shall show results for comprehensive global circulation models. The results are promising in terms of suggesting new ways for approaching the problem of climate change prediction and for using more efficiently the enormous amounts of data produced by modeling groups around the world.

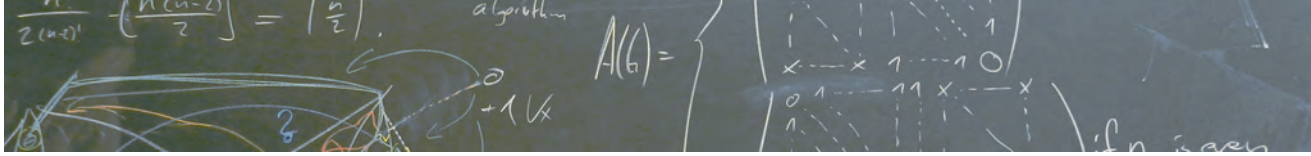
[1] V. Lucarini, R. Blender, C. Herbert, F. Ragone, S. Pascale, J. Wouters, Mathematical and Physical Ideas for Climate Science, Reviews of Geophysics 52, 809–859 (2014).

Covariant Lyapunov vectors of a quasi-geostrophic baroclinic model: analysis of instabilities and feedback

Sebastian Schubert
Max-Planck-Institut für Meteorologie, Germany

The classical approach for studying atmospheric variability is based on defining a background state and studying the linear stability of the small fluctuations around such a state. Weakly nonlinear theories can be constructed using higher order expansion terms. While these methods undoubtedly have great value for elucidating the relevant physical processes, they are unable to follow the dynamics of a turbulent atmosphere. We provide a first example of the extension of classical stability analysis to a nonlinearly evolving quasi-geostrophic flow. The so-called covariant Lyapunov vectors (CLVs) provide a covariant basis describing the directions of exponential expansion and decay of perturbations to the nonlinear trajectory of the flow. We use such a formalism to re-examine the basic barotropic and baroclinic processes of the atmosphere with a quasi-geostrophic beta-plane two-layer model in a periodic channel driven by a forced meridional temperature gradient ΔT. We explore three settings of ΔT, representative of relatively weak turbulence, well-developed turbulence and intermediate conditions.

We construct the Lorenz energy cycle for each CLV describing the energy exchanges with the background state. A positive baroclinic conversion rate is a necessary but not sufficient condition for instability. Barotropic instability is present only for a few very unstable CLVs for large values of ΔT. Slowly growing and decaying hydrodynamic Lyapunov modes closely mirror the properties of the background flow. Following the classical necessary conditions for barotropic/baroclinic instability, we find a clear relationship between the properties of the eddy fluxes of a CLV and its



instability. CLVs with positive baroclinic conversion seem to form a set of modes for constructing a reduced model of the atmospheric dynamics.

[1] S. Schubert, V. Lucarini (2015). Covariant Lyapunov vectors of a quasi-geostrophic baroclinic model: analysis of instabilities and feedbacks. to appear in: Quarterly Journal of the Royal Meteorological Society (doi:10.1002/qj.2588).

Chaos and predictability in geophysical flows

Stéphane Vannitsem
Royal Meteorological Institute of Belgium, Belgium

The predictability problem of the atmosphere and climate has been a central concern for decades since the discovery of the property of sensitivity to initial conditions in models based on the conservation laws for fluid flows. Nowadays, the short term predictability (up to 15 days) of the large-scale atmosphere is well understood. However new challenges are arising with the necessity to resolve convection-scale processes (short-time and kilometer scale) on one hand, and on the other hand, the necessity to produce decadal time-scale climate forecasts. In this talk, we review key results of the past analyses of the predictability of the atmosphere and the current challenges at both ends of the spatio-temporal spectrum associated with very short term high-resolution forecasts, and long-term climate predictions.

MS#22: Mathematics on the Web and Mathematical Knowledge Management

Organisatoren: Wolfram Sperber, Karlsruhe; Michael Kohlhase, Bremen

The subject is the presentation and processing of mathematical knowledge on the Web. New approaches and methods allow not only an adequate presentation but also automatic processing of mathematical knowledge. There are a lot of projects and developments regarding different aspects of mathematical information and communication:

1. presentation of mathematical knowledge, e.g., TEX, MathML, OpenMATH, and OMDOC;
2. creation and further development of information services, e.g., digital mathematics libraries, information services as the bibliographic database zbMATH and the software database swMATH, or of mathematical glossaries;
3. application of mathematics in industry and services.

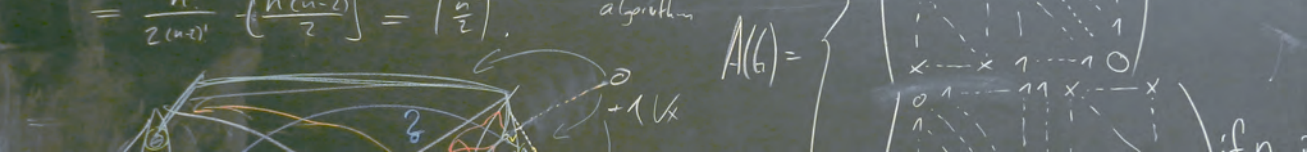
Moreover, the communication and workaday life is under permanent transformation by the digitization and the emergence of the Web.

Some recent trends and initiatives where German institutions are involved will be presented at the minisymposium.

What the OEIS can do for you and what you can do for the OEIS

Jörg Arndt
Technische Hochschule Nürnberg Georg Simon Ohm, Germany

The On-Line Encyclopedia of Integer Sequences (OEIS) is a collection of “mathematical fingerprints”, containing sequences from many areas of mathematics. I shall show how the OEIS can be a useful tool and give examples of interesting content and open problems posed. Stronger connections to other mathematical resources would be beneficial to the mathematical community.



Specifically, the many formulas contained in the OEIS should be made available for the formula search mechanism of the database zbMATH.

Mathematics software information: The swMATH service

Gert-Martin Greuel
Uni Kaiserslautern, Germany

Software is an emerging field of mathematical research and knowledge. The Open Access database swMATH (`http://www.swmath.org`) containing information about nearly 10.000 software packages is one of the most comprehensive information services on mathematical software. Its unique feature is the linking of software with publications which describe or apply the software. The publication-based approach allows to create and update information about the content and other features of mathematical software in an efficient semi-automatic way. Therefor, the information of the database swMATH are analysed systematically. swMATH is a project of the German research campus MODAL and will be provided by FIZ Karlsruhe. The talk gives an overview of the state of the art and planned developments of the swMATH service.

Was ist der neue Fachinformationsdienst Mathematik?

Katharina Habermann
Universität Göttingen, Deutschland

Mit einem neuen Förderprogramm stellt die DFG im Zeitraum 2013-2015 das System der Sondersammelgebiete auf *Fachinformationsdienste für die Wissenschaft* um. Seit Januar 2015 betreiben die SUB Göttingen und die TIB Hannover den „Fachinformationsdienst Mathematik“, welcher die bisherigen Sondersammelgebiete „Reine Mathematik“ an der SUB Göttingen und „Angewandte Mathematik“ an der TIB Hannover abgelöst hat. In diesem Vortrag soll erläutert werden, mit welchem Konzept beide Bibliotheken gemeinsamen an die Ausgestaltung des neuen Fachinformationsdienstes für die Mathematik gehen.

SMGloM: Towards a Semantic Terminology of Mathematics.

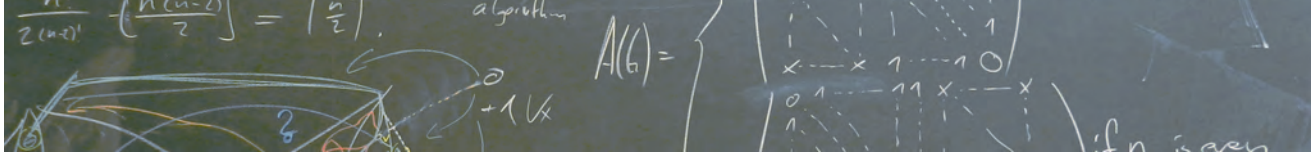
Michael Kohlhase
Jacobs University Bremen, Germany

Mathematical vernacular—the everyday language we use to communicate about mathematics is characterized by a special vocabulary. If we want to support humans with mathematical documents, we need a resource that captures the terminological, linguistic, and ontological aspects of the mathematical vocabulary. In the SMGloM project and system, we aim to do just this. We present the glossary system prototype, the content organization, and the envisioned community aspects.

Mathematical Theory Development via Theory Intersection Terminology of Mathematics.

Dennis Mueller
Jacobs University Bremen, Germany

One important driver of mathematical progress is the discovery of specific commonalities between structures, that allow for translating certain results in one to possibly novel results in the other. In fact, many theories—especially in the Bourbaki approach—are the result of extracting common principles of certain classes of structures, yielding, e.g., the well-known hierarchical collection of basic algebraic theories such as groups, lattices, rings or vector spaces, all connected with each



other by different translations, inclusions, reframings, etc. Consequently, it is a quite natural approach to see these as nodes in a theory graph and to look for useful operations extending it in an intuitive way; thus potentially giving rise to new interesting mathematical theories.

We shall discuss specifically the concept of theory intersections along partial views (as a formal analogue to the process described above) and their current implementations in MMT (a module system for mathematical theories). By theory intersection, we mean: given two theories S and T, we would like to find "interesting" (for some adequate definition of the word) partial mappings v from S to T, yielding a corresponding common subtheory of $v(S)$ and T. The actual question is consequently, how to find partial mappings between two given theories such, that the associated theory intersection becomes interesting.

MMT: A Foundation-Independent Approach to Formalized Mathematics

Florian Rabe
Jacobs University Bremen, Germany

The formalization and mechanical verification of mathematics in proof assistants is a growing trend in mathematics. However, current proof assistants employ incompatible logical foundations and libraries. This has the effect that all systems are mutually incompatible, and mathematical knowledge cannot be shared well across systems.

The MMT framework is a new approach aiming at overcoming this problem. MMT is a framework for representing logics, type theories, set theories, and similar languages in a uniform way. MMT achieves a high level of generality by systematically avoiding a commitment to a particular syntax or semantics. Instead, individual language features (e.g., function types, conjunction, etc.) are represented as reusable modules, which are composed into concrete languages. These modules can be declarative by specifying features as MMT theories or programmatic by providing individual rules as plugins.

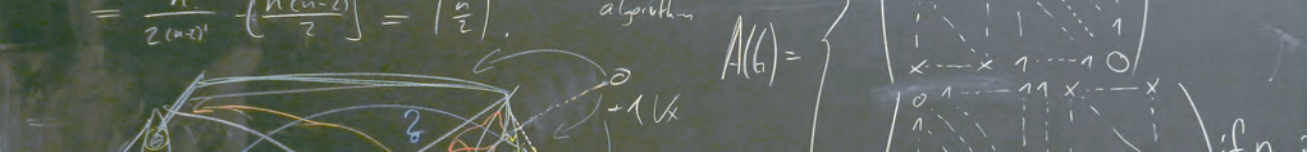
Despite this high degree of abstraction, it is possible to implement advanced algorithms generically at the MMT level. These include knowledge management algorithms (e.g, IDE, search, change management) as well as logical algorithms (e.g., parsing, type reconstruction, module system).

Thus, we can use MMT to obtain advanced implementations of logical languages at extremely low cost. Moreove, the resulting applications are very scalable and optimized for interoperability and knowledge sharing.

Author profiles and authorship disambiguation at zbMATH

Nicolas Roy
FIZ Karlsruhe/zbMATH, Germany

A solid and distinctive online record of a scientist's research achievements is nowadays almost inevitable to advance one's academic career. This necessitates a reliable presentation of a scientist's research achievements, in particular publications. However, authorship identification is a nontrivial problem for various reasons: author related data contained in a publication may be incomplete (abbreviated or missing name parts) or incorrect (typos or transliteration problems), or a given author may publish under different names. Author disambiguation is a challenge that can be taken up only with a proper mixture of identification algorithms and manual curation. One approach is trying to grab pieces of information everywhere, from any Internet service providing author profiles (like ORCID, MGP, ResearchGate, `Mathnet.ru`, ...). Through a reliable matching of the corresponding author profile, one can fetch biographical or bibliographical information which, in return, allows to extend and refine the authorship disambiguation of the given author profiles. The talk gives an overview of the recent developments in zbMATH, in the directions of algorithmic and manual disambiguation of author profiles. In particular, we shall present our



1-year-old graphical interface through which zbMATH users can have a direct impact on author profiles. We shall also discuss which linkings to and collaboration with other services zbMATH uses for its authorship disambiguation process.

Citing software: A proposal

Wolfram Sperber
FIZ Karlsruhe/zbMATH, Germany

Software citations in literature are typically sparse and contain often not more than the name of the software. This makes the identification of software references in publications difficult. Up to now, the swMATH information service (`http://www.swmath.org`) on mathematical software uses heuristic methods for identifying software citations in publications. A standard for software citations would really increase the visibility and a positive identification of the software. In the first part of the talk, the situation for software references is analyzed which differs from that of publications. Then, some proposals for standardizing software citations are presented.

Toward a Global Digital Mathematics Library: building connections between reviewing services, digital collections and formalized mathematics

Olaf Teschke
FIZ Karlsruhe/zbMATH, Germany

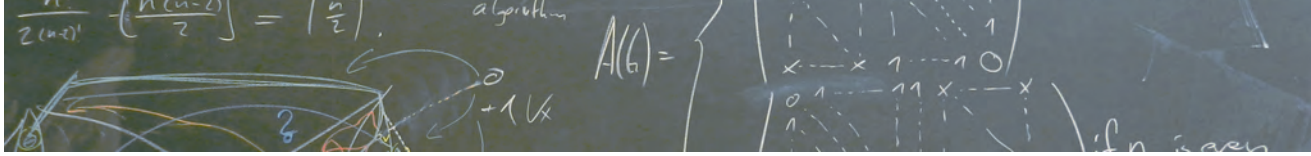
The specific features of mathematical information have led to an ecosystem of specialized services: reviewing databases like zbMATH, collections like EuDML, repositories of mathematical objects like the OEIS, or libraries of formalized mathematics. While they well-designed to solve the typical problems they have been build for, the 21st century challenge of building a global information system for mathematics is to build connections between them, thereby enhancing the value of each system considerably. We outline some approaches which currently take shape to achieve this goal.

MS#23: Moment Problems and Applications

In memory of Murray Angus Marshall (24 March 1940–1 May 2015).

Organisatoren: Maria Infusino, Konstanz; Salma Kuhlmann, Konstanz; Tobias Kuna, Reading

The moment problem is a multi-facet theory with connections not only to several branches of mathematics but also to numerous applied fields. Despite of the huge literature about the moment problem and its applications, this is far to be a static theory. Indeed, there are many unknown aspects of the problem and also many related questions arising from applied fields. These are interesting to be explored both for their contribution to the moment problem and for their impact on other kind of problems. The aim of this minisymposium is to present this two-way interaction existing between the moment problem and other areas such as probability theory, operator theory, statistical mechanics and polynomial optimization. Specifically the intention is to highlight some questions arising in applications which are naturally connected to the moment problem, to present how these questions can shed some light on the unsolved points in moment theory and, at the same time, to explain how the moment problem can serve the progress in such areas. In particular, many instances of the moment problem appearing in applications are posed in an infinite dimensional setting. Therefore, this minisymposium also represents a first encounter between the scientific community working on moment problems in finite dimensions and the one working in the infinite dimensional case. A deep interest for the interaction between the two communities has already



been shown during the Oberwolfach workshop in April 2014 (ID 1415). This minisymposium is a kickoff meeting in preparation for the next Oberwolfach workshop about this topic. For more information see the minisymposium webpage:

`http://www.math.uni-konstanz.de/~infusino/Minisymposium-DMV2015/home.html`

Some moment problems in one to infinite dimensions

Sergio Albeverio
Rheinische Friedrich-Wilhelms-Universität Bonn, Germany

We present some problems of the theory of the moment problem as related to infinite dimensional analysis, the theory of stochastic process and quantum (field) theory. Relations with spectral theory and some integrable systems are also discussed.

The operator theoretic moment problem

Sabine Burgdorf
Centrum voor Wiskunde en Informatica, The Netherlands

The moment problem has a direct application in polynomial optimization, where one wants to optimize the value a polynomial can attain over a given set. Several interesting problems in polynomial optimization turn out to be hard, but a suitable method to approximate these problems is the so-called Lasserre relaxation, i.e., one replaces positive polynomials by sums of squares. This results in a semidefinite program (SDP) which can be dualized via conic duality, resulting in an SDP where one optimizes over linear functionals. In this step the moment problem plays a crucial role: If the optimizing linear functional turns out to be a moment function, i.e., its moments are the moments of a positive measure, then the relaxation is actually exact and one obtains the optimal value of the original polynomial optimization problem.

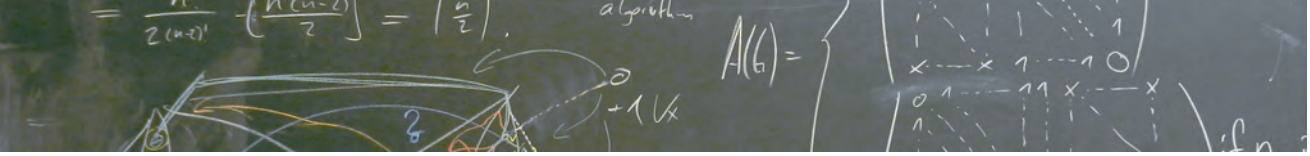
The classical moment problem for linear functionals on polynomials in commuting variables has a long and fruitful history, whereas the investigation of the moment problem in non-commuting variables is relatively new. The latter is closely related to operator theory and one can end up in possibly infinite-dimensional spaces. In this talk we shall introduce the non-commutative equivalent(s) of the moment problem and show how the theory can be applied to polynomial optimization problems arising in quantum theory.

A continuous moment problem for locally convex spaces

Maria Infusino
University of Konstanz, Germany
Murray A. Marshall†
University of Saskatchawan, Canada

This talk was supposed to be given by Murray A. Marshall who suddenly passed away on 1 May 2015 and is given in his memory.

It is explained how a locally convex (lc) topology τ on a real vector space V extends naturally to a locally multiplicatively convex (lmc) topology $\overline{\tau}$ on the symmetric algebra $S(V)$. This allows application of the results on lmc topological algebras obtained by Ghasemi, Kuhlmann and Marshall to obtain representations of $\overline{\tau}$-continuous linear functionals $L\colon S(V) \to \mathbb{R}$ satisfying $L(\sum S(V)^{2d}) \subseteq [0,\infty)$ (more generally, of $\overline{\tau}$-continuous linear functionals $L\colon S(V) \to \mathbb{R}$ satisfying $L(M) \subseteq [0,\infty)$ for some $2d$-power module M of $S(V)$) as integrals with respect to uniquely determined Radon measures μ supported by special sorts of closed balls in the dual space of V. The result is simultaneously more general and less general than the corresponding result of Berezansky,



Kondratiev and Šifrin. It is more general because V can be any locally convex topological space (not just a separable nuclear space), the result holds for arbitrary $2d$-powers (not just squares), and no assumptions of quasi-analyticity are required. It is less general because it is necessary to assume that $L\colon S(V) \to \mathbb{R}$ is $\overline{\tau}$-continuous (not just that L is continuous on the homogeneous parts of degree k of $S(V)$, for each $k \geq 0$). This is joint work with Mehdi Ghasemi and Salma Kuhlmann.

Multidimensional moment problems, the subnormal completion problem and cubature rules.

David Kimsey
Ben-Gurion University of the Negev, Israel

Given a positive integer t, a set $K \subseteq \mathbb{R}^d$ and a real multisequence $s = \{s_{\gamma_1,\ldots,\gamma_d}\}_{0\leq\gamma_1+\ldots+\gamma_d\leq m}$ we shall formulate new moment matrix conditions for s have a K-representing measure $\sigma = \sum_{q=1}^{t} \varrho_q \delta_{w_q}$ with t atoms, i.e.,

$$s_{\gamma_1,\ldots,\gamma_d} = \int_{\mathbb{R}^d} x_1^{\gamma_1} \cdots x_d^{\gamma_d} d\sigma(x_1,\ldots,x_d) \quad \text{for} \quad 0 \leq \gamma_1 + \ldots + \gamma_d \leq m$$

and

$$w_1, \ldots, w_t \in K.$$

Using these conditions, we shall establish new minimal inside cubature rules for planar measures in $\mathbb{R}^2$ and also pose a solution to the subnormal completion problem in d variables, i.e., given a collection of positive numbers $\mathcal{C} = \{\alpha_{(\gamma}^{(1)}, \ldots, \alpha_{\gamma)}^{(d)}\}_{0\leq|\gamma|\leq m}$ we wish to determine whether or not $\mathcal{C}$ gives rise to a d-variable subnormal weighted shift operator whose initial weights are given by $\mathcal{C}$. We shall also highlight recent results for a full moment problem in a countably infinite number of variables and briefly discuss an application to stochastic processes. This talk is partially based on joint work with Daniel Alpay and Palle Jorgensen.

Multidimensional moment problem on the sphere and application to cubature formulas on the sphere

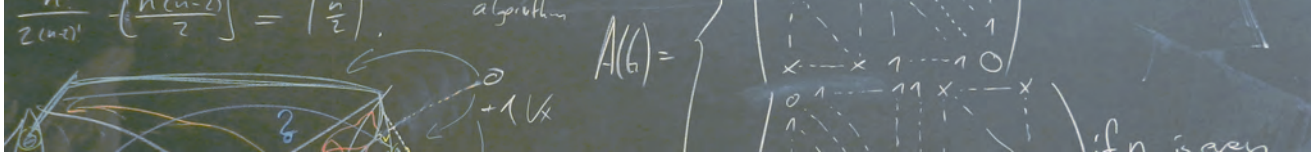
Ognyan Kounchev
Bulgarian Academy of Sciences, Bulgaria
IZKS University of Bonn, Germany

A recent breakthrough was the discovery that the spherical polynomials have an Almansi type representation. Hence, one may follow the framework of the multidimensional moment problem developed in previous works for the euclidean space (arXiv: 0509380) and (arXiv:0802.0023). We formulate the full moment problem on the sphere S^n, and define also the truncated moment problem. We provide a solution for the truncated pseudo-positive moment problem. As a by-product we discover new cubature formulas on the sphere. The remarkable thing is that the new cubature method satisfies the classical criterion for weak* convergence of Osgood, Vitali, Lebesgue, Pólya, and Banach. This is joint work with Hermann Render.

Moment Closure—A Brief Review

Christian Kuehn
Vienna University of Technology, Austria

Moment closure methods appear in myriad scientific disciplines in the modelling of complex systems. The goal is to achievea closed form of a large, usually even infinite, set of coupled differential



(or difference) equations. Each equation describes the evolution of one moment, a suitable coarse-grained quantity computablefrom the full state space. If the system is too large for analytical and/or numerical methods, then one aims to reduce it by finding a moment closure. In this talk, we focus on highlighting how moment closure methods occur in different contexts. We also conjecture via a geometric explanation why it has been difficult to rigorously justify many moment closure approximations although they work very well in practice.

A moment problem for random discrete measures

Eugene Lytvynov
Swansea University, Wales

Let X be a locally compact Polish space. A random measure on X is a probability measure on the space of all (nonnegative) Radon measures on X. Denote by $\mathbb{K}(X)$ the cone of all Radon measures η on X which are of the form $\eta = \sum_i s_i \delta_{x_i}$, where, for each i, $s_i > 0$ and δ_{x_i} is the Dirac measure at $x_i \in X$. A random discrete measure on X is a probability measure on $\mathbb{K}(X)$. The main result of the talk states a necessary and sufficient condition (conditional upon a mild *a priori* bound) when a random measure μ is also a random discrete measure. This condition is formulated solely in terms of moments of the random measure μ. Classical examples of random discrete measures are completely random measures and additive subordinators, however, the main result holds independently of any independence property. As a corollary, a characterisation via moments is given when a random measure is a point process. This is joint work with Yuri Kondratiev and Tobias Kuna.

New upper bounds for the density of translative packings of superspheres

Frank Vallentin
Universität zu Köln, Germany

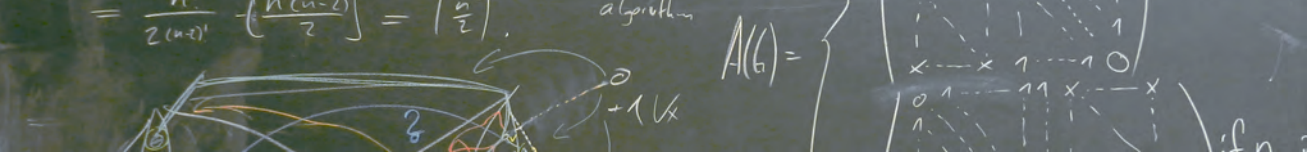
In this talk I shall present new upper bounds for the maximum density of translative packings of superspheres in three dimensions (unit balls for the l^p-norm). This will give some strong indications that the lattice packings experimentally found in 2009 by Jiao, Stillinger, and Torquato are indeed optimal among all translative packings. We apply the linear programming bound of Cohn and Elkies which originally was designed for the classical problem of packings of round spheres. The proof of our new upper bounds is computational and rigorous. Our main technical contribution is the use of invariant theory of pseudo-reflection groups in polynomial optimization. This is joint work with Maria Dostert, Cristobál Guzmán, and Fernando Mário de Oliveira Filho.

MS#24: Motivic Homotopy Theory and its application to problems in Algebra and Algebraic Geometry

Organisatoren: Marc Levine, Essen; Philip Herrmann, Hamburg

The initial breakthrough leading to the creation of the subject of motivic homotopy theory was the construction by Morel-Voevodsky of new versions of a stable homotopy category, which brought the "classical" versions from homotopy theory together with inputs from algebraic geometry and enabled one for the first time to work with the basic material of algebraic geometry, solutions of polynomial equations, with the flexibility and power previously only available in homotopy theory.

Voevodsky used these homotopical methods in his proof of the celebrated Milnor conjecture, and motivic homotopy theory played an even more central role in his contribution to the proof of the Bloch-Kato conjecture, the successful culmination of thirty years of intensive research.



Besides these quite spectacular applications, the fact that one could now use the ideas and methods of homotopy theory to solve problems in algebraic geometry has drawn in mathematicians from both fields and has led to a wealth of new constructions and applications. This mini-symposium intends to bring together experts working in current problems in motivic homotopy theory and its application to problems in algebra and algebraic geometry to promote the interaction and exchange of expertise between the different research directions and to profit from and contribute to these interactions.

Operations in derived Witt theory

Alexey Ananyevskiy
Saint Petersburg State University, Russia

Derived Witt theory introduced by Paul Balmer immerses Witt groups of schemes into the realm of generalized cohomology theories providing a family of shifted Witt groups. These groups have some crucial basic properties similar to the ones of topological K-theory of real vector bundles with inverted 2: besides the fact that they are based on vector bundles equipped with a nondegenerate bilinear form, these groups are 4-periodic with the periodicity realized via multiplication by Bott element and the coefficients are concentrated in the 0 mod 4 degrees. Derived Witt theory is representable in the motivic stable homotopy category, and as I shall show in the talk its algebras of stable operations and cooperations with rational coefficients have the same structure as in the case of topological K-theory of real vector bundles. In particular, rational stable operations are given by the values on the powers of Bott element. As an application one obtains a rational degeneration of a Brown-Gersten type spectral sequence for derived Witt theory. These results are inspired by the joint work with Ivan Panin and Marc Levine on motivic Serre's finiteness theorem.

Algebraizing topological vector bundles

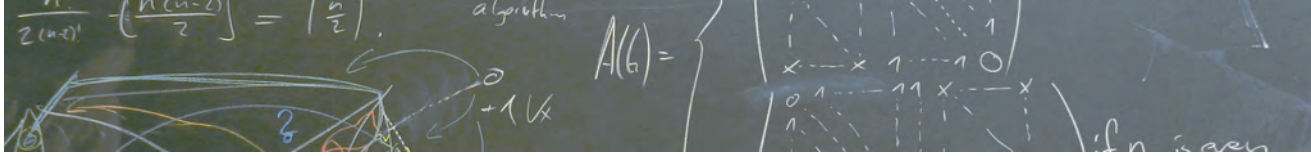
Aravind Asok
University of Southern California, United States of America

I shall discuss the question of when a topological complex vector bundle on a smooth complex variety admits an algebraic structure. A necessary condition for algebraizability is that the topological Chern classes of the bundle must be algebraic (i.e., they must lie in the image of the cycle class map from Chow groups to integral cohomology). A folk conjecture (that arguably can be attribute to P. Griffiths) states that if a topological complex vector bundle on a smooth complex affine variety has algebraic Chern classes, then it admits an algebraic structure. This conjecture is known to be true for varieties of dimension ≤ 3. I shall explain joint work with Jean Fasel and Mike Hopkins that shows that the conjecture is false for $n \geq 4$. In particular, we shall construct a new obstruction to algebraizability for rank 2 vector bundes on smooth affine 4-folds and give an example of a smooth complex affine 4-fold that carries topological vector bundles with algebraic Chern classes yet for which this obstruction is non-zero.

Cohomological detection of complete intersections

Jean Fasel
Institut Fourier, France

Let k be a field and X a smooth affine variety over k. If $Z \subseteq X$ is a closed subvariety equipped with a trivialization of its conormal bundle, then we shall give cohomological criteria for Z to be a complete intersection in X. Along the way, we shall compare the Euler class groups as defined by Nori, Bhatwadekar and Sridharan with the Chow-Witt groups introduced by Barge and Morel and give a conditional answer to a conjecture of Murthy. Our method relies on the geometry of smooth split quadrics.



Étale descent for algebraic K-theory

Niko Naumann
University of Regensburg, Germany

In pioneering work, Thomason showed that Bott-inverted algebraic K-theory with finite coefficients admits étale descent. We present an entirely different proof of a slightly weaker result which relies crucially on the E_∞-structure of algebraic K-theory and which generalizes to derived algebraic geometry. This is joint work with Akhil Mathew and Justin Noel.

A^1-contractibility of Koras-Russell threefolds

Paul Arne Østvær
University of Oslo, Norway

Finite suspensions of Koras-Russell threefolds are contractible in A^1-homotopy theory.

Quadratic spaces and algebraic cobordisms

Ivan Panin
Steklov Mathematical Institute at Saint Petersburg, Russia

Let R be a regular local ring, K its field of fractions and (V, φ) a quadratic space over R. In the case of R containing a field of characteristic zero we show that if $(V, \varphi) \otimes_R K$ is isotropic over K, then (V, φ) is isotropic over R. This solves the characteristic zero case of a question raised by J.-L. Colliot-Thélène. The proof is based on a moving lemma in algebraic cobordism of Levine-Morel.

Algebraic K-theory of motivic spaces

Oliver Röndigs
Universität Osnabrück, Germany

Waldhausen's algebraic K-theory machine can be applied to suitable categories appearing in motivic homotopy theory. The talk will discuss some properties of the resulting homotopy types. For example, the path components will be related to the Grothendieck ring of varieties.

Integral Tate Motives and Fundamental Groups

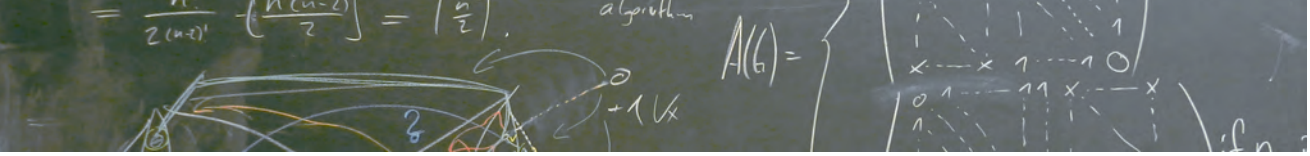
Markus Spitzweck
Universität Osnabrück, Germany

We shall discuss abelian categories of Mixed Tate Motives over arithmetic base schemes satisfying the Beilinson-Soule vanishing Conjecture. They arise as heart of a t-structure on integral triangulated Tate Motives. This t-structure restricts to a t-structure on compact objects, giving rise to an abelian category of integral Tate Motives of finite type. Finally we address integral geometric fundamental groups whose representations model Tate Motives.

A^1-h-cobordism and A^1-weak equivalence of projective line bundles

Matthias Wendt
University of Warwick, England
Universität Duisburg-Essen, Germany

In the talk, I shall outline the results of joint work with Aravind Asok and Stefan Kebekus in which we compared the A^1-homotopy and A^1-h-cobordism classification of projectivizations of



rank two vector bundles on the projective plane. Over algebraically closed fields of characteristic not 2, the A^1-homotopy classification is "classical", everything is determined by characteristic classes. The A^1-h-cobordism classification of projective line bundles is somehow related to moduli spaces of rank two vector bundles, which leads to some subtleties. For topologically split bundles, A^1-h-cobordism and A^1-weak equivalence of bundles agree, while in the other cases the A^1-h-cobordism classification is still unknown.

MS#25: Numerical Methods in Dynamical Systems

Organisatoren: Peter Giesl, Brighton; Sigurdur Hafstein, Reykjavik

Dynamical systems, given by differential equations or iteration of maps, are a central modeling tool in physics, biology, chemistry, economics, weather forecast, cancer research and many more. Dynamical systems are interested in qualitative statements about solutions. In particular, the long-time behavior of solutions with different initial values is of fundamental importance. They can be characterized by the stability of invariant sets, the basin of attraction of (local) attractors or chaos. Depending on parameters, fundamental changes in their behavior can be studied by bifurcation. A further area of interest is non-autonomous systems, which can exhibit even more complicated dynamics and require new definitions and methods for their analysis.

Many analytical tools have been developed for the study and analysis of dynamical systems. However, since the first studies of chaos by Lorenz, numerical methods have played a prominent role within Dynamical Systems. They have been used to study and describe dynamical systems and their use ranges from simulations of specific systems to their rigorous analysis. For example, the construction of Lyapunov functions to study basins of attraction has been an active area of research over the last decades [2]. Set-valued methods have been used to study invariant sets and dynamics [1] and have been incorporated into the computer package GAIO.

The type of numerical methods employed includes as different methods as collocation to solve linear PDEs, approximation of functions in Reproducing Kernel Hilbert Spaces, set-valued methods, graph theoretical methods, and methods that use linear programs, linear matrix inequalities and convex optimization techniques. The minisymposium will present a range of these numerical methods and will facilitate the exchange between the different methods. This will lead to fruitful collaborations to combine various methods, or to generalize existing methods to new problems in dynamical systems.

[1] M. Dellnitz and O. Junge. Set oriented numerical methods for dynamical systems. In: Handbook of dynamical systems, Vol. 2, North-Holland, Amsterdam, 221–264, 2002.

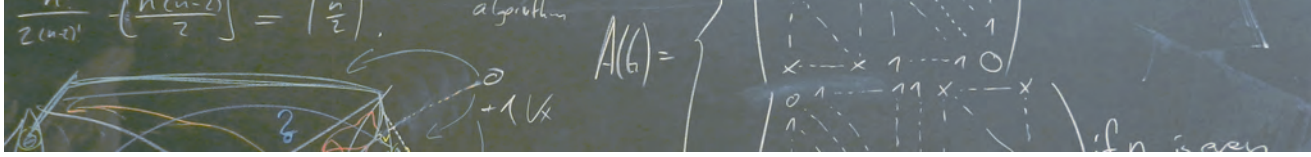
[2] P. Giesl and S. Hafstein. Review on Computational methods for Lyapunov functions. Discrete Contin. Syst. Ser. B 20(8):2291–2331 (2015).

Control Lyapunov Functions Computed Via Mixed Integer Linear Programming

Robert Baier
University of Bayreuth, Germany

An algorithm for computing control Lyapunov functions for nonlinear affine, asymptotically controllable systems is presented. It is based on a simplicial triangulation and the ansatz with continuous, piecewise affine (CPA) functions. Due to the missing regularity of the ansatz functions nonsmooth versions of the weak infinitesimal decrease condition of the control Lyapunov function using subdifferentials have to be used.

The characterizing conditions for a CPA control Lyapunov function are stated in all vertices of the triangulation and lead to a mixed integer linear optimization problem in which the values of



the CPA function can be computed. By incorporating error bounds on this CPA interpolation the calculated CPA function is a control Lyapunov function and not an approximate one.

A first numerical example, problems with the decay condition formulated with Clarke's subdifferential and possible improvements are discussed.

Constructing continuous piecewise-affine Lyapunov functions for continuous-time dynamical systems with multiple attractors

Jóhann Björnsson
Reykjavik University, Iceland

In this talk we present a graph-theoretical method to approximate local attractors for continuous-time dynamical systems, and consequently use a Massera-like construction in order to construct a continuous piecewise-affine (CPA) function on a simplicial complex, which approximates a Lyapunov function for the system. We present some sufficient conditions for such a CPA functions to be an actual Lyapunov function for a given system, and finally we give some examples.

Computation and verification of Lyapunov functions

Peter Giesl
University of Sussex, England

Lyapunov functions are an important tool to determine the basin of attraction of equilibria in Dynamical Systems through their sublevel sets. Recently, several numerical construction methods for Lyapunov functions have been proposed, among them the RBF (Radial Basis Function) and CPA (Continuous Piecewise Affine) methods. While the first method, in its original form, does not include a verification that the constructed function is a valid Lyapunov function, the second method is rigorous, but computationally much more demanding.

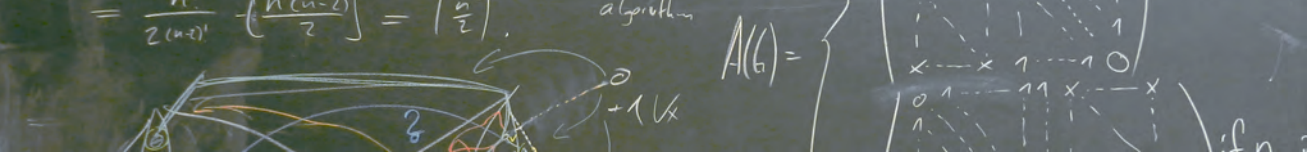
In this talk, we propose a combination of these two methods, using their respective strengths: we use the RBF method to compute a Lyapunov function. Then we interpolate this function by a continuous piecewise affine (CPA) function. Checking a finite number of inequalities, we are able to verify that this interpolation is a Lyapunov function. Moreover, sublevel sets are arbitrarily close to the basin of attraction. This is joint work with Sigurður Hafstein (Reykjavik University, Iceland).

Triangulation Transformations in $\mathbb{R}^n$ and their Preservation of Non-Degeneracy

Skúli Guðmundsson
Reykjavik University, Iceland

Simplicial triangulations of $\mathbb{R}^n$ have a wide range of applications. Of particular interest to us, is using a triangulation to facilitate the introduction of so-called *continuous and piecewise-affine* (CPA) functions for their use in the numerical generation of Lyapunov functions for dynamical systems.

Using a standardized triangulation with the $\mathbb{Z}^n$ lattice its vertices, we consider a class of transformations which distribute the vertices in a desired way, maintaining certain symmetry properties around the origin. A new family of simplices is generated as follows: For each simplex in the original triangulation, a new convex combination of the *mapped* vertices is generated. We are interested in examining when this new family of simplices represents a proper simplicial triangulation. Furthermore, we prove that not only is the new triangulation proper for our transformation, but its simplices also remain non-degenerate in a sense which is particularly meaningful for our application.



Computation of ISS Lyapunov functions for nonlinear systems

Sigurður Hafstein
Reykjavik University, Iceland

Input-to-state-stability is a measure of robustness of the stability of an attractor in dynamical systems. Recently, the CPA method to compute Lyapunov functions for nonlinear systems using linear programming was adapted to computing ISS Lyapunov functions. We shall discuss this new algorithm.

A contour algorithm for computing stable fiber bundles of nonautonomous, noninvertible maps

Thorsten Hüls
University of Bielefeld, Germany

Stable fiber bundles are the nonautonomous analog of stable manifolds and these objects provide valuable information on the underlying dynamics. We propose an algorithm for their approximation that is based on computing zero contours of a particular operator.

The resulting program applies to a wide class of models, including noninvertible and nonautonomous discrete time systems. Precise error estimates are provided and fiber bundles are computed for several examples.

Adaptive dynamic programming using radial basis functions

Oliver Junge
Technische Universität München, Germany

Recently, a numerical scheme for the dynamic programming problem has been proposed which is based on approximations by radial basis functions in combination with a least squares projection type approach. In this talk, we extend this method by adaptively choosing the basis functions' centers. We show convergence of this scheme for vanishing fill distance and present several numerical examples.

Coherent Families: Spectral Theory for Transfer Operators in Continuous Time

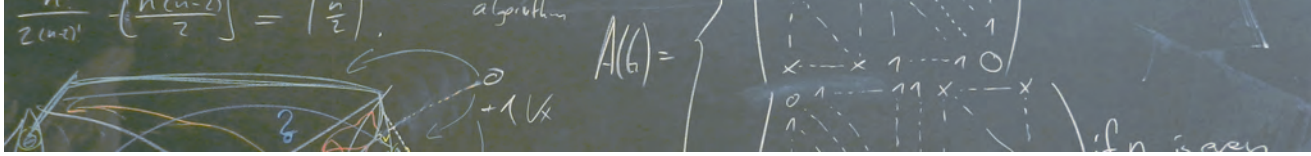
Péter Koltai
Freie Universität Berlin, Germany

The decomposition of the state space of a dynamical system into metastable or almost-invariant sets is important for understanding macroscopic behavior. This concept is well understood for autonomous dynamical systems, and has recently been generalized to non-autonomous systems via the notion of coherent sets. We elaborate here on the theory of coherent sets in continuous time for periodically-driven flows and describe a numerical method to find periodic families of coherent sets without trajectory integration.

Verification Estimates for Lyapunov Functions constructed by Radial Basis Functions

Nalja Mohammed
University of Sussex, England

Lyapunov functions are functions whose orbital derivative is negative. They play a significant role in the stability analysis of equilibrium points of non-linear systems, since sublevel sets of a Lyapunov function are subsets of the domain of attraction of an equilibrium. However, construct-



ing such functions is a challenging task. One of the numerical methods to construct Lyapunov functions is the RBF (Radial Basis Function) method.

We present two verification estimates to check the negativity of the orbital derivative of Lyapunov functions constructed by this method. The proposed estimates specify the density of the grid points in a given compact set, where we have to examine the sign of the constructed Lyapunov function which will in turn indicate the efficiency of the function.

Computing Barriers of Ordinary Differential Equations

Stefan Ratschan
Czech Academy of Sciences, Czech Republic

Given an ordinary differential equation, a set of initial states, and a set of states considered to be unsafe, a barrier is positively invariant set that contains the set of initial states but does not contain any unsafe state. Hence the existence of a barrier certifies that no unsafe state is reachable from an initial state. Classical techniques for computing global information for dynamical systems are interval methods and set-oriented numerics. In the talk, we shall present a method for computing barriers that tries to combine the advantages of both approaches, together with first numerical experiments.

Towards the Approximation of Stochastic Lyapunov Functions

Florian Rupp
German University of Technology in Oman, Sultanate of Oman

Based on the deterministic radial basis interpolation method and the sums of square decomposition we discuss the construction of Lyapunov functions for asymptotically stable equilibria in dynamical systems generated by random and stochastic differential equations.

Approximation of Lyapunov Functions from Data

Kevin Webster
Imperial College, England
Potsdam Institute for Climate Impact Research (PIK), Germany

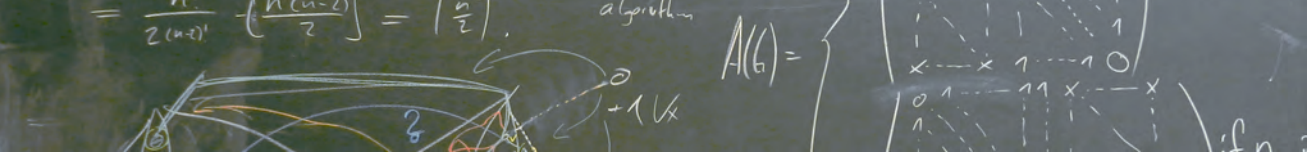
Methods have previously been developed for the approximation of Lyapunov functions using radial basis functions. However these methods assume knowledge of the evolution equations. We consider the problem of approximating a given Lyapunov function using radial basis functions where the evolution equations are not known, but instead we have sampled data which is contaminated with noise. Our approach is to first approximate the underlying vector field, and use this approximation to then approximate the Lyapunov function. Our approach combines elements of machine learning/statistical learning theory with the existing theory of Lyapunov function approximation. Error estimates are provided for our algorithm.

MS#26: Octonion algebras, their norms and subspaces

Organisatoren: Markus Stroppel, Stuttgart; Norbert Knarr, Stuttgart

Isometry types of subspaces in octonion algebras play their role in areas such as

1. classical groups generated by suitable sets of multiplications by octonions,
2. homomorphisms between such classical groups (which may belong to different series of algebraic groups),



3. anisotropic forms of algebraic groups,
4. related Tits buildings,
5. subalgebras and related geometries (e.g., Clifford parallelisms),
6. isomorphisms and automorphisms of octonion algebras.

The space of Clifford parallelisms over octonions

Andrea Blunck
Universität Hamburg, Germany

The classical right (or left) Clifford parallelism in real projective 3-space can be described by using Hamilton's quaternions. Analogously, an octonion division algebra O over a field F gives rise to a right (or left) Clifford parallelism of lines in $\mathrm{PG}(7,F)$. However, in contrast to the quaternion case, here the parallelism depends on the choice of a base point.

More exactly, there is a 1–1 correspondence between the point set of $\mathrm{PG}(7,F)$ and the set Π^+ of all right Clifford parallelisms in $\mathrm{PG}(7,F)$. We show that this bijection can be seen as an isomorphism of point-line geometries $\mathrm{PG}(7,F) \to (\Pi^+, \mathcal{C}^+, \ni)$, where $\mathcal{C}^+$ is the set of all parallel classes of all right Clifford parallelisms. A similar result holds for the left Clifford parallelisms.

The spaces of Clifford parallelisms can also be interpreted on the hyperbolic quadric in $\mathrm{PG}(7,E)$ given by the split octonions over a quadratic extension E/F contained in O.

Octonions and Symmetric Spaces

Jost-Hinrich Eschenburg
Universität Augsburg, Germany

There are two types of compact symmetric spaces (other than Lie groups): the classical ones which come in 7 infinite series, and the 12 exceptional ones. Classical symmetric spaces are just Grassmannians $\mathbf{G}_k(\mathbb{K}^n)$ over the real, complex and quaternion numbers ($\mathbb{K} = \mathbb{R}, \mathbb{C}, \mathbb{H}$) and further spaces of self-reflective subspaces of Grassmannians (fixed spaces of certain involutions); e.g., $\mathrm{O}_{2n}/\mathrm{U}_n = \{\mathbb{C}\mathrm{P}^{n-1} \subset \mathbf{G}_2(\mathbb{R}^{2n})\}$ = the set of all subspaces congruent to $\mathbb{C}\mathrm{P}^{n-1} \subset \mathbf{G}_2(\mathbb{R}^{2n})$. The 12 exceptional spaces should be somehow related to the octonions $\mathbb{K} = \mathbb{O}$, but the relation is still not fully understood. Among these spaces the role of the Grassmannians is played by the so called Rosenfeld planes of dimension 16, 32, 64, 128; all others are spaces of reflective subspaces. Boris Rosenfeld (around 1956) tried to describe these spaces as projective planes over $\mathbb{O} \otimes \mathbb{K}$ for $\mathbb{K} = \mathbb{R}, \mathbb{C}, \mathbb{H}, \mathbb{O}$, but his attempt failed. However, there are several reasons for a tight relation between the Rosenfeld planes and projective planes:

(1) the isotropy representation is the (slightly enlarged) spin representation on $(\mathbb{O} \otimes \mathbb{K})^2$,

(2) there is Vinberg's infinitesimal description in terms of 3×3 matrices over $\mathbb{O} \otimes \mathbb{K}$,

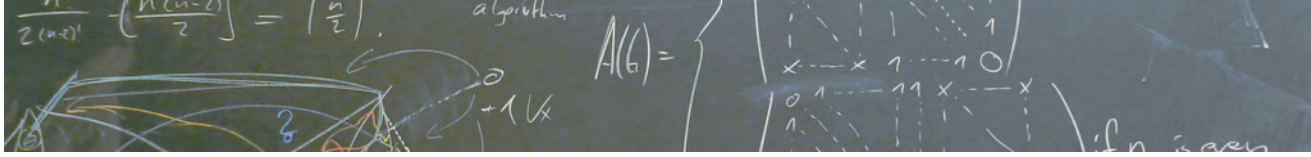
(3) there are "projective lines".

The "projective lines" are certain self-reflective submanifolds joining any two points in the Rosenfeld planes, but they are not always unique. In the talk I would like to report mainly about ongoing work on (1) and (2).

Groups of similitudes generated by octonions

Norbert Knarr
Universität Stuttgart, Germany

Let V be a subspace of an octonion division algebra over a field F. We investigate the group generated by all left multiplications by non-trivial elements of V. Using the autotopism group



and the principle of triality, we get conclusive results for subspaces of sufficiently high rank which either contain the identity or are contained in the space of pure octonions. This yields a new approach to some of the isomorphisms between classical groups of low rank, in particular in the anisotropic case.

Octonion geometries in the Freudenthal-Tits Magic Square

Hendrik Van Maldeghem
Universiteit Gent, Belgium

The sevgeometries in the last row and the last column of the Freudenthal-Tits Magic Square are all connected with (octonion) Cayley-Dickson algebras. We discuss some features of these connections.

Octonions from a Clifford Algebra point of view

Karsten Naert
Universiteit Gent, Belgium

Throughout the literature, there are many equivalent descriptions of octonion algebras, in particular octonions are: (1) composition algebras, described by the Cayley-Dickson doubling process; (2) related to vector cross products, frequently described by the 'Fano plane mnemonic'; (3) related to a trilinear form in 7 dimensions; (4) constructible from root systems of type G_2 as in the classification of semi-simple complex Lie algebras.

We shall connect these constructions in a very concrete way, using an associated Clifford algebra and corresponding contraction operators. This point of view provides good insight into the structure of the Lie algebras and groups of type G_2 (both split and anisotropic) while shunning long computations. In particular it helps us understand why certain exceptional behaviour arises in characteristics 3 (twisted Ree groups "${}^2G_2$") and 7.

Degenerate Cayley-Dickson algebras

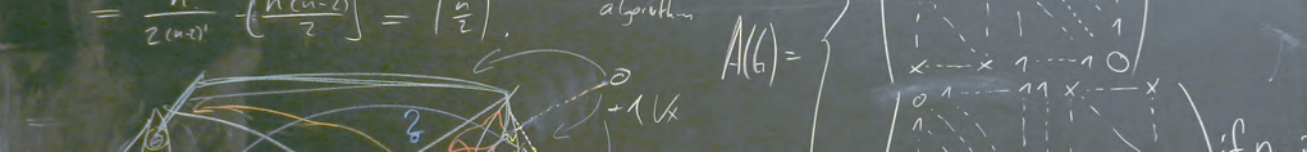
Anneleen De Schepper
Universiteit Gent, Belgium

Quadratic alternative algebras are connected with the geometries of the Freudenthal-Tits Magic Square. Traditionally, there is a split and a nonsplit version of this square, and for the first column, these two version coincide. We discuss a possibility to introduce "degenerate" versions of the Magic Square that connect the split with the nonsplit version. This would turn the square into a triangular prism: the i-th column would admit $2i-1$ different versions, and hence the last column would correspond to 7 different non-associative but possibly degenerate Cayley-Dickson algebras. The corresponding geometries are projective remoteness planes.

MS#27: Optimal Control of Nonlinear PDEs

Organisatoren: Eduardo Casas, Santander; Fredi Tröltzsch, Berlin

The focus of this minisymposium is analysis and numerics of optimal control problems with partial differential equations as state equation. Special emphasis will be laid on nonlinear equations, but also new results on problems with linear equations are welcome. Contributions are expected that extend the theory in the following directions: Error analysis for numerical approximations of optimal control problems, convergence of numerical optimization methods for solving PDE constrained



control problems, numerical analysis for new applications in this field, extensions of the theory of necessary and sufficient optimality conditions, sparse optimal control and measure control.

Error Estimates for the Approximation of the Velocity Tracking Problem with Bang-Bang Controls

Eduardo Casas
University of Cantabria, Spain

In this talk we consider an optimal control problem of the evolutionary Navier-Stokes system in two spatial dimensions. The control is distributed and submitted to bound constraints. The cost is the tracking functional, but it does not include the Tikhonov's regularization term. The numerical approximation of this problem is considered. The lack of coercivity of the cost functional in the control variable makes the analysis more complicated in several aspects. First, the sufficient second order optimality conditions, which are the main tool for the error estimates, are not the standard ones. Second, the strong convergence of the optimal controls for the numerical discretization approximation is not clear at all. This convergence can be proved for bang-bang optimal controls. In this case, we prove some error estimates for the difference between the discrete and the continuous optimal states.

Stability estimates of discontinuous Galerkin schemes for the Allen-Cahn equation and applications to optimal control.

Konstantinos Chrysafinos
National Technical University of Athens, Greece

Fully-discrete approximations of the Allen-Cahn equation are considered. In particular, we analyze a discontinuous Galerkin (in time) approach combined with standard conforming finite elements (in space), and we prove that these schemes are unconditionally stable under minimal regularity assumptions on the given data. Stability estimates in the natural energy norms are proved using an appropriate duality argument, combined with a boot-strap technique. Great care is exercised in order to quantify the dependence upon $1/\varepsilon$ of various constants appearing in these estimates. In particular, the polynomial dependence upon $1/\varepsilon$ is demonstrated. The applicability of our estimates in a optimal control setting is also demonstrated.

Preconditioned Solution of Nonlinear Optimal Control Problems by Trust-Region SQP Methods

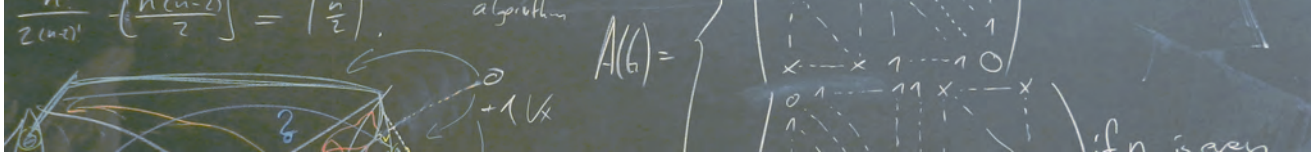
Roland Herzog
Technische Universität Chemnitz, Germany

We address the solution of nonlinear optimal control problems by sequential quadratic programming (SQP) methods in function space. A composite-step trust-region framwork is employed for globalization. In each substep, a quadratic programming problem needs to be solved, possibly subject to a trust-region constraint. We discuss the efficient solution of those problems by tailored preconditioned Krylov subspace methods in function space. Numerical results will be included.

Global minima of semilinear optimal control problems

Michael Hinze
Universität Hamburg, Germany

We present a simple criterion which allows to decide whether a semilinear optimal control problem admits a unique global solution. For the discretized problem this criterium can be checked



exactly. We present several numerical examples with unique global solutions. This is joint work with Ahmad Ali (Hamburg) and Klaus Deckelnick (Magdeburg).

On internal exponential stabilization to a nonstationary solution for 1D Burgers equation

Axel Kröner
INRIA Saclay and CMAP, Ecole Polytechnique, France

The feedback stabilization of the Burgers system to a nonstationary solution using finite-dimensional internal controls is considered. Estimates for the dimension of the controller are derived. In the particular case of no constraint on the support of the control a better estimate is derived and the possibility of getting an analogous estimate for the general case is discussed; some numerical examples are presented illustrating the stabilizing effect of the feedback control. This is joint work with Sergio S. Rodrigues.

On an optimal control problem governed by a regularized phase field fracture propagation model

Ira Neitzel
Technische Universität München, Germany

We consider an optimal control problem governed by a phase-field fracture model. One challenge of this model problem is a non-differentiable irreversibility condition on the fracture growth, which we relax using a penalization approach. We then discuss existence of a solution to the penalized fracture model, existence of at least one solution for the regularized optimal control problem, as well as first order optimality conditions. This is joint work with Thomas Wick and Winnifried Wollner.

A parallel space-time multigrid method for parabolic optimal control problems

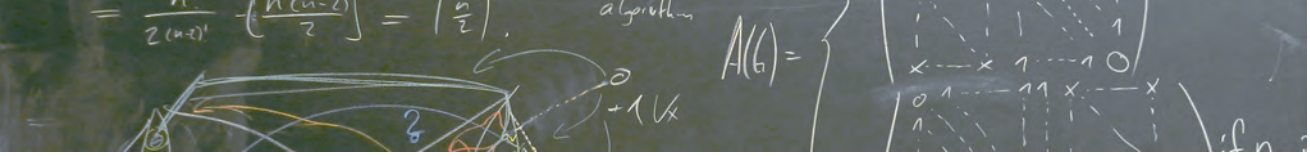
Martin Neumüller
Johannes Kepler University, Austria

We present and analyze a new space-time parallel multigrid method for optimal control problems with parabolic equations as constraints. The method is based on arbitrarily high order discontinuous Galerkin discretizations in time, and a finite element discretization in space. The key ingredient of the new algorithm is an inexact block Jacobi smoother. By using local Fourier mode analysis we determine asymptotically optimal smoothing parameters, a precise criterion for semi-coarsening in time or full coarsening, and give an asymptotic two grid contraction factor estimate. We then explain how to implement the new multigrid algorithm in parallel, and show with numerical experiments its excellent strong and weak scalability properties.

Optimal Control of a Chemotaxis System

Arnd Rösch
Universität Duisburg-Essen, Germany

Chemotaxis describes a biological phenomenon of self organization and pattern forming of cell populations caused by chemical substances. It can be modelled by a two component reaction diffusion system in which the equations are coupled by a quasilinear cross-diffusion term. In this talk, we consider an optimal control problem with Neumann boundary control for the chemoattractant. This is joint work with Hendrik Feldhordt and Michael Winkler.



On the optimal control of wave-type solutions in some reaction-diffusion equations

Christopher Ryll
Technische Universität Berlin, Germany

We investigate optimal control problems for some reaction diffusion equations, where patterns of traveling wave fronts, impulses, spiral waves, and other phenomena appear. In particular, we discuss the consideration of pointwise state constraints. We derive first-order necessary optimality conditions for the associated control problem and present various numerical examples.

Optimal Control of Electromagnetic Fields in Multiply Connected Conductors

Fredi Tröltzsch
Technische Universität Berlin, Germany

The optimal control of low-frequency electromagnetic fields is considered in a time-harmonic setting. For the state equation, a non-standard H-based formulation of the equations of electromagnetism is used for multiply connected conductors. The magnetic field H in the conductor is obtained from an elliptic equation with the $\operatorname{curl}\sigma^{-1}\operatorname{curl}$-operator, while the $\operatorname{div}\mu\nabla$-operator is set up for a potential in the isolator. Both equations are coupled by interface conditions. The control is the electrical current in the conducting domain. In particular, the problem of sparse optimal control is sketched. This is joint work with Alberto Valli, University of Trento.

Exponential convergence of hp-finite element discretization of optimal boundary control problems with elliptic partial differential equations

Daniel Wachsmuth
University of Würzburg, Germany

We investigate the numerical solution of a boundary control problem with elliptic partial differential equation by the hp-finite element method. We prove exponential convergence with respect to the number of unknowns for an a priori chosen discretization. Here, we have to prove that derivatives of arbitrary order of the solution are in suitably chosen weighted Sobolev spaces. Numerical experiments confirm the theoretical findings.

MS#28: Polytopes, Algebra & Statistics

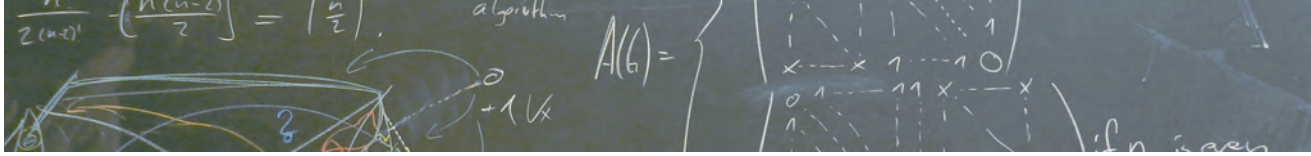
Organisatoren: Christian Haase, Berlin; Thomas Kahle, Magdeburg

This minisymposium is concerned with applications of polyhedral geometry and (commutative) algebra to statistics. The connection between these fields builds on foundational work of Diaconis and Sturmfels as well as Pistone, Riccomagno, and Wynn. In the last 15 years related work has been gathered under the name *algebraic statistics*. The minisymposium will be a forum to connect researchers working in algebraic statistics and also allow interested mathematicians to get involved.

Circuit Diameters

Steffen Borgwardt
Technische Universität München, Germany
University of California at Davis, United States of America

The study of the combinatorial diameter of polyhedra is a classical open problem in the theory of linear optimization. In a new approach to this field, we introduce a hierarchy of so-called circuit diameters, which generalize the combinatorial diameter and provide lower bounds on it.



In contrast to traditional edge walks, circuit walks take steps along potential edge directions, so in particular they can walk through the interior of a polyhedron. We examine the structure of this hierarchy in detail, prove similarities and differences between the many diameter notions, and exhibit for which of these classes the Hirsch conjecture bound holds and for which it is open. Finally, we turn to some classes of polyhedra to highlight the insight gained from these studies.

Circuit Diameter II—Circuits in Optimization

Elisabeth Finhold
University of California at Davis, United States of America

In this talk we continue our investigation of circuit diameters. We show the potential of augmentation along circuits as an approach for solving optimization problems. Thereto we study families of polyhedra whose circuit diameter is much lower than their combinatorial diameter, which indicates the possible benefits of circuit algorithms compared to the Simplex method. We further demonstrate that several well-known efficient algorithms actually are circuit augmentation algorithms.

Recovering Newton polytopes from tropical hypersurfacse

Anders Jensen
Aarhus Universitet, Denmark

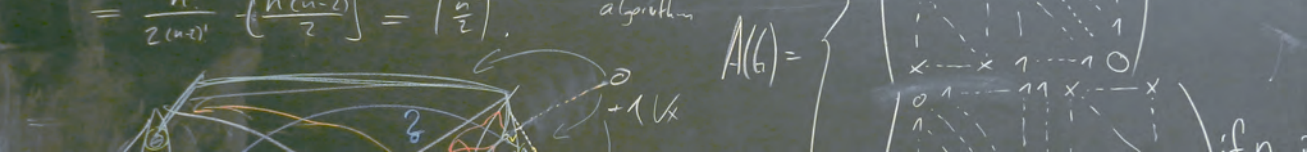
In the article *An Implicitization Challenge for Binary Factor Analysis*, Tobis, Cueto and Yu computed the Newton polytope of the defining equation of a certain statistical model. The model is obtained by marginalising two variables in the undirected graphical model of the complete bipartite graph $K_{2,4}$. The result, a polytope in 16-dimensional space with 17,214,912 vertices, was computed with "ray shooting" and the beneath-beyond method for vertex-facet conversion of polytopes. In this talk I present a more efficient method, namely an output sensitive geometric algorithm for recovering tropical polynomials from their tropical hypersurfaces. This algorithm arose in the study of tropical resultants. This is joint work with Josephine Yu.

Semialgebraic geometry of nonnegative and psd rank

Kaie Kubjas
Aalto University, Finland

One of many definitions gives the rank of an $m \times n$ matrix M as the smallest natural number r such that M can be factorized as AB, where A and B are $m \times r$ and $r \times n$ matrices, respectively. In many applications, we are interested in factorizations of a particular form. For example, factorizations with nonnegative entries define the nonnegative rank and are closely related to mixture models in statistics. Another rank I shall consider in my talk is the positive semidefinite (psd) rank.

Both nonnegative and psd rank have geometric characterizations using nested polytopes. I shall explain how to use these characterizations to derive a semialgebraic description of the set of matrices of nonnegative/psd rank at most r in some small cases, and to study boundaries of this set. The talk is based on joint work with Rob H. Eggermont, Emil Horobet, Elina Robeva, Richard Z. Robinson, and Bernd Sturmfels.



Graphical models for random networks

Steffen Lauritzen
University of Copenhagen, Denmark

We consider models for random networks that are *exchangeable* in the sense that the distribution $P_{\mathcal{N}}$ of the network is invariant under relabeling of the nodeset $\mathcal{N}$. In particular we study exchangeable random networks that are *extendable* in the sense that $P_{\mathcal{N}}$ is the marginal distribution of larger exchangeable random network with nodeset $\mathcal{N}'$.

The set $\mathcal{P}_{\mathcal{N}}$ of exchangeable distributions is a polytope and corners represent distributions that are uniform over isomorphism classes. Similarly the set of extendable distributions $\mathcal{P}_{\mathcal{N}}^{\mathcal{N}'}$ is a polytope sitting inside $\mathcal{P}_{\mathcal{N}}$. When the size of $\mathcal{N}'$ tends to infinity, the limit $\mathcal{P}_{\mathcal{N}}^{\infty}$ is a simplex where the extreme points are *dissociated*, so that presence of non-incident edges are independent, hence satisfying the bidirected Markov property w. r. t. the *line graph* of the complete graph on $\mathcal{N}$.

We shall study the convex sets above and explain the connection to marginal binary independence models [4], de Finetti theorems for exchangeable arrays [1], [3], [2], and the theory of graphons and graph limits [5], as well the consequences for estimation of pararameters of random networks. The lecture is based on joint work with Alessandro Rinaldo and Kayvan Sadeghi.

[1] Aldous, D. (1981). Representations for partially exchangeable random variables. Journal of Multivariate Analysis, 11:581–598.

[2] Aldous, D. (1985). Exchangeability and related topics. In Hennequin, P., editor, École d'Été de Probabilités de Saint–Flour XIII, 1983, pages 1–198. Springer-Verlag, Heidelberg. Lecture Notes in Mathematics 1117.

[3] Diaconis, P. and Freedman, D. (1981). On the statistics of vision: the Julesz conjecture. Journal of Mathematical Psychology, 24:112–138.

[4] Drton, M. and Richardson, T. S. (2008). Binary models for marginal independence. Journal of the Royal Statistical Society Series B, 70(2):287–309.

[5] Lovász, L. and Szegedy, B. (2006). Limits of dense graph sequences. J. Combin. Theory Ser. B, 96(6):933–957.

MS#29: Qualitative Aspects of Nonlinear Partial Differential Equations

Organisatoren: Christoph Walker, Hannover; Joachim Escher, Hannover

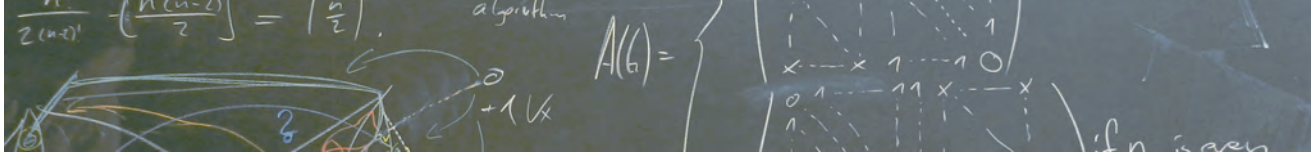
This minisymposium offers the possibility to present new developments and recent research on qualitative aspects of nonlinear partial differential equations. It particularly addresses young scientists in this field. Topics include bifurcation phenomena and stability investigations for parabolic equations, regularity of solutions to free boundary problems, and geometrical evolutions equations.

Minimising a relaxed Willmore functional for graphs subject to Dirichlet boundary condition

Hans-Christoph Grunau
Otto-von-Guericke-Universität Magdeburg, Germany

For a bounded smooth domain $\Omega \subset \mathbb{R}^2$ and a smooth boundary datum $\varphi\colon \overline{\Omega} \to \mathbb{R}$ we consider the minimisation of the Willmore functional

$$W(u) := \frac{1}{4} \int_\Omega H^2 \, \sqrt{1 + |\nabla u|^2} \, dx$$



for graphs $u : \overline{\Omega} \to \mathbb{R}$ with mean curvature $H := \operatorname{div}\left(\frac{\nabla u}{\sqrt{1+|\nabla u|^2}}\right)$ subject to Dirichlet boundary conditions, i.e., in the class

$$\mathcal{M} := \{u \in H^2(\Omega) : (u - \varphi) \in H_0^2(\Omega)\}.$$

Making use of a celebrated result by L. Simon [3] we first show that *in this class*, bounds for the Willmore energy imply area and diameter bounds. Examples show that stronger bounds in terms of the Willmore energy are not available. This means that $\mathrm{L}^\infty \cap \mathrm{BV}(\Omega)$ is the natural solution class where, however, the original Willmore functional is not defined. So, we need to consider its L^1-lower semicontinuous relaxation. Our main result states that this relaxation coincides on $\mathcal{M}$ with the original Willmorefunctional so that the relaxed functional is indeed its largest possible L^1-lower semicontinuous extension to $\mathrm{BV}(\Omega)$. Moreover, finiteness of the relaxed energy encodes attainment of the Dirichlet boundary conditions in a suitable sense. Finally, weobtain theexistence of a minimiser in $\mathrm{L}^\infty \cap \mathrm{BV}(\Omega)$ for the relaxed/extended energy. The major benefit of our non-parametric approach is the validity of a-priori diameter and area bounds, which are not available in the general setting of R. Schätzle's work [2]. On the other hand we need to leave open most of the regularity issues. (This joint work with Klaus Deckelnick (Magdeburg) and Matthias Röger (Technische Universität Dortmund).)

[1] Klaus Deckelnick, Hans-Christoph Grunau, Matthias Röger, Minimising a relaxed Willmore functional for graphs subject toboundary conditions, Preprint 2015, arxiv:1503.01275.

[2] Reiner Schätzle, The Willmore boundary problem, Calc. Var. Partial Differential Equations, 37, 275–302,2010.

[3] Leon Simon,Existence of surfaces minimizing the Willmore functional, Comm. Anal. Geom. 1, 281–326, 1993.

On qualitative properties of solutions to microelectromechanical systems with general Permittivity

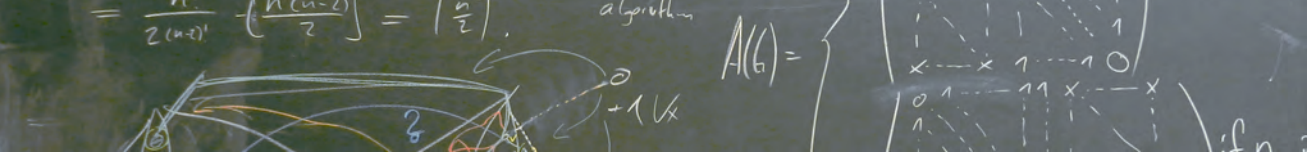
Christina Lienstromberg
Leibniz Universität Hannover, Germany

Qualitative properties of solutions to the evolution problem modeling microelectromechanical systems with general permittivity profile are investigated. The system couples a parabolic evolution problem for the displacement of a membrane with an elliptic free boundary value problem for the electric potential in the region between the membrane and a rigid ground plate. Conditions are specified which ensure the non-positivity of the membrane's displacement. Moreover, assuming to have a non-positive displacement, it is shown that the solution develops a singularity after a finite time of existence.

Variational modeling and analysis of a Stokes-Osmosis problem

Friedrich Lippoth
Leibniz Universität Hannover, Germany

Within the framework of variational modeling we derive a two-phase moving boundary problem that describes the motion of a semipermeable membrane separating two viscous liquids in a fixed container. The model includes the effects of osmotic pressure and surface tension of the membrane. For this problem we prove the existence of classical solutions for a short time. Moreover, we show that the manifold of steady states is locally exponentially attractive.



On the parabolicity of the Muskat problem

Bogdan Matioc
Leibniz Universität Hannover, Germany

The Muskat problem is a moving boundary problem describing the evolution of two immiscible layers of Newtonian fluids with different densities and viscosities, for example oil and water, in a porous medium under the influence of surface tension effects and/or gravity. This problem has been studied in the last two decades by many mathematicians, the methods employed being various.

We show that in the absence of surface tension effects the Rayleigh-Taylor sign condition identifies a domain of parabolicity for the Muskat problem. When allowing for surface tension effects, the Muskat problem is of parabolic type for general initial and boundary data. The parabolicity property is used to establish the well-posed of the problem and to study the stability properties of equilibria. Based on joint papers with Joachim Escher, Anca Matioc, Christoph Walker.

Dynamics of a fluid model for tokamak plasma

Jens D. M. Rademacher
Universität Bremen, Germany

Tokamaks are a promising design of fusion reactors and the analysis of model equations poses a number of challenges. For a simplified two-fluid description of an idealized tokamak plasma some basic experimental findings can be recovered. We view high and low temperature components of the electron velocity distribution as miscible phases and account for nonlinear effect by drift only. Then the global attractor for large temperature difference is a confined, laminar steady state, which destabilises for low temperature difference and viscosity. Stable spatio-temporal oscillations in the form of travelling waves bifurcate and a number of secondary bifurcations off the laminar state occur. Numerically, we find secondary bifurcations along the branches, which yield complex dynamics and intricate bifurcation scenarios. This is joint work with Delyan Zhelyasov (L'Aquila) and Daniel Han-Kwan (Palaiseau).

Flow of micromagnetic complex fluids

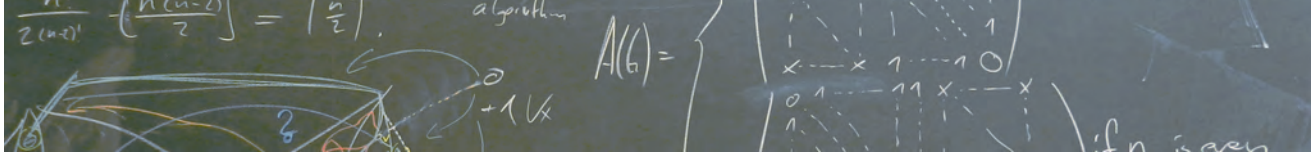
Anja Schlömerkemper
University of Würzburg, Germany

Magnetic materials have the special property that they react to applied external fields in remarkable ways and have therefore many technological applications. They can not only be found in medical applications, but, for example, also in loud speakers and shock absorbers.

We propose a model for micromagnetic materials in the framework of complex fluids. The system of PDEs to model the flow of the material is derived in a continuum mechanical setting from variational principles including the least action principle and the maximum dissipation principle. We outline this process of modeling and the energetic variational approach. Moreover, we highlight the coupling between the elastic and the magnetic properties of the material.

The obtained model reflects most of the phenomena represented in micromagnetic fluids but, on the other hand, is rather complex. Therefore, we provide also a simplified version of the model that is amenable for analysis but applies only to some particular flow regimes. As an illustration, we shall concentrate on the two dimensional case where an explicit ansatz for the solution of the magnetization can be found. With this ansatz we simplify the model even further and show existence of weak solutions.

This is joint work with Johannes Forster (Institute for Mathematics, University of Würzburg, Germany), Carlos García-Cervera (Mathematics Department, University of California, Santa Bar-



bara, United States of America), and Chun Liu (Department of Mathematics, Penn State University, University Park, United States of America).

Three-Dimensional Solitary Water Waves with Weak Surface Tension

Erik Wahlén
Lund University, Sweden

I shall discuss a variational existence theory for three-dimensional fully localised solitary water waves with weak surface tension. The water is modelled as a perfect fluid of finite depth, undergoing irrotational flow. The surface tension is assumed to be weak in the sense that $0 < B < 1/3$, where B is the Bond number. A fully localised solitary wave is a travelling wave which decays to the undisturbed state of the water in every horizontal direction. Such solutions are constructed by minimising a certain nonlocal functional on its natural constraint. A key ingredient is a variational reduction method, which reduces the problem to a perturbation of the Davey-Stewartson equation.

Mathematical challenges arising in the analysis of chemotaxis-fluid interaction

Michael Winkler
Universität Paderborn, Germany

We consider models for the spatio-temporal evolution of populations of microorganisms, moving in an incopressible fluid, which are able to partially orient their motion along gradients of a chemical signal. According to modeling approaches accounting for the mutual interaction of the swimming cells and the surrounding fluid, we study parabolic chemotaxis systems coupled to the (Navier-)Stokes equations through transport and buoyancy-induced forces.

The presentation discusses mathematical challenges encountered even in the context of basic issues such as questions concerning global existence and boundedness, and attempts to illustrate this by reviewing some recent developments. A particular focus will be on strategies toward achieving a priori estimates which provide information sufficient not only for the construction of solutions, but also for some qualitative analysis.

MS#30: Random Discrete Structures and Processes

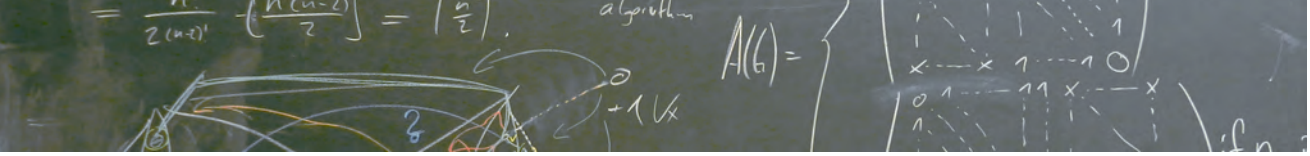
Organisatoren: Konstantinos Panagiotou, München; Yury Person, Frankfurt

Random discrete structures and processes have been investigated systematically since the 60's, when Erdős and Rényi published their seminal paper about random graphs. From today's viewpoint, random structures have remained an influential area of studies not only in Mathematics, but also in Theoretical Computer Science and in Statistical Physics. This session will focus on recent advances in the study of various properties of random discrete structures and modern developments. This meeting aims at bringing together researchers in German speaking countries and neighbouring countries as well. We shall also invite younger researchers to present their results.

Random Sub-Critical Graph Classes

Michael Drmota
Technische Universität Wien, Austria

Sub-critical graph classes are special block-stable graph classes that are defined by an analytic condition on their generating functions. However, they appear quite frequently as minor closed graph classes. For example, series-parallel graphs ($\mathrm{Ex}(K_4)$) or outerplanar graphs ($\mathrm{Ex}(K_4, K_{2,3})$)



are sub-critical and in general it is conjectured that a minor closed graph class is sub-critial if at least one of the excluded minors is planar. In particular it is known that planar graphs $\mathrm{Ex}(K_5, K_{3,3})$ are not sub-critical.

During the last few years random sub-critical graph classes have been intensively studied and many characteristics (degree distribution, maximum degree, maximum block, scaling limit etc.) have been characterized. The purpose of this talk is to give a survey of these results and to present also new ones (for example on the size of maximal independent sets or on a central limit theorem for subgraph counts).

A phase transition on the evolution of bootstrap percolation processes on preferential attachment graphs

Nikolaos Fountoulakis
University of Birmingham, England

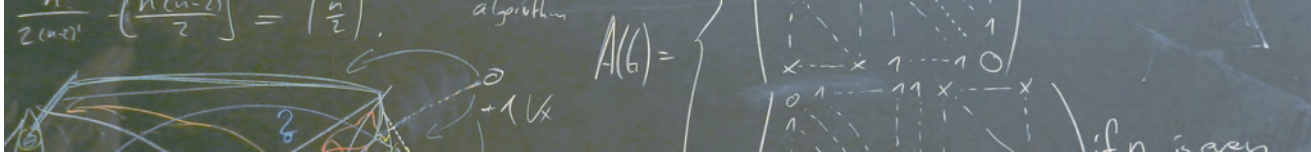
In this talk, we shall consider bootstrap percolation processes on random graphs generated by preferential attachment. This is a class of processes where vertices have two states: they are either infected or susceptible. At each round every susceptible vertex which has at least r infected neighbours becomes infected and remains so forever. Assume that initially $a(t)$ vertices are randomly infected, where t is the total number of vertices of the graph. Suppose also that $r < m$, where 2m is the average degree. We determine a critical function $a_c(t)$ such that when $a(t) >> a_c(t)$ complete infection occurs with high probability as t grows, but when $a(t) << a_c(t)$, then with high probability the process evolves only for a bounded number of rounds and the final set of infected vertices is asymptotically equal to $a(t)$. This is joint work with Mohammed Abdullah (Huawei Labs, Paris).

Almost-spanning universality in random graphs

Nemanja Skoric
ETH Zürich, Switzerland

A graph G is said to be $H(N, \Delta)$-universal if it contains a copy of every graph on N vertices with maximum degree at most Δ. Determining the threshold for the property that a typical graph $G \sim G(n, p)$ is $H(N, \Delta)$-universal is an intriguing question in the theory of random graphs, with two most common scenarios being $N = n$ (spanning subgraphs) and $N = (1-\varepsilon)n$ (almost-spanning subgraphs). A result of Alon, Capalbo, Kohayakawa, Rödl, Ruciński and Szemerédi shows that for $N = (1 - \varepsilon)n$ it suffices to take $p \geq (\log n/n)^{1/\Delta}$. This was further improved by Dellamonica, Kohayakawa, Rödl and Ruciński, who showed that for the same value of p one can take N to be as large as n. On the other hand, the only known lower bound on the threshold for these two properties is of order $n^{-2/(\Delta+1)}$. It is worth noting that even for the simpler property of containing a single (arbitrary) spanning graph $H \in H(n, \Delta)$, no better bound on p is known (result of Alon and Füredi).

We make a step towards closing this gap. In particular, we bypass a natural barrier of $p \geq (\log n/n)^{1/\Delta}$ by showing that, in the case $\Delta \geq 3$, a typical graph $G \sim G(n, p)$ is $H((1 - \varepsilon)n, \Delta)$-universal for $p \geq n^{-1/(\Delta-1)} \log^5 n$. This determines, up to the logarithmic factor, the asymptotic value of the threshold in case $\Delta = 3$. (Joint work with David Conlon, Asaf Ferber and Rajko Nenadov.)



Scaling limits of unlabelled trees

Benedikt Stufler
University of Munich, Germany

The continuum random tree (CRT) was constructed by David Aldous in the early nineties and plays a major role in the study of typical metric properties of large random trees and graphs. We show that the model "all unlabelled unrooted trees with n vertices and vertex degrees in a fixed set equally likely" admits the CRT as a scaling limit. This confirms a long-standing conjecture by Aldous and completes the now long list of families of random discrete objects converging towards the CRT. Our approach is based on the cycle-pointing method, a combinatorial technique developed by Bodirsky, Fusy, Kang and Vigerske.

On the method of typical bounded differences

Lutz Warnke
University of Cambridge, England

Concentration inequalities are fundamental tools in probabilistic combinatorics and theoretical computer science for proving that functions of random variables are typically near their means. Of particular importance is the case where $f(X)$ is a function of independent random variables $X = (X_1, \dots, X_n)$. Here the well-known *bounded differences inequality* (also called McDiarmid's or Hoeffding-Azuma inequality) establishes sharp concentration if the function f does not depend too much on any of the variables. One attractive feature is that it relies on a very simple Lipschitz condition (L): it suffices to show that $|f(X) - f(X')| \leq c_k$ whenever X, X' differ only in X_k. While this is easy to check, the main disadvantage is that it considers *worst-case* changes c_k, which often makes the resulting bounds too weak to be useful.

In this talk we discuss a variant of the bounded differences inequality which can be used to establish concentration of functions $f(X)$ where (i) the *typical* changes are small although (ii) the worst case changes might be very large. One key aspect of this inequality is that it relies on a simple condition that (a) is easy to check and (b) coincides with heuristic considerations as to why concentration should hold. Indeed, given an event Γ that holds with very high probability, we essentially relax the Lipschitz condition (L) to situations where Γ occurs. The point is that the resulting *typical* changes c_k are often much smaller than the worst case ones.

If time permits, we shall illustrate its application by considering the reverse H-free process, where H is 2-balanced. We prove that the final number of edges in this process is concentrated, and also determine its likely value up to constant factors. This answers a question of Bollobás and Erdős.

MS#31: Recent Trends in the Arithmetic of Automorphic Forms

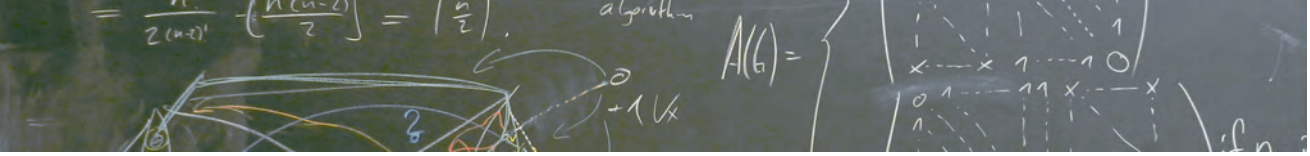
Organisatoren: Jens Funke, Durham; Ian Kiming, Copenhagen

The symposium will review the latest developments in the arithmetic of automorphic forms, in particular modular forms.

Harmonic Maass forms, periods and CM values

Claudia Alfes
Technische Universität Darmstadt, Germany

In this talk we present two applications of the theory of harmonic Maass forms. We explain how half-integer weight harmonic Maass forms serve as "generating series" for traces of CM values



of integer weight harmonic Maass forms. This generalizes work by Zagier on the traces of the modular j-function.

Moreover, we show that there are special harmonic Maass form related to elliptic curves. Certain periods of these forms encode the vanishing of the central L-derivatives of the Hasse-Weil zeta function of E.

A combinatorial approach to classical modular forms inspired by multiple zeta values

Henrik Bachmann
Universität Hamburg, Germany

Modular forms for the full modular group are the first and easiest examples of automorphic forms. They are given by holomorphic functions in the upper half-plane possessing a Fourier expansion (q-series) whose coefficients are of arithmetical interest. Using complex analysis one can prove a lot of relations between these functions which then yield relations between their Fourier coefficients. In this talk we want to discuss a purely combinatorial approach to prove such relations, without using any complex analysis, which was inspired by the theory of multiple zeta values. Multiple zeta values are generalizations of the classical Riemann zeta values appearing in different areas of mathematics and theoretical physics. There are a lot of Q-linear relations between these real numbers which are called double shuffle relations. The goal of this talk is to introduce a space of certain q-series which has the modular forms as a subspace and whose algebraic structure is similar to the one of multiple zeta values. We shall see that these q-series also fulfill a variation of the double shuffle relations which then enables us to recover well-known relations of modular forms in a purely combinatorial way.

Classes of Heegner divisors and traces of singular moduli

Jan Hendrik Bruinier
Technische Universität Darmstadt, Germany

In parallel to the Gross-Kohnen-Zagier theorem, Zagier proved that the traces of the values of the j-function at CM points are the coefficients of a weakly holomorphic modular form of weight 3/2. Later this result was generalized in different directions and also put in the context of the theta correspondence. We recall these results and report on some newer aspects.

Kronecker limit type formulae and regularized determinants

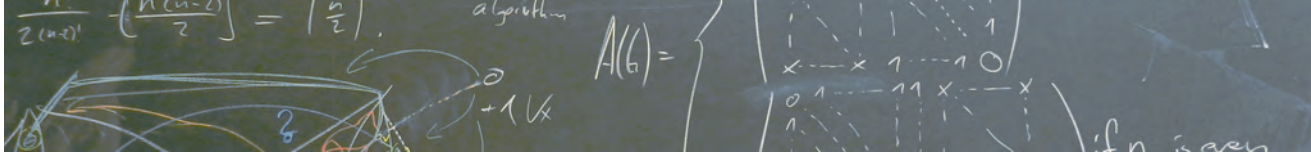
Anna v. Pippich
Technische Universität Darmstadt, Germany

The classical Kronecker limit formula describes the derivative at $s = 0$ of the non-holomorphic Eisenstein series for the modular group in terms of the Dedekind Delta function. In our talk, we shall first recall how this formula can be used to compute the regularized determinant of the Laplacian on an elliptic curve. Then, we shall discuss recent results for hyperbolic Riemann surfaces.

The hyperbolic circle problem

Morten S. Risager
University of Copenhagen, Denmark

We review the hyperbolic circle problem and explain some recent results concerning the error term. We also explain how these results relate to L-functions of certain automorphic forms.



CM values of regularized theta lifts over totally real fields.

Maryna Viazovska
Humboldt-Universität zu Berlin, Germany

Discovery of regularized theta lifts made by Harvey-Moore and Borcherds lead to many advances in physics and number theory. For a long time such regularized theta lifts where known only for dual reductive pairs $(\mathrm{SL}_2, \mathrm{O}(V))$, where V is a rational quadratic space. Recently, J. Bruinier has defined regularized theta lifts from SL_2 to orthogonal groups over totally real fields. In this talk we shall analyze CM values of such theta lifts.

MS#32: Set Theory

Organisatoren: Yurii Khomskii, Hamburg; Alexander C. Block, Hamburg; Hugo Nobrega, Amsterdam

Set theory is the study of the foundations of mathematics, and lies at the intersection of logic, philosophy, topology, analysis and other fields of pure mathematics. The field has undergone dramatic changes in the latter half of the 20th century, with new developments in forcing, large cardinals and descriptive set theory that led to unexpected progress, the resolution of long-standing open problems such as the Continuum Hypothesis, and the motivation of a search for new axioms of infinity. Moreover, in recent years set theory has seen a rise in applications and interactions with other fields of mathematics, ranging from algebraic topology to graph theory.

This mini-symposium will bring together a small group of researchers in set theory from Germany and abroad, covering a wide variety of topics including forcing, large cardinals, inner model theory, descriptive set theory and applications to topology.

This mini-symposium is supported by the *Deutsche Vereinigung für Mathematische Logik und für Grundlagenforschung der exakten Wissenschaften* (DVMLG).

Y-c.c. and Y-proper posets

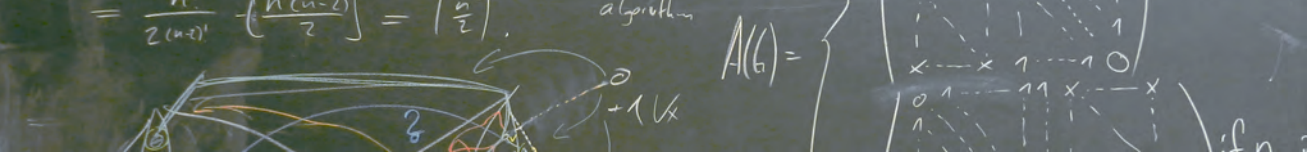
David Chodounsky
Czech Academy of Sciences, Czech Republic

I shall introduce two new classes of forcing notions, which are intermediate between σ-centered and c.c.c., and strongly proper and proper, respectively. Forcings in these classes have nice and interesting properties, including not adding random reals, not adding uncountable anti-cliques in open graphs, the ω_1 approximation property, iterability, and other properties. Many classical forcing notions fall into these newly defined classes. This is joint work with Jindrich Zapletal.

Generic I0 at $\aleph_\omega$

Vincenzo Dimonte
Universität Wien, Austria

It is common practice to consider the generic version of large cardinals defined with an elementary embedding, but what happens when such cardinals are really large? The talk will concern a form of generic I0 and the consequences of this extravagant hypothesis on the "largeness" of the power set of $\aleph_\omega$. This research is a result of discussions with Hugh Woodin.



On the width of wqos

Mirna Džamonja
University of East Anglia, England

Well quasi orders, a "frequently discovered concept" to quote Kruskal, are of immense importance in combinatorial set theory and logic in general, including computer sciences. One can associate several different ordinal-valued ranks to such orders and in general, they are well understood. With one exception, that of the rank of the tree of incomparable sequences, called the width. We have studied this rank in joint work with Schmitz and Schnoebellen and the talk will present some of our results.

Bounding, splitting and almost disjointness can be quite different

Vera Fischer
Universität Wien, Austria

Elaborating on Shelah's isomorphism-of-names argument, typical for the Hechler iteration along a template we obtain the consistency of $\aleph_1 < \mathfrak{s} < \mathfrak{b} < \mathfrak{a}$. The construction heavily depends on the iteration of non-definable posets along a template.

On a class of maximality principles

Daisuke Ikegami
Kobe University, Japan

The Maximality Principle (MP) states that for any first-order sentence φ in the language of set theory, if it is forced by a set forcing that φ is true in any further set generic extension, then φ must be true. The MP was proposed by Shanon and its basic theory was developed by Hamkins. In this talk, we shall discuss several variants of maximality principles and their relations with forcing axioms, bounded forcing axioms, and large cardinals. This is joint work with Nam Trang.

Chain conditions, layered partial orders and weak compactness

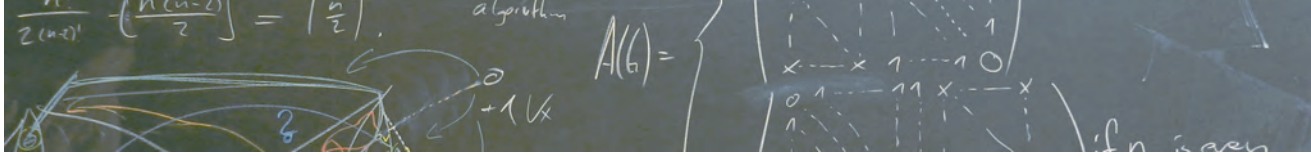
Philipp Lücke
Rheinische Friedrich-Wilhelms-Universität Bonn, Germany

Motivated by a conjecture of Todorčević, we study strengthenings of the κ-chain conditions that are equivalent to the κ-chain condition in the case where κ is a weakly compact cardinal. We then use such properties to provide new characterisations of weakly compact cardinals. This is joint work in progress with Sean D. Cox (VCU Richmond).

Subforcings of Blass-Shelah Forcing

Heike Mildenberger
Albert-Ludwigs-Universität Freiburg, Germany

We define σ-centred subforcings of the Blass-Shelah forcing order. Along a countable support iteration of length $\aleph_2$ we construct an increasing system of maximal centred sets of pure conditions. Their projection to the set of subsets of ω gives a non-rapid $\mathrm{P}_{\aleph_2}$-point.



More maximal independent sets in forcing extentions

David Schrittesser
University of Copenhagen, Denmark

A recent joint result with Asger Törnquist is that both in the Sacks and the Miller extensions of $\mathbf{L}$, there is a co-analytic maximal orthogonal family. Orthogonal families are but one example of what I shall here call maximal independent sets. Many other examples were discussed in a classic paper of Miller: most notably, Hamel bases for the real numbers, 2-point sets, and maximal independent subsets of the natural numbers; aprés Miller, more examples have been studied. Unfortunately, the result of Törnquist and Schrittesser was not general enough to apply to these latter examples of maximal independent families. In this talk, I shall generalize our previous result to Hamel bases and some of the other examples.

Invariant random subgroups of locally finite groups

Simon Thomas
Rutgers University, United States of America

Let G be a countable discrete group and let Sub_G be the compact space of subgroups $H \leqslant G$. Then a probability measure ν on Sub_G which is invariant under the conjugation action of G on Sub_G is called an *invariant random subgroup*. In this talk, I shall discuss the invariant random subgroups of inductive limits of finite alternating groups.

Definable maximal orthogonal families in the forcing extension of L

Asger Dag Törnquist
University of Copenhagen, Denmark

Two Borel probability measures ν and μ on Cantor space are orthogonal if there is a Borel set which has measure 1 for ν, but measure 0 for μ. An orthogonal family of measures is a family of pairwise orthogonal measures; it is maximal if it is maximal under inclusion.

It can be shown that no analytic maximal orthogonal family (mof) exists (Preiss-Rataj), but if $\mathbf{V}$=$\mathbf{L}$ then there is a Π^1_1 (lightface coanalytic) mof (Fischer-Törnquist). However, if we add a Cohen or random real to $\mathbf{L}$, then there are no Π^1_1 mofs (Fischer-Friedman-Törnquist).

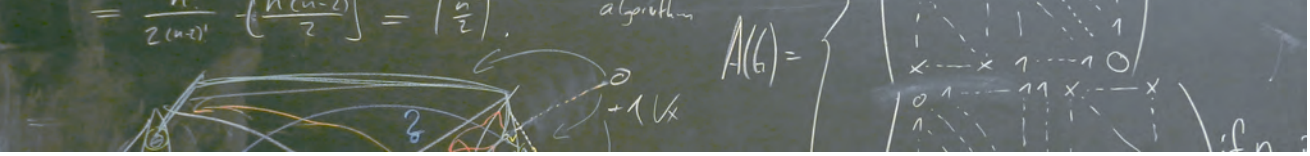
This motivated the question: Can a Π^1_1 mof coexist with a non-constructible real? In this talk, we answer this by showing that there is a Π^1_1 mof in the Sacks and Miller extensions of $\mathbf{L}$. By contrast, we also show that if we add a Mathias real to $\mathbf{L}$ then there are no Π^1_1 mofs.

Mice with finitely many Woodin cardinals from optimal determinacy hypotheses

Sandra Uhlenbrock
Westfälische Wilhelms-Universität Münster, Germany

Mice are countable sufficiently iterable models of set theory. Itay Neeman has shown that the existence of such mice with finitely many Woodin cardinals implies that projective determinacy holds. In fact he proved that the existence and ω_1-iterability of $\mathbf{M}^{\#}_n(x)$ for all reals x implies that boldface Π^1_{n+1}-determinacy holds.

We prove the converse of this result, that means boldface Π^1_{n+1}-determinacy implies that $\mathbf{M}^{\#}_n(x)$ exists and is ω_1-iterable for all reals x. This level-wise connection between mice and projective determinacy is an old so far unpublished result by W. Hugh Woodin. As a consequence we can obtain the determinacy transfer theorem for all levels n. These results connect the areas of inner model theory and descriptive set theory, so we shall give an overview of the relevant topics in both fields and briefly sketch a proof of the result mentioned above. The first goal is to show how to



derive a model of set theory with Woodin cardinals from a determinacy hypothesis. The second goal is to prove that there is such a model which is iterable. For this part the odd and even levels of the projective hierarchy are treated differently. This is joint work with Ralf Schindler and W. Hugh Woodin.

MS#33: Statistics on complex structures

Organisatoren: Gilles Blanchard, Potsdam; Natalie Neumeyer, Hamburg; Angelika Rohde, Bochum

Statistics is a science of information: a central question is to analyze and quantify as precisely as possible how much information about a partially unknown mathematical structure of a given type can (or cannot) be conveyed through observed random data. Recent developments in the mathematical analysis of complex data have been particularly successful and pathbreaking when they were able to bring together traditional notions and questions of mathematical statistics (such as various notions of statistical convergence) with tools and points of views from other areas of mathematics, in order to have a better grasp of complex mathematical structures arising in modern data.

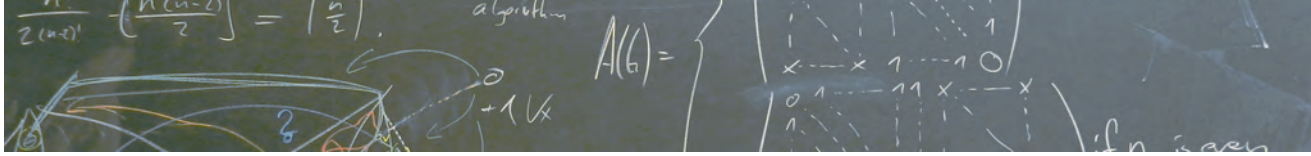
The goal of this minisymposium is to focus on some specific topics where such interactions are currently particularly active and to open new perspectives for further developments. The intent is to foster interaction between the mathematical statistics community and other communities, and to raise the interest of mathematicians with an open eye towards interaction of their own field with that of statistics and data analysis. Topics covered will include:

(1) *Statistics of functional data and on general metric measure spaces.* While functional analysis has been interacting for a long time with nonparametric statistics, a relatively young area opened by modern massive data collection possibilities is to model the observed data themselves as random functions. In parallel, going beyond standard spaces, there is a growing interest in statistics for using the tools and ideas of analysis on metric measure spaces. This interaction is still in its infancy and there is much untapped potential.

(2) *High-dimensional structured matrix models and graphical models.* There have been enormous efforts in developing new methodologies and theory for the analysis of high-dimensional covariance and precision matrices and graphical models in the past decade, based on a small sample of high-dimensional measurements and incorporating complexity reducing structural assumptions. Nevertheless, there is still a big gap between theoretical developments and real data analysis. For instance, theoretically optimal estimators, with optimality defined typically in a minimax sense, may not be computationally feasible. On the other hand, recent advances in optimization theory allow meanwhile the development of implementable and fast algorithms to fit complicated models. Such estimators, however, may not be minimax optimal, or may even not have basic properties, such as consistency at a reasonable rate. Optimal adaptive estimation that is at the same time computationally feasible is very challenging, especially when the complexity of the data sets, and associated models, grows with the amount of data.

(3) *Statistics on graphs.* A growing zoology of models for random graphs have been introduced, motivated by new sources of data taking such a form (such as social networks, communication networks, omics-data, brain modeling). Similarly to the previous topic, with which it overlaps partly, the question of statistical versus computational efficiency is a central one. Additionally, addressing the issue of adequation of these various models to observed data, as well as considering appropriate statistical limits of random graphs of growing size, are intensely being explored. Finally, the use of more sophisticated tools well-established in graph theory is only beginning to find its way towards addressing statistical questions.

The minisymposium is associated with the DFG Research Unit 1735 “Structural Inference in Statistics”.



Modeling communities in random graph by a mixture-based approach

Etienne Birmelé
Université Paris Descartes, France

Most of the large networks studied in applications (sociology, internet, biology ...) exhibit a notion of communities, that is nodes having the same connection patterns between them and toward the rest of the network. Several approaches are possible to take communities into account when describing a random graph model, one of them being to consider mixtures of Erdős-Rényi graphs. The present talk will consist in the presentation of such models, and in particular of a generalization allowing a node to be part of several communities. The statistical tools devoted to parameter inference and classification of the nodes will be investigated, as well as perspectives for the application on very large graphs.

On the CLT for discrete Fourier transforms of functional time series

Siegfried Hörmann
Université Libre de Bruxelles, Belgium

We consider a strictly stationary and ergodic sequence of random elements (X_t) taking values in some Hilbert space. Such a setting is broad enough to cover most practically relevant functional time series models. Our target is then to study the weak convergence of the discrete functional Fourier transforms of the observations under sharp conditions. As an application we discuss detection of a possibly periodic mean curve of the time series. The talk is based on joint work Clément Cerovecki (ULB).

Adaptive Bayesian estimation in indirect Gaussian sequence space models

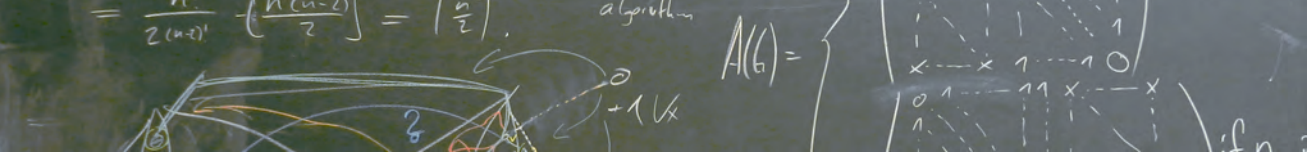
Jan Johannes
CREST-Ensai, France
Université catholique de Louvain, Belgium

In an indirect Gaussian sequence space model lower and upper bounds are derived for the concentration rate of the posterior distribution of the parameter of interest shrinking to the parameter value ϑ° that generates the data. While this establishes posterior consistency, however, the concentration rate depends on both ϑ° and a tuning parameter which enters the prior distribution. We first provide an oracle optimal choice of the tuning parameter, i.e., optimized for each ϑ° separately. The optimal choice of the prior distribution allows us to derive an oracle optimal concentration rate of the associated posterior distribution. Moreover, for a given class of parameters and a suitable choice of the tuning parameter, we show that the resulting uniform concentration rate over the given class is optimal in a minimax sense. Finally, we construct a hierarchical prior that is adaptive. This means that, given a parameter ϑ° or a class of parameters, the posterior distribution contracts at the oracle rate or at the minimax rate over the class, respectively. Notably, the hierarchical prior does not depend neither on ϑ° nor on the given class. Moreover, convergence of the fully data-driven Bayes estimator at the oracle or at the minimax rate is established.

Spectral analysis of high-dimensional sample covariance matrices with missing observations

Kamil Jurczak
Ruhr-Universität Bochum, Germany

We study high-dimensional sample covariance matrices based on independent random vectors with missing coordinates. The presence of missing observations is common in modern applications



such as climate studies or gene expression micro-arrays. A weak approximation on the spectral distribution in the "large dimension d and large sample size n" asymptotics is derived for possibly different observation probabilities in the coordinates. The spectral distribution turns out to be strongly influenced by the missingness mechanism. In the null case under the missing at random scenario where each component is observed with the same probability p, the limiting spectral distribution is a Marčenko-Pastur law shifted by $(1-p)/p$ to the left. As $d/n \to y \in (0,1)$, the almost sure convergence of the extremal eigenvalues to the respective boundary points of the support of the limiting spectral distribution is proved, which are explicitly given in terms of y and p. Eventually, the sample covariance matrix is positive definite if p is larger than

$$1-(1-\sqrt{y})^2\,,$$

whereas this is not true any longer if p is smaller than this quantity.

How to calibrate tuning parameters

Johannes Lederer
University of Washington, United States of America

High-dimensional statistics is the basis for analyzing large and complex data sets that are generated by cutting-edge technologies in genetics, neuroscience, astronomy, and many other fields. However, Lasso, Ridge Regression, Graphical Lasso, and other standard methods in high-dimensional statistics depend on tuning parameters that are difficult to calibrate in practice. In this talk, I shall illustrate the role of tuning parameters in modern data analysis. Moreover, I present two novel approaches to establish accurate calibration of these parameters. My first approach is based on a novel testing scheme that is inspired by Lepski's idea for bandwidth selection in non-parametric statistics. This approach provides tuning parameter calibration for estimation and prediction with the Lasso and other standard methods and is to date the only way to ensure high performance, fast computations, and optimal finite sample guarantees. My second approach is based on the minimization of an objective function that avoids tuning parameters altogether. This approach provides accurate variable selection in regression settings and, additionally, opens up new possibilities for the estimation of gene regulation networks, microbial ecosystems, and many other network structures.

Linear and nonparametric models in functional data analysis

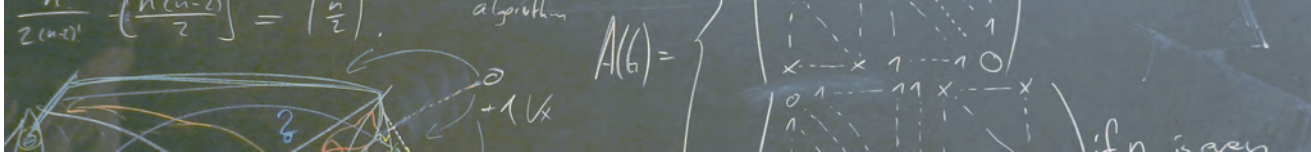
Alexander Meister
University of Rostock, Germany

We start with an introduction to the field of functional data and principal components. Then we provide an overview on the literature on statistical topics in functional data analysis. In particular, we consider the model of functional linear regression and show that it is asymptotically equivalent to a white noise inverse problem. Furthermore we discuss asymptotic minimax results in nonparametric regression and classification for functional data.

Invariance and Causal Models

Jonas Peters
MPI Tübingen, Germany

In causal inference, we often represent the causal structure of a data generating process with a directed graph. What do we use such causal models for? In many situations, we are interested in the system's behavior under a change of environment. Here, causal models become important because they are usually considered invariant under those changes. A causal prediction (which



uses only direct causes of the target variable as predictors) remains valid even if we intervene on predictor variables or change the whole experimental setting. In this talk, we use data from different environments in order to estimate the causal structure and provide statistical guarantees. Reversely, we predict the models' behavior in different environments given the causal structure.

MS#34: Structural and algorithmic aspects in graph theory

Organisatoren: Henning Bruhn-Fujimoto, Ulm; Matthias Kriesell, Ilmenau

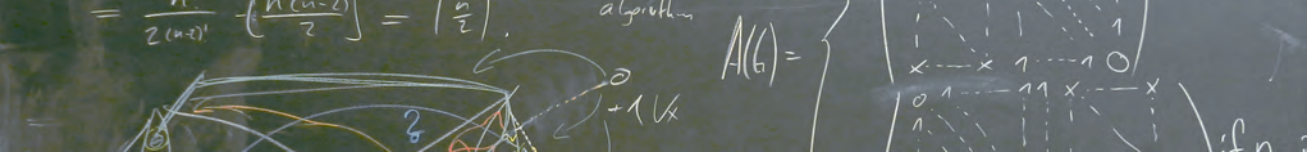
Graphs are a fundamental modelling tool with applications in a large number of different domains. One of their main feature is their apparent simplicity that often allows to reduce a problem to its essential core. Yet despite this simplicity many algorithmic or structural problems involving graphs are wide open. Often, there is a fruitful interplay between algorithmic and structural aspects: advances on one of the two sides provides insights into the other, and vice versa.

In this mini-symposium we shall focus in particular on the interaction between structural and algorithmic questions in graph theory. Suggested topics include digraphs, graph colouring, connectivity, width parameters, and polyhedral questions.

Arc-disjoint flows in capacitated digraphs

Jørgen Bang-Jensen
University of Southern Denmark, Denmark

A feasible flow in a network $N = (V, A, u)$ is any non-negative function $x : A \to R$ which satisfies that $x_{ij} \leq u_{ij}$ for all arcs $ij \in A$. In many cases N is also equipped with a so-called balance vector b: $V \to R$ and then a feasible flow must also satisfy that at every vertex $v \in V$ the sum of the flow on outgoing arcs from v minus the sum of the flow on incomming arcs at v must equal $b(v)$. The theoretical and algorithmic aspects of network flows are well understood and flows form a very useful tool for modelling problems, as a machinery to prove results or develop polynomial algorithms for (di)graphs. Examples are: Menger's theorem, Halls theorem, finding subdigraphs with prescribed in- and out-degrees etc. There are polynomial algorithms for testing whether a given network $N = (V, A, u, b)$ has a feasible flow and to find such a flow when it exists. In this talk we consider an extension of the flow model which allows us to model a large number of different problems which cannot be modelled in the standard flow model. Two flows x, y in a network N are arc-disjoint if $x_{ij} * y_{ij} = 0$ for every arc ij. A very natural problem, which is also interesting from an applications point of view, is as follows: given a network $N = (V, A, u, b)$; does N have a pair of arc-disjoint feasible flows x, y. This innocent sounding problem contains several problems that cannot be modelled by standard flows as special cases: arc-disjoint linkages, number partitioning and arc-disjoint spanning subdigraphs with prescribed degrees. Hence the arc-disjoint flow problem is NP-complete in general and it is interesting to focus on special cases. A branching flow from a root s in a network $N = (V, A, u)$ is a flow x whose balance vector is -1 at all vertices except s where it is $n - 1$. Here $n = |V|$. If all capacities are $n - 1$, then a feasible branching flow exists if and only if $D = (V, A)$ has an out-branching from s and there are k arc-disjoint branching flows in N if and only if D has k arc-disjoint out-branchings. By Edmonds' branching theorem, this can be checked in polynomial time using a polynomial algorithm for the maximum flow problem. When the capacities are (much) smaller than $n-1$, the structure of the arc-set carying non-zero flow in a faesible branching flow may become quite complicated, but we can still determine the existence of a feasible branching flow in polynomial time using any polynomial maxflow algorithm. However, if we want to determine the existence of a pair of arc-disjoint branching flows the problem becomes



NP-complete when capacities are bounded by any constant. We shall discuss the complexity of the problem when the capacities are all $n-k$ for some k. Our analysis reveals interesting structure of feasible branching flows in network with these capacity bounds.

Remarks on the packing/covering conjecture

Nathan Bowler
Universität Hamburg, Germany

The packing/covering conjecture, a unifying generalisation of the base packing, base covering, union and intersection theorems (and so also of Menger's theorem) to infinite matroids, is the most important open problem in infinite matroid theory. For example, it implies the Erdős-Menger Conjecture, recently proved by Aharoni and Berger. I'll explain why it is so important and talk about what progress has been made in proving special cases.

The Directed Grid Theorem

Stephan Kreutzer
Technische Universität Berlin, Germany

The grid theorem, originally proved by Robertson and Seymour in *Graph Minors V* in 1986, is one of the fundamental results in the study of graph minors. It has found numerous applications in algorithmic graph structure theory, for instance in bidimensionality theory, and it is the basis for several other structure theorems developed in the graph minors project.

In the mid-90s, Reed and Johnson, Robertson, Seymour and Thomas, independently, conjectured an analogous theorem for directed graphs, i.e., the existence of a function $f\colon N \to N$ such that every digraph of directed tree-width at least $f(k)$ contains a directed grid of order k. In an unpublished manuscript from 2001, Johnson, Robertson, Seymour and Thomas give a proof of this conjecture for planar digraphs. In 2014 we finally managed to prove the conjecture in full generality.

In this talk we shall give an introduction to directed tree width and present the main ideas of the proof of the directed grid theorem. We shall also present some algorithmic application of this result to routing problems on digraphs as well as to Erdős-Pósa problems for directed graphs. This is joint work with Ken-ichi Kawarabayashi, National Institute of Informatics, Tokyo.

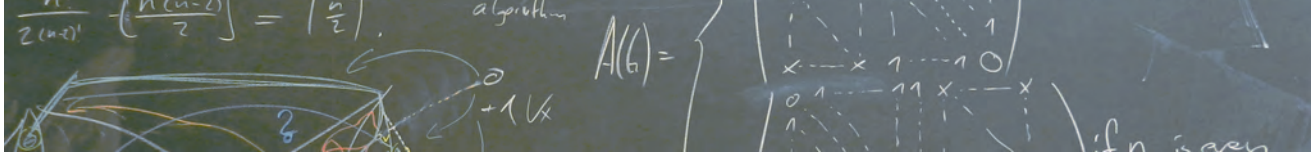
Coloring graphs without long induced paths

Oliver Schaudt
Universität zu Köln, Germany

The complexity of coloring graphs without long induced paths is a notorious problem in algorithmic graph theory. An especially intriguing case is that of 3-colorability. Here, the state of the art is our recent poly-time algorithm to solve the problem on graphs without induced paths on seven vertices, so-called P_7-free graphs.

So far, much less was known about certification in this context. We prove that there are 24 minimally non-3-colorable graphs in the class of P_6-free graphs, and give the complete list. In particular, we obtain a certifying algorithm for 3-coloring graphs in this class.

We also show that our result is best possible, in the following sense. If H is a connected graph that is not an induced subgraph of P_6, then there are infinitely many minimally non-3-colorable H-free graphs. (Joint work with Flavia Bonomo, Maria Chudnovsky, Peter Maceli, Maya Stein, and Mingxian Zhong as well as Maria Chudnovsky, Jan Goedgebeur, and Mingxian Zhong.)



Gabriel Andrew Dirac (1925–1984) and his pioneering work in graph theory.
Bjarne Toft
University of Southern Denmark, Denmark

G. A. Dirac initiated and created several areas of modern graph theory, starting with his Ph. D. thesis in 1951 on critical graphs. He was of Hungarian origin, but grew up in England, where he graduated with Richard Rado as supervisor. He obtained strong contacts with graph theory in Germany through his appointments in Hamburg and Ilmenau around 1960 and the personal relations that developed. These contacts flourished during his appointment at Aarhus University in Denmark from 1966 on. In the lecture an overview of Dirac's achievements in structural graph theory will be presented, together with an evaluation of the significance of his German relations.

MS#35: Symplectic Structures in Geometric Analysis

Organisatoren: Nils Waterstraat, Kent; Bernhelm Booss-Bavnbek, Roskilde

The aim of this Minisymposium is to bring together specialists from symplectic geometry, global analysis, nonlinear differential equations, and mathematical physics. The emphasis is on recent applications of symplectic invariants to problems in geometric analysis. The topics covered will include spectral invariants of operators of Dirac- and Laplace-type and other geometrically defined differential operators, (weak) symplectic structures in Banach spaces, Conley-Zehnder and Maslov indices, as well as applications to bifurcation theory, Hamiltonian systems, the N-body problem, boundary value problems, (closed) geodesics, and minimal varieties.

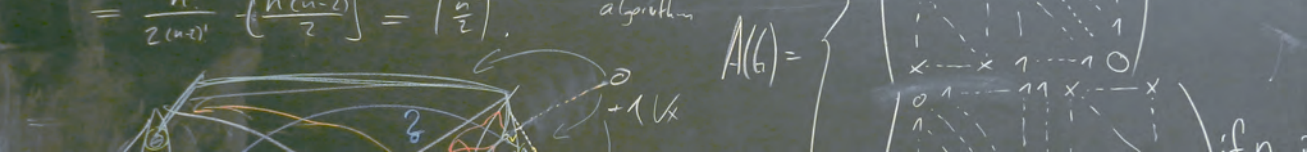
Sharp systolic inequalities in Reeb dynamics
Alberto Abbondandolo
University of Bochum, Germany

Can the minimal period of closed Reeb orbits on a contact three-sphere be bounded from above in terms of the contact volume? I shall discuss positive results and counterexamples related to this question, together with applications in symplectic and Finsler geometry. This talk is based on joint work with B. Bramham, U. Hryniewicz and P. Salomão.

Relative spectral invariants and operator algebraic point of view
Sara Azzali
University of Potsdam, Germany

Atiyah, Patodi and Singer constructed the relative K-theory class $[\alpha]$ associated with a flat unitary vector bundle over a closed manifold. This class is related to the spectral invariant rho of a Dirac operator by the so called index theorem for flat bundles, which computes the pairing between $[\alpha]$ and the K-homology class $[D]$ of the Dirac operator. The pairing is in turn equal to a type II spectral flow, as proved by Douglas, Hurder and Kaminker.

In this talk we shall focus on the operator algebraic point of view on these relative invariants by showing how the construction of $[\alpha]$ can be seen as a consequence of Atiyah's L^2 index theorem. We shall also give new relative K-theory construction obtained in joint work with Paolo Antonini and Georges Skandalis that generalize the class $[\alpha]$ to a noncommutative setting.



An index theorem for Lorentzian manifolds

Christian Bär
University of Potsdam, Germany

We prove an index theorem for the Dirac operator on compact Lorentzian manifolds with spacelike boundary. Unlike in the Riemannian situation, the Dirac operator is not elliptic. But it turns out that under Atiyah-Patodi-Singer boundary conditions, the kernel is finite dimensional and consists of smooth sections. The corresponding index can be expressed by a curvature integral, a boundary transgression integral and the eta-invariant of the boundary just as in the Riemannian case. There is a natural physical interpretation in terms of particle-antiparticle creation. This is joint work with Alexander Strohmaier.

Isospectral but non-diffeomorphic nilmanifolds attached to Clifford modules

Kenro Furutani
Tokyo University of Science, Japan

I shall introduce several new examples of isospectral but non-diffeomorphic nilmanifolds. These nilmanifolds are constructed from Clifford modules. Their classification leads us to such examples, not only just pairs, but any given number of such manifolds.

Maximal symplectic covariance properties for classes of pseudo-differential operators

Maurice A. de Gosson
University of Vienna, Austria

We show in this talk that the symplectic group is a maximal symmetry group for covariance properties of Weyl pseudodifferential operators. We thereafter address the case of Shubin and Jordan operators, and show that the corresponding pseudodifferential calculi are covariant under the action of certain subgroups of the symplectic group. We relate these symmetry properties to those of the Wigner transform in the Weyl case, and to the Cohen class in the more general case.

Modular curvature and Morita equivalence

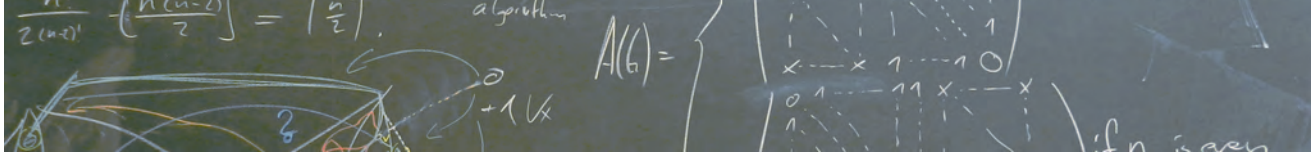
Matthias Lesch
University of Bonn, Germany

We prove that the modular curvature of a conformal metric structure on the noncommutative torus $T^2_\vartheta (\vartheta \notin \mathbb{Q})$ is invariant under Morita equivalence. More precisely, the curvature associated to a Hermitian structure on a Heisenberg bimodule E realizing the Morita equivalence between $A_\vartheta = C(T_\vartheta)$ and $A_{\vartheta'}$, with $A_{\vartheta'}$ identified to the algebra of endomorphisms $End_{A_\vartheta}(E)$, coincides with the intrinsic curvature of the conformal metric on T^2_ϑ with corresponding Weyl factor. The main analytical tool is the extension of Connes? pseudodifferential calculus to Heisenberg modules, the novel technical aspect being that the entire computation is free of any computer assistance. This is joint work with Henri Moscovici.

Geometric potential analysis for minimal surfaces and foams

Steen Markvorsen
Technical University of Denmark, Denmark

We survey some recent results obtained with A. Hurtado, V. Gimeno, and V. Palmer, concerning comparison geometric aspects of the Dirichlet spectrum and the mean exit time moment spectrum for extrinsic balls in minimal submanifolds. Possible extensions to foam structures and to similar comparison geometric results in Finsler spaces will also be discussed.



Deformations of coisotropic submanifolds and index of a class of Fourier integral operators

Ryszard Nest
University of Copenhagen, Denmark

Given a conic coisotropic submanifold B of a cotangent bundle of a manifold X, Guillemin and Sternberg associated to it a certain algebra A of Fourier Integral Operators on X. We shall explain how the deformation of B relates to the full symbol calculus of the elements of A and show how to deduce an index theorem for Fredholm operators belonging to A.

Symplectic areas of triangles and the Maslov index

Bent Ørsted
Aarhus University, Denmark

For bounded symmetric domains in complex Euclidian Space there is a natural notion of areas of geodesic triangles; this is related to the Maslov index. In this lecture we shall explain this and also discuss some generalizations to other complex manifolds.

Index theory in celestial mechanics: recent results and new perspectives

Alessandro Portaluri
University of Turin, Italy

In the last decades a zoo of new symmetric periodic collision-less orbits for the n-body problem appeared in the literature as critical points of the Lagrangian action functional. Certainly one of the important features of such orbits, for a better understanding of the dynamics, is the knowledge of the Morse index as well as their linear (in)stability properties. A central device for computing this index is a Morse-type index theorem and a refined computation of the Maslov index. However, a key role in order to penetrate the intricate dynamics of this singular problem is represented by the collision orbits. In this talk, after a presentation of a new variational regularisation of the Lagrangian action functional, we shall show how to define a suitable index theory for a special class of colliding trajectories. This is joint work with V. Barutello, X. Hu, and S. Terracini.

Index theorems for symplectic projections

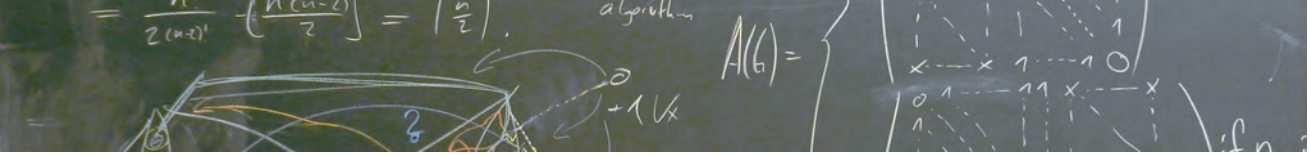
Hermann Schulz-Baldes
Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany

In an operator algebra furnished with an anti-linear involution it is possible to consider Lagrangian projections which specify KR-group elements. Pairing such projections with KR-cycles leads to index theorems which can be 2Z- or Z2-valued. The heart of the argument is based on methods from symplectic linear algebra and leads to a new type of Kramers degeneracy argument. Applications concern topological condensed matter systems.

On the noncommutative Maslov index

Charlotte Wahl
Leibniz Bibliothek Hannover, Germany

We shall explain the definition and properties of the noncommutative Maslov index for projective modules over C^*-algebras and its connection to recent work of Barge and Lannes, who studied a



Maslov index over commutative rings. In particular we correct and make more precise a statement on the dependence of the choices contained in our previous work on the subject. All this generalizes classical work of Cappell, Lee and Miller. The proofs involve index theory over C^*-algebras.

MS#36: Topics in Delay Differential Equations

Organisatoren: Hans-Otto Walther, Giessen; Eugen Stumpf, Hamburg

The minisymposium shall pick up the discussion of the survey article [1] about delay differential equations. In particular, it is intended to provide an insight into both some recent developments of the general theory as well as into some applications of delay differential equations in other sciences as Biology, Physics etc.. The participation of young researchers, especially, of those who would like to present own results concerning delay differential equations and their applications, is welcome and encouraged.

[1] Walther, H.-O: Topics in Delay Differential Equations. *Jahresbericht der DMV* 116(2):87–114 (2014).

Challenges in modeling immuno-epidemiology ... and how delays can help

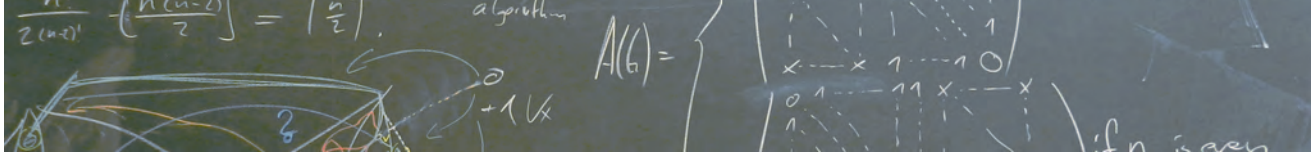
Maria Vittoria Barbarossa
University of Szeged, Hungary

When the body gets infected by a pathogen the immune system develops pathogen-specific immunity. Induced immunity decays in time and years after recovery the host might become susceptible (S) again. Exposure to the pathogen in the environment, that is, contact with infectives (I), boosts the immune system thus prolonging the time in which a recovered individual is immune (R). Such an interplay of within host processes and population dynamics poses significant challenges in rigorous mathematical modeling of immuno-epidemiology. In the first part of the talk we propose a framework to model SIRS dynamics, monitoring the immune status of individuals and including both waning immunity (W) and immune system boosting. Our model is formulated as a system of two ordinary differential equations (ODEs) coupled with a partial differential equation for the immune population. We prove basic properties of this model, such as existence and uniqueness of a classical solution and the stability of the unique disease-free stationary solution. In the second part of the lecture we show how to obtain, under particular assumptions on the general model, known examples such as large systems of ODEs for SIRWS dynamics, as well as SIRS with constant and state-dependent delay, which we shall consider in detail. This is joint work with G. Röst.

Periodic square-wave oscillations in nonlinear optics

Thomas Erneux
Université Libre de Bruxelles, Belgium

Nonlinear delay differential equation problems appear in all scientific disciplines. Classical problems such as chatter instabilities in mechanical engineering, abnormal physiological controls, and lasers experiencing delayed feedbacks are now systematically investigated [1]. Although we may simulate these problems numerically, asymptotic approaches based on natural limits of some of the parameters (large delay, low or high feedback levels, multiple time scales) are needed to substantiate analytically specific dynamical phenomena caused by the delay. Lasers and optical oscillators are particularly interesting devices because the effects of a delayed feedback can be studied both



theoretically and experimentally. In this presentation, we concentrate on time-periodic square-wave (SW) oscillations. SW oscillations of scalar delay differential equations exhibiting a large delay have been rigorously studied in the 1980's. They result from Hopf bifurcations and the plateau lengths are nearly equal to one delay. Here we show both mathematically and experimentally the possible existence of periodic SWs with different plateau lengths and periods close to one delay. We also found that multiple stable SWs of different periods may coexist for the same values of the parameters [2-3]. The model equations are second or higher order delay differential equations and Hopf bifurcations are the basic mechanisms for the SWs.

[1] T. Erneux, *Applied Delay Differential Equations*, Springer, 2009.

[2] G. Friart, G. Verschafelt, J. Danckaert, and T. Erneux, All-optical controlled switching between time-periodic square waves in diode lasers with delayed feedback, Optics Letters 39, 6098–6101 (2014).

[3] L. Weicker, T. Erneux, D. P. Rosin and D. J. Gauthier, Multi-rhythmicity in an optoelectronic oscillator with large delay, Phys. Rev. E91, 012910 (2015).

Quiescent Phases and Differential Delay Equations

Karl Peter Hadeler
Universität Tübingen, Germany

When an ordinary differential equation is diffusively coupled to a zero vector field (doubling the space dimension) then a dynamical system with quiescent phases is obtained, similarly for maps coupled to the identity. The question how the dynamics of the coupled system is related to that of the original system has been partially answered. Such results can be extended to delay equations.

There are several ways to connect quiescent phases to vector-valued delay equations.

First, one can see a delay equation as a retarded ordinary differential equation and couple it to zero as in the ODE case. Secondly, one can look at a delay equation as a dynamical system in some function space (space of histories) and do the same thing there—with a different result. Thirdly, one can start from a system with quiescent phases with distributed exit times and get a system of delay equations. In this case the delay is the length of the quiescent phase. Finally, one can consider a Gurtin-MacCamy population model with quiescent phases and a maturation period. Then one gets the same result as in the first approach and the delay is the maturation period.

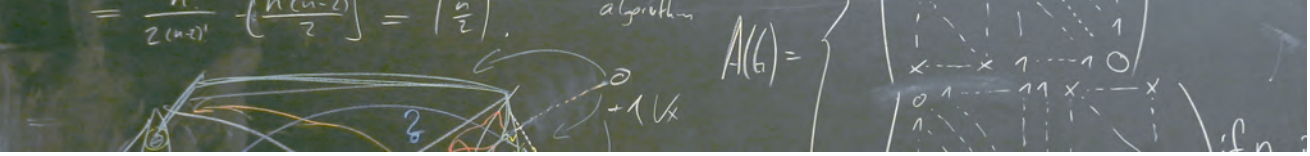
In all these ways one arrives at systems of vector-valued delay equations—of different types and with different stability conditions—which show similar behavior. If the rates (of going quiescent and returning to the active phase) are the same for all dependent variables, then quiescent phases act stabilizing (against Hopf bifurcations). For unequal rates there may be excitation phenomena unless the Jacobian matrix of the underlying ODE system has some strong stability properties. For two dependent variables exact algebraic conditions for strong stability can be given.

Chaotic motion in delay equations

Bernhard Lani-Wayda
Universität Giessen, Germany

This is a survey talk about results on 'chaotic' or complicated motion in the infinite-dimensional semiflows generated by delay equations. The focus is on analytically proven results, but numerical simulations will also be mentioned. Examples start from 1977 and include nonlinearities such as smoothed step functions, negative and also sine-like feedback, and state-dependent delay.

The proofs combine traditional ideas, like transverse homoclinic intersections described by Poincaré and homoclinic behavior as analyzed by L.P. Shilnikov for ODEs, with more recent approaches, e.g., fixed-point index methods for the proof of symbolic dynamics.



Large-amplitude periodic solutions for delay equations with positive feedback

Gabriella Vas
University of Szeged, Hungary

This talk considers scalar delay differential equations of the form

$$\dot{x}(t) = -ax(t) + f(x(t-1)),$$

where $a > 0$ and f is a strictly increasing C^1-function. We say that a periodic solution has large amplitude if it oscillates about at least two unstable equilibria. We investigate what type of large-amplitude periodic solutions may exist at the same time when the number of unstable equilibria is arbitrarily large. We also discuss the geometrical properties of the unstable sets of certain large-amplitude periodic orbits oscillating about exactly two unstable equilibria.

Stability of plane wave solutions in complex Ginzburg–Landau equation with delayed feedback

Serhiy Yanchuk
Weierstrass Institute for Applied Analysis and Stochastics, Germany

I shall discuss plane wave solutions and their stability in a one-dimensional complex cubic-quintic Ginzburg–Landau equation with delayed feedback. Our study reveals how multistability and snaking behavior of plane waves emerge as time delay is introduced. More can be found here: `http://epubs.siam.org/doi/abs/10.1137/130944643`.

MS#37: Topology and geometry of Lie group actions

Organisatoren: Manuel Amann, Karlsruhe; Oliver Goertsches, München

The concept of symmetry has always played a crucial role in understanding geometric objects. A classical way of modeling symmetry of spaces is to impose the action of a group. This approach still proves to be very successful in modern mathematics yielding beautiful results in a multitude of fields, such as algebraic and geometric topology, or Riemannian and symplectic geometry.

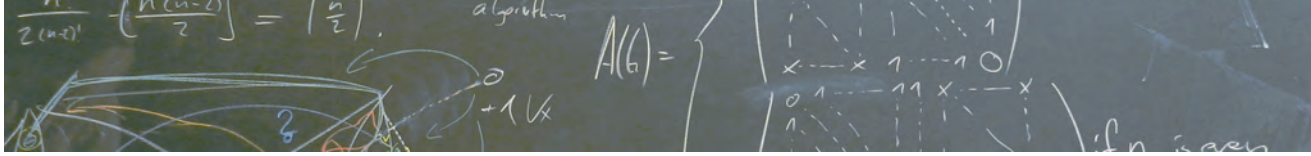
In this mini-symposium we shall discuss recent results in this area; on the one hand concerning the theory of Lie transformation groups itself, and on the other hand using the existence of Lie group actions as a means to understand various geometric structures.

Congruence invariants for holomorphic maps and rigidity

Stefan Bechtluft-Sachs
Maynooth University, Ireland

Metric rigidity of holomorphic maps (as that of smooth maps between Riemannian mannifolds) generally requires some kind of non degeneracy assumptions. Thus holomorphic maps in complex projective spaces are congruent if they have the same first fundamental form. In Hermitian symmetric target spaces of higher rank however, the maps should be full in the sense that their osculating space exhausts the ambient tangent space.

In Grassmannians this can be resolved by fixing the second fundamental form as well, but this over determines the map. For holomorphic maps into Grassmannians, we determine a complete set of invariants and some of the arising relations. Most of this also works for harmonic maps.



Tamed symplectic structures on solvmanifolds

Anna Fino
Universitá di Torino, Italy

Symplectic forms taming complex structures on compact manifolds are strictly related to a special type of Hermitian metrics, known in the literature also as *pluriclosed* metrics. I shall present some general results on pluriclosed metrics and their link with symplectic geometry for solvmanifolds. Moreover, I shall show for certain 4-dimensional non-Kähler 4-manifolds some recent results about the Calabi-Yau equation in the context of symplectic geometry.

Localization for K-contact manifolds

Jonathan Fisher
Universität Hamburg, Germany

The Jeffrey-Kirwan residue formula computes the intersection pairings on a symplectic quotient $M/\!/G$ as the residues of certain meromorphic differential forms associated to the fixed point set M^T, where T is a maximal torus of the compact Lie group G. Key ingredients of the proof are equivariant integration and localization. We extend these techniques to the setting of K-contact manifolds and obtain an analogous residue formula. This is based on joint work with Lana Casselmann.

Isometric Lie group actions on Alexandrov spaces

Fernando Galaz-Garcia
Karlsruher Institut für Technologie, Germany

Alexandrov spaces (with curvature bounded below) are a natural synthetic generalization of Riemannian manifolds. In this talk I shall discuss recent developments on the geometry and topology of Alexandrov spaces with isometric actions of compact Lie groups.

Recent results on polar actions

Andreas Kollross
Universität Stuttgart, Germany

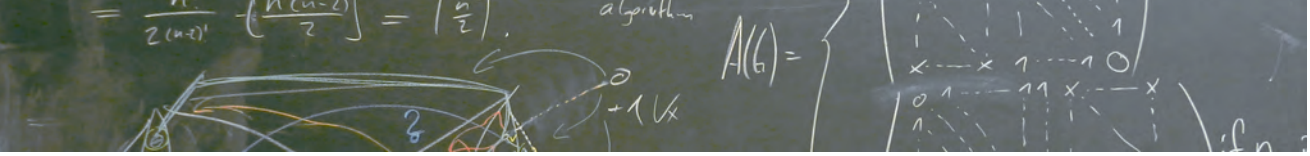
Isometric Lie group actions on Riemannian manifolds are called polar if there is a submanifold, called section, which meets all orbits of the group action and meets them orthogonally at any intersection point; they are called hyperpolar in the special case where the section is flat.

I shall talk about a result on hyperpolar actions on reducible compact symmetric spaces and a recent classification of infinitesimally polar (i.e., all slice representations are polar) actions on compact rank one symmetric spaces. The latter is joint work with Claudio Gorodski.

Assignments for topological group actions

Liviu Mare
University of Regina, Canada

Let T be a (compact) torus that acts on a topological space X. A polynomial assignment is a map A that assigns to any $x \in X$ a polynomial function $A(x) : \mathrm{Lie}(T_x) \to \mathbb{R}$, where T_x is the stabilizer of x; A is required to be T-invariant and satisfy a certain compatibility condition involving fixed points of various subtori of T. The space of all such assignments is an algebra over the polynomial ring of $\mathrm{Lie}(T)$, the so-called *assignment algebra*. This notion was introduced by Ginzburg, Guillemin, and Karshon in 1999. For smooth actions on manifolds, connections with



the T-equivariant cohomology algebra were established recently by Guillemin, Sabatini, and Zara (2014). I shall explain that the same relationship between assignments and equivariant cohomology exists in the topological setting. I shall also discuss assignment versions of the Chang-Skjelbred lemma and the Goresky-Kottwitz-MacPherson presentation. This is a report on joint work with Oliver Goertsches (LMU Munich).

Group actions in symplectic geometry

Silvia Sabatini
Universität Köln, Germany

Let a torus act on a compact symplectic manifold with isolated fixed points. In this talk I shall discuss about recent results concerning the classification of the topological invariants of such a manifold, including equations involving the Chern numbers of the manifold, depending on its minimal Chern number. This includes both the Hamiltonian and non-Hamiltonian case.

Weakly complex homogeneous spaces

Uwe Semmelmann
Universität Stuttgart, Germany

We present a classification of compact homogeneous spaces with positive Euler characteristic admitting an almost complex structure and more generally a tangent bundle which is stably complex. We show that such a space is a product of compact equal rank homogeneous spaces which either carry an invariant almost complex structure, or have stably trivial tangent bundle, or belong to an explicit list of weakly complex spaces which have neither stably trivial tangent bundle, nor carry invariant almost complex structures. The talk is based on joint work with Andrei Moroianu.

MS#38: Well-quasi orders: from theory to applications

Organisatoren: Peter Schuster, Verona; Monika Seisenberger, Swansea; Andreas Weiermann, Gent

This minisymposium is devoted to multiple and deep interactions between the theory of well quasi-orders (known as wqo-theory) and several fields of mathematics and logic (commutative algebra, braid groups, graph theory, analytic combinatorics, theory of relations, reverse mathematics, subrecursive hierarchies, and proof theory). Wqo-theory is currently a highly developed part of combinatorics with surprising applications in logic, mathematics and computer science. Well-quasi orders provide a unifying tool for elegant finiteness proofs and to some extent they even have frequently been rediscovered in various contexts.

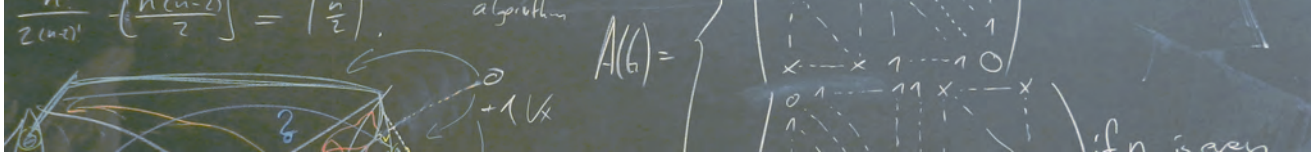
With the minisymposium we want to communicate recent developments in the field via talks by speakers from different areas, thereby facilitating knowledge transfer between different subjects in mathematics.

This mini-symposium is supported by the *Deutsche Vereinigung für Mathematische Logik und für Grundlagenforschung der exakten Wissenschaften* (DVMLG).

Well quasi-orders in a categorical setting

Marco Benini
Università dell'Insubria at Como, Italy

Each quasi-order, and thus, each order, can be easily presented as a category. In turn, the category of orders with monotone maps is a reflective subcategory in the category of quasi orders. By



imposing appropriate structural conditions, it is possible to present well quasi-orders in a purely categorical way, and it happens that well quasi-orders form a full subcategory of quasi-orders, as well orders form a full subcategory of orders. More interestingly, the subcategory of well orders is reflective in the category of well quasi-orders.

By expressing the properties of well quasi orders as logical propositions, it becomes natural to consider them inside the internal language of the presheaf topos over the category of well quasi orders. In this context, the above mentioned relations between categories provide ways to transport theorems from a subtopos to the including topos and vice versa.

The purpose of the present contribution is to systematically illustrate the overall picture, and to characterise which properties, and to what extent, are subject to the transport process above.

Well quasi-orders, better quasi-orders, and classification problems in descriptive set theory

Riccardo Camerlo
Politecnico di Torino, Italy

I shall present and discuss a few examples and some applications of well quasi-orders and better quasi-orders, mostly arising in the theory of linear orders. I shall try to clarify the connections between them, and point to some related questions stemming from descriptive set theory.

Constructive topology in Ramsey theory and well quasi-orderings via Gelfand duality.

Willem L Fouché
University of South Africa, South Africa

Many results in classical Ramsey theory and the theory of well-quasi-orderings can be proven by topological means, or be expressed as topological phenomena.

Thierry Coquand has given many examples of such topological expressions of these combinatorial phenomena which are classically equivalent to statements in point-free topology but which are, thus formulated, constructively provable.

We shall discuss these results from the viewpoint of Gelfand duality of commutative C^*-algebras, the latter being provable in constructive mathematics, when adequately phrased, and having, therefore, interesting computational content.

The VJGL Lemma

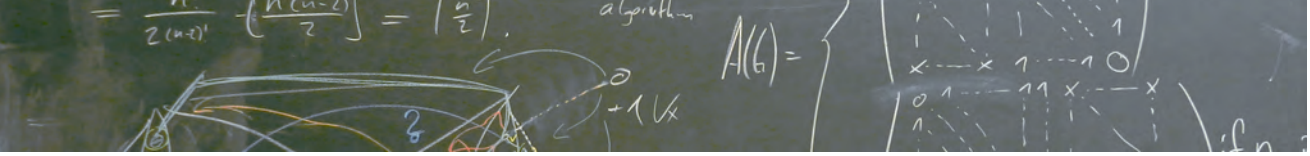
Jean Goubault-Larrecq
ENS Cachan, France

Every upward closed subset A in a wqo has a finite basis. Computing such a finite basis is a basic step in the verification of so-called well-structured transition systems. Generalizing a lemma of Valk and Jantzen (1985), we show that, in wqos with the so-called effective complement property, that question reduces to the simpler question of the decidability whether A meets a given order ideal. The proof is elementary. The poset of ideals itself is a completion of the original wqo, and we show that it has concrete, computable presentations in many interesting cases.

Connecting the worlds of well partial-orders and ordinal notation systems

Jeroen Van Der Meeren
Ghent University, Belgium

Well-partial-orders play an important role in logic, mathematics and computer science. There are the essential ingredient of famous theorems like Higman's lemma and Kruskal's theorem. The



maximal order type of a well-partial-order characterizes that order's proof-theoretical strength. Moreover, in many natural cases, the maximal order type of a well-partial-order can be represented by an ordinal notation system. However, there are a number of natural well-partial-orders whose maximal order types and corresponding ordinal notation systems remain unknown. Prominent examples are Friedman's well-partial-orders on trees with finitely may labels with the so-called gap-embeddability relation. Friedman introduced these well-partial-orders in 1985 to obtain an independence result for the strongest theory of the Big Five in reverse mathematics. It was for a long time unknown if such a natural independence result even existed.

In this talk we discuss a conjecture of Weiermann about the connection between maximal order types of specific well-partial-orders, each ordered by a certain gap-embeddability relation, and ordinal notation systems based on the well-known collapsing functions ϑ_i. This conjecture yields a representation of for example the big Veblen number and the Howard-Bachmann number in terms of rooted trees. Furthermore, it implies an exact classification of Friedman's well-partial-orders in terms of maximal order types and ordinal notation systems.

Well quasi-orders in philosophical logic

Sara Negri
University of Helsinki, Finland

Well quasi-orders are ubiquitous, through relational semantics, in many areas of philosophical logic such as provability, epistemic, temporal, and dynamic logics. The defining semantic conditions for such logics, given in terms of Noetherian or ancestral relations, cannot be expressed in a first-order language, but it is often possible to develop well-behaved proof systems. The talk will survey the results obtained (analyticity, semantic and syntactic completeness, decidability) and the current challenges.

WQO of Classes of Graphs

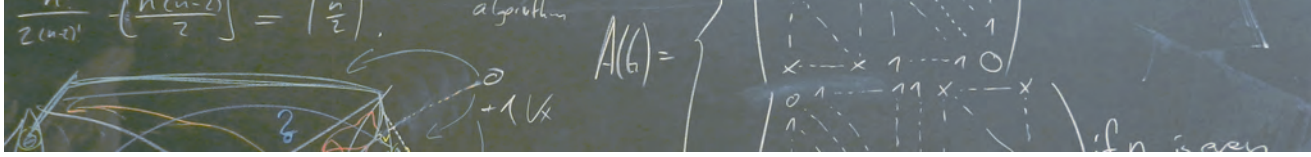
Jaroslav Nešetřil
Charles University Prague, Czech Republic

Motivated by the structure theory for sparse classes (cf., e.g., Sparsity, Springer 2012) we present several new WQO classes of graphs. The interpretation is a powerful tool for generating new WQO classes from old ones, we give several examples of such use. This is a joint project with P. Ossona de Mendez.

Well quasi ordering and enumeration of finite relational structures.

Maurice Pouzet
Institut Camille Jordan, France
The University of Calgary, Canada

A relational structure R is embeddable in a relational structure R' if R is isomorphic to an induced substructure of R'. In the late forties, Fraïssé, following the work of Cantor, Hausdorff and Sierpiński, pointed out the role of the quasi-ordering of embeddability and hereditary classes in the theory of relations. Recent years have seen a renewed interest for the study of hereditary classes particularly those made of finite structures. Many results have been obtained. Several are about their profile, i.e., the function φ_C, the profile of a hereditary class C, which counts for every integer n the number of members of C on n elements, counted up to an isomorphism. General counting results as well as precise results for graphs, tournaments, ordered graphs and permutations have been obtained, with a particular emphasis on jumps in the growth of the profile. I shall



illustrate the role of well quasi order in the classification of hereditary classes of small growth and conclude with several questions.

What is the strength of the graph minor theorem?

Michael Rathjen
University of Leeds, England

Reverse mathematics (RM) is a program that strives to classify the logico-existential strength of theorems of "ordinary" mathematics by means of set existence principles, mainly as they appear in subsystems of second order arithmetic. The graph minor theorem, GM, is arguably the most important theorem of graph theory. The strength of GM exceeds that of the standard classification systems of RM known as the "big five". An upper bound not too far removed from the biggest of the five was claimed in the literature but later rescinded. In this talk I shall survey the current knowledge about the strength of GM and other Kruskal-like principles, presenting lower and upper bounds.

Who was working on well quasi-orders 40+ years ago and why?

Diana Schmidt
Heilbronn University of Applied Sciences, Germany

Well quasi-orders and Kruskal's Tree Theorem are nowadays being applied in several areas of computer science, a development which perhaps no-one expected in the seventies. I shall sketch what led me to study these topics then, but also who was there before me and laid vital foundations, and what their backgrounds and objectives were. I hope also to sketch the proof in my 1979 *Habilitationsschrift* of the maximal order types of the Kruskal's Tree Theorem well quasi-orders.

Well quasi-orders and descriptive set theory

Victor Selivanov
A. P. Ershov Institute of Informatics Systems, Russia

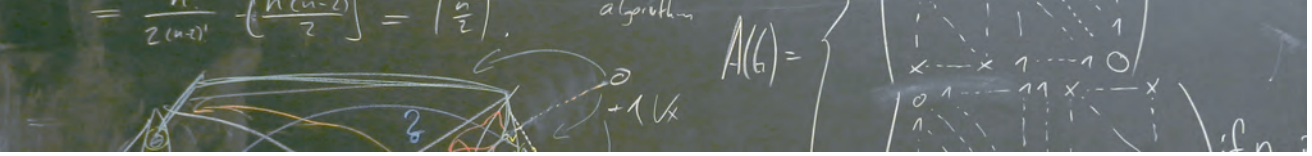
The classical approach to measure the descriptive complexity of a subset of a topological space is to use ordinals to estimate the number of iterations of suitable set-theoretic operations needed to obtain the set from the open sets. In contrast, ordinals are often not sufficient to measure the descriptive complexity of functions between topological spaces in an appropriate way. Some useful classifications of functions are obtained by employing natural well quasi-orders, in particular those arising from suitable embeddings between labeled trees.

In this talk, we survey recent results in the specified direction, considering some such classifications from descriptive set theory and automata theory.

On the well quasi-orderedness of pure patterns of resemblance of order two

Gunnar Wilken
Okinawa Institute of Science and Technology, Japan

Elementary patterns of resemblance, which are finite structures of nested trees, were discovered by Timothy J. Carlson and constitute the basic levels of his general program on patterns of embeddings as an ultrafine-structural approach to contribute to Gödel's suggestion of using large cardinals to solve mathematical incompleteness. The particular class of pure patterns of order two is well-quasi ordered with respect to coverings, as was shown by Carlson. We show that this result is unprovable in the subsystem Π^1_1-Comprehension with set induction of second-order number theory, which is the strongest system of the so-called Big Five in reverse mathematics.



MS#39: Zum Einsatz von Mathematik-Brückenhilfen in den Schulen

Organisatoren: Ingenuin Gasser, Hamburg; Thomas Schramm, Hamburg

In diesem Minsymposium soll auf die Frage eingegangen werden, ob und wie sogenannte Mathematik-Brückenhilfen an der Schnittstelle Schule-Hochschule, wie z.B. der OMB+ (Online Mathe Brückenkurs +), auch teilweise in der Schule genutzt und eingesetzt werden könnten. Das primäre Ziel solcher Hilfen ist die kontinuierliche Auseinandersetzung mit Standardschulthemen der Mittel- und Oberstufenmathematik, um einen sicheren und schnellen Umgang mit diesen Grundlagen zu fördern. Der Verlust des sicheren und schnellen Umgangs mit den schulmathematischen Grundlagen wird häufig als eine der wichtigsten Ursachen beim Scheitern an Hochschulen in wirtschaftswissenschaftlich, mathematisch, informatisch und naturwissenschaftlichen Studiengängen gesehen. Das Minisymposium richtet sich u. a. auch an Lehrer.

Mathematik-Brückenhilfen an der Schnittstelle Schule-Hochschule: die Beispiele OMB+ und Hamburger Orientierungstest

Helena Barbas
Technische Universität Hamburg-Harburg, Germany

Es werden zwei Projekte aus dem Bereich E-Learning vorgestellt, an deren Entwicklung die Hamburger Hochschulen UHH, HCU, TUHH und HAW beteiligt waren. Der OMB+ (Online Mathematik Brückenkurs +) ist ein Online-Kurs, mit dessen Hilfe Studieninteressierte noch vor Studienbeginn die Schulmathematik selbständig wiederholen können. Mit dem Hamburger Orientierungstest wurde ein kurzer diagnostischer Online-Test bereitgestellt, der Studieninteressierten eine Rückmeldung darüber gibt, in welchen Bereichen der Schulmathematik sie Nachholbedarf haben. Als Grundlage für den zu vermittelnden Stoff diente der Mindestanforderungskatalog Mathematik der baden-württembergischen COSH-Gruppe. Teilnahme an Orientierungstest und OMB+ sind kostenlos und können von zuhause erfolgen, es soll jedoch auch das Angebot geben, diese in Gänze oder in Teilen in den Schulunterricht zu integrieren.

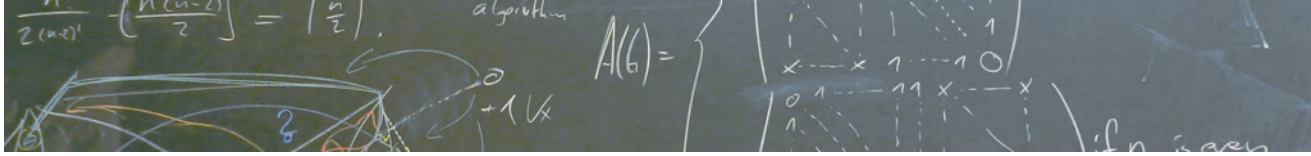
Einsatzszenarien für MINT-Onlinematerial und Onlinekurse an der Schnittstelle Schule/Hochschule.

Daniel Haase
Karlsruher Institut für Technologie, Germany

Mengenlehre im Schulunterricht. Ein Beitrag zur Verbesserung der Studierfähigkeit im MINT-Bereich?

Dirk Schlingemann
Gymnasium Wentorf, Germany

Viele mathematische Vorlesungen und Seminare an Hochschulen setzen das Verständnis mengentheoretischer Grundlagen voraus. Diese Aspekte werden im Schulunterricht meist nur auf einer intuitiven Ebene behandelt, so dass hier gegenüber den Anforderungen der Hochschule eine Lücke besteht. Das kann für Schulabsolventen zu einem Hindernis werden, die an Hochschulen und im wissenschaftlichen Bereich verwendeten mathematischen Formalismen nachzuvollziehen. Es soll die Fragestellung diskutiert werden, inwieweit die Grundlagen der Mengenlehre im Schulunterricht vermittelt werden können, um diese Lücke zu schließen.



Back to (School/University) : Ein Modell zur Kooperationen von Schulen und Hochschulen.

Thomas Schramm
HafenCity Universität Hamburg, Germany

Was glaubt ein Hochschullehrer noch vom Schulalltag zu wissen und was ein Schullehrer von den Anforderungen einer Hochschulausbildung? Wir stellen die Erfahrungen aus mehr als 10 Jahren einer gegenseitigen Kooperation vor und entwickeln ein Modell, um dieses Konzept auf der Basis der vorgestellten mathematischen Brückenkurse nachhaltig zu implementieren.

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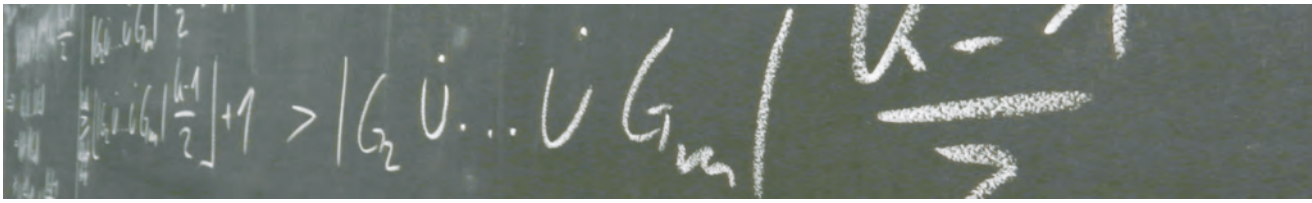


Workshops

Satellite Workshop: Recent Trends in Stochastic Analysis and Related Topics

Organisers: Leif Döring, Zürich; Alexander Drewitz, New York NY

This workshop is partially funded by the *Deutsche Forschungsgemeinschaft*.

Sunday, 20 September 2015.

10:00–10:35 Peter Mörters (Bath): *The contact process on evolving scale-free networks*

10:35–11:10 Antti Knowles (Zürich): *Eigenvalue distribution of random regular graphs*

11:10–11:45 Benedikt Jahnel (Berlin): *Classes of nonergodic interacting particle systems with unique invariant measure*

11:45–12:20 Peter Eichelsbacher (Bochum): *Malliavin-Stein method for Variance-Gamma approximation on Wiener space*

12:20–14:20 *Lunch Break*

14:20–14:55 Andrej Depperschmidt (Freiburg): *Random walks in dynamic random environments and ancestry under local population regulation*

14:55–15:30 Anton Bovier (Bonn): *Scaling limits in adaptive dynamics*

15:30-16:05 Hanna Döring (Osnabrück): *Connection times in large ad-hoc networks*

16:05–16:40 *Coffee Break*

16:40–17:15 Frank Aurzada (Darmstadt): *Persistence Probabilities*

17:15–17:50 Vitali Wachtel (Augsburg): *Invariance principles for random walks in cones*

Monday, 21 September 2015.

9:00–9:35 Markus Heydenreich (München): *Spontaneous symmetry breaking and the formation of crystals*

9:35–10:10 Volker Betz (Darmstadt): *Metastable dynamics of non-reversible perturbed Markov chains*

10:10–10:45 Sebastian Riedel (Berlin): *Invariant measures for rough differential equations*

10:45–11:15 *Coffee Break*

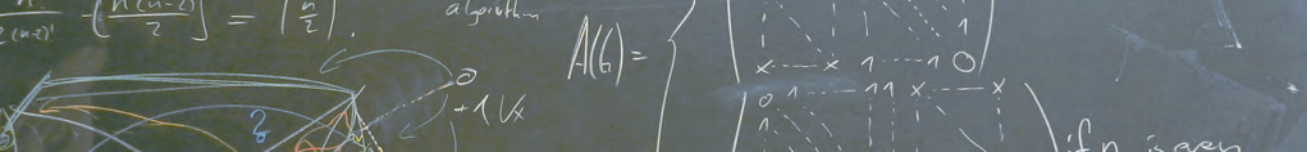
11:15–11:50 Markus Reiss (Berlin): *A remark on the rates of convergence for integrated volatility estimation in the presence of jumps*

11:50–12:25 Anita Winter (Duisburg-Essen): *Evolving phylogenies of trait-dependent branching with mutation and competition*

12:25–14:30 *Lunch Break*

14:30–15:05 Perla Sousi (Cambridge): *Mixing, hitting and intersection times for Markov chains*

15:05–15:40 Jason Miller (Cambridge): *Liouville quantum gravity and the Brownian map*



Satellite Workshop: Generalized Baire Space

Organisers: Giorgio Laguzzi, Freiburg; Wolfgang Wohofsky, Hamburg

This workshop aims to provide the platform for exchange for the researchers active in the field of the set theory of the generalized Baire space and continues the tradition of the Amsterdam workshop on the same topic held in 2014. It is partially funded by the *Deutsche Forschungsgemeinschaft* (grant number LO834/12-1). The two days of the workshop will consist of three tutorials, several contributed talks and a concluding discussion session.

Sunday, 20 September 2015

11:00-12:00 Vadim Kulikov: *The language $M^{\kappa^+\kappa}$ and Borel sets*

12:15-14:00 *Lunch Break*

14:00-14:45 Dorottya Sziráki: *A dichotomy for Σ^0_2 relations and elementary embeddability of uncountable cardinals*

15:00-15:45 Diana Montoya: *On Cichon's diagram for uncountables*

15:45-16:15 *Coffee Break*

16:15-17:00 Philipp Schlicht: *TBA*

17:15-18:00 Philipp Lücke: *Lightface Δ^1_1 subsets of $\omega_1^{\omega_1}$*

Monday, 21 September 2015

10:00-11:00 Luca Motto Ros: *On some classification problems concerning uncountable structures and non-separable spaces*

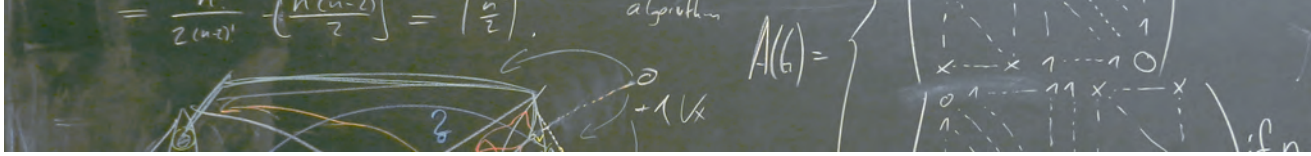
11:10-11:30 *Coffee Break*

11:30-12:30 Andrew Brooke-Taylor: *On large cardinal preservation for generalized Baire Space*

12:30-14:00 *Lunch Break*

14:00-14:45 TBA: *TBA*

14:45-15:30 Final discussion session



Satellite Workshop: Trends in Proof Theory

Organiser: Stefania Centrone, Oldenburg

This workshop continues the Humboldt Kolleg "Proof" held in Bern in 2013. It is funded by the *Altonaer Stiftung für philosophische Grundlagenforschung*, the *Deutsche Forschungsgemeinschaft* and the *Deutsche Vereinigung für Mathematische Logik und für Grundlagenforschung der exakten Wissenschaften*.

Sonntag, 20.09.2015

09:15-10:00 H. Schwichtenberg: *Logic for Real Number Computation*

10:00-10:45 U. Petersen: *On Levels of Induction in a Contraction Free Logic with Unrestricted Abstraction*

10:45-11:00 *Coffee Break*

11:00-11:45 S. Negri: *On Neighbourhood Semantics and Sequent Calculus*

11:45-12:30 L. Crosilla: *Philosophy of Mathematics and Proof Theory: Some Thoughts*

12:30-14:30 *Lunch Break*

14:30-15:15 M. Siebel: *Knowing-That and Knowing-Why in Plato, Aristotle and Bolzano*

15:15-16:00 G. Sundholm: *TBA*

16:00-16:30 *Coffee Break*

16:30-17:15 V. Peckhaus: *The Notion of Proof in the Early Algebra of Logic*

17:15-18:00 D. Føllesdal: *The Role of Mathematics and Science in Bildung*

Montag, 21.09.2015

09:15-10:00 P. Schuster: *Eliminating Disjunctions by Disjunction Eliminations*

10:00-10:45 M. Okada: *Husserlian Notion of Manifold as Proof-Rewrite Networks and its Extension*

10:45-11:00 *Coffee Break*

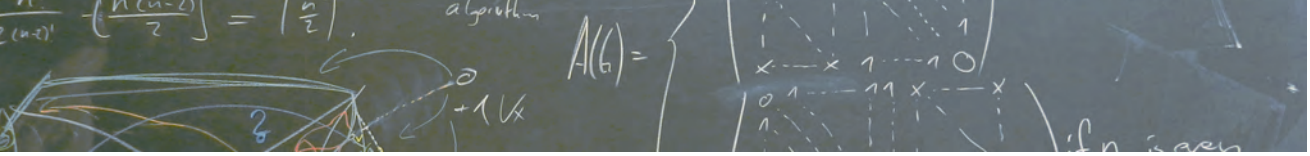
11:00-11:45 T. Strahm: *A Feferman-style Type System for the Small Veblen Ordinal*

11:45-12:30 M. Benini. *Proof-Theoretic Semantics: Point-free meaning of first-order systems*

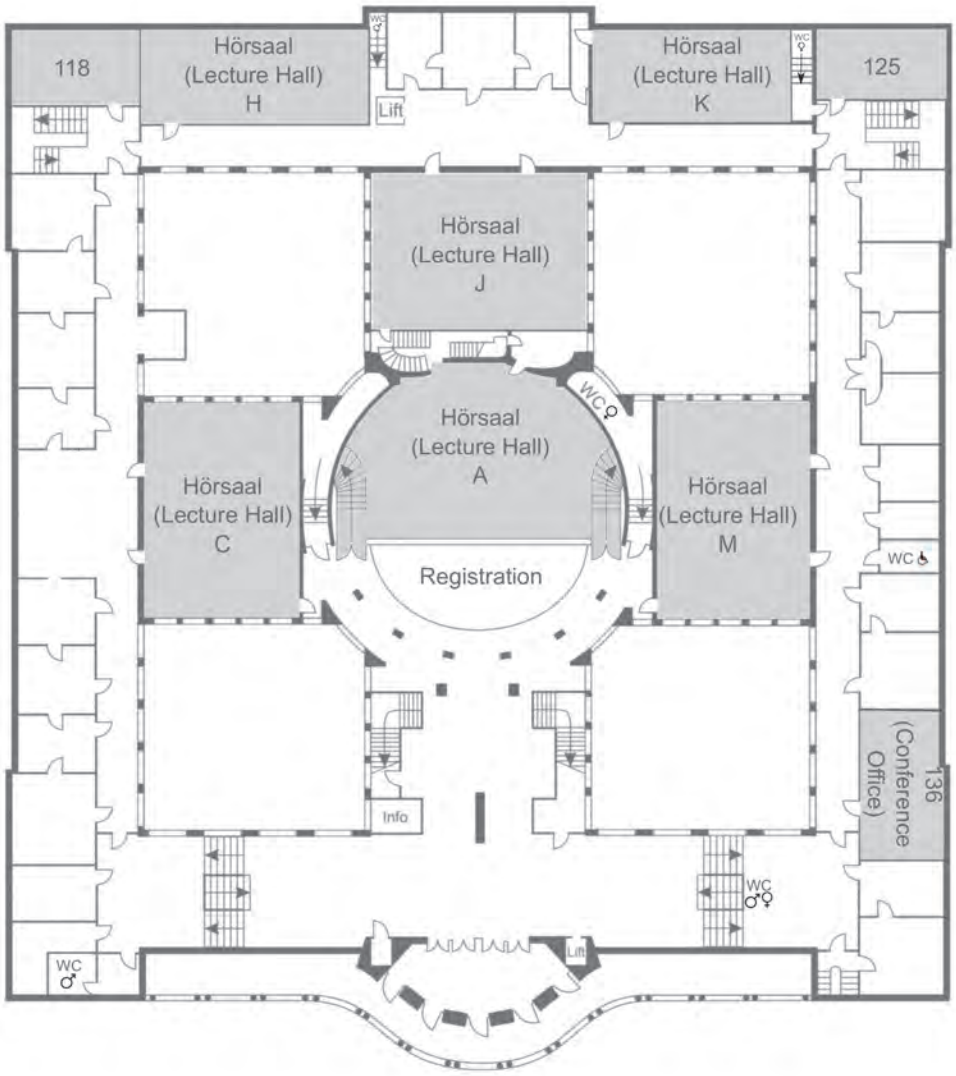
12:30-14:00 *Lunch Break*

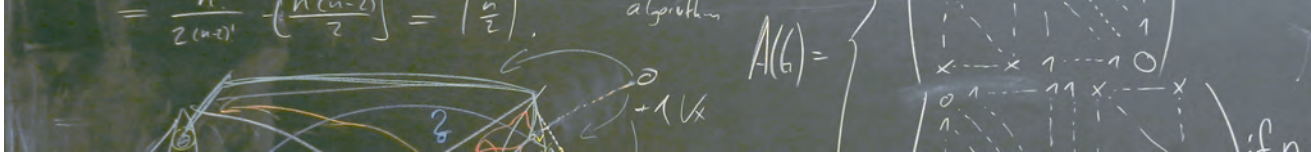
14:00-14:45 D. Probst: *Modular Ordinal Analysis of Subsystems of Second Order Arithmetic of Strength up to* ID_1

14:45-15:30 G. Jäger: *Recent Developments in Operational Set Theory*

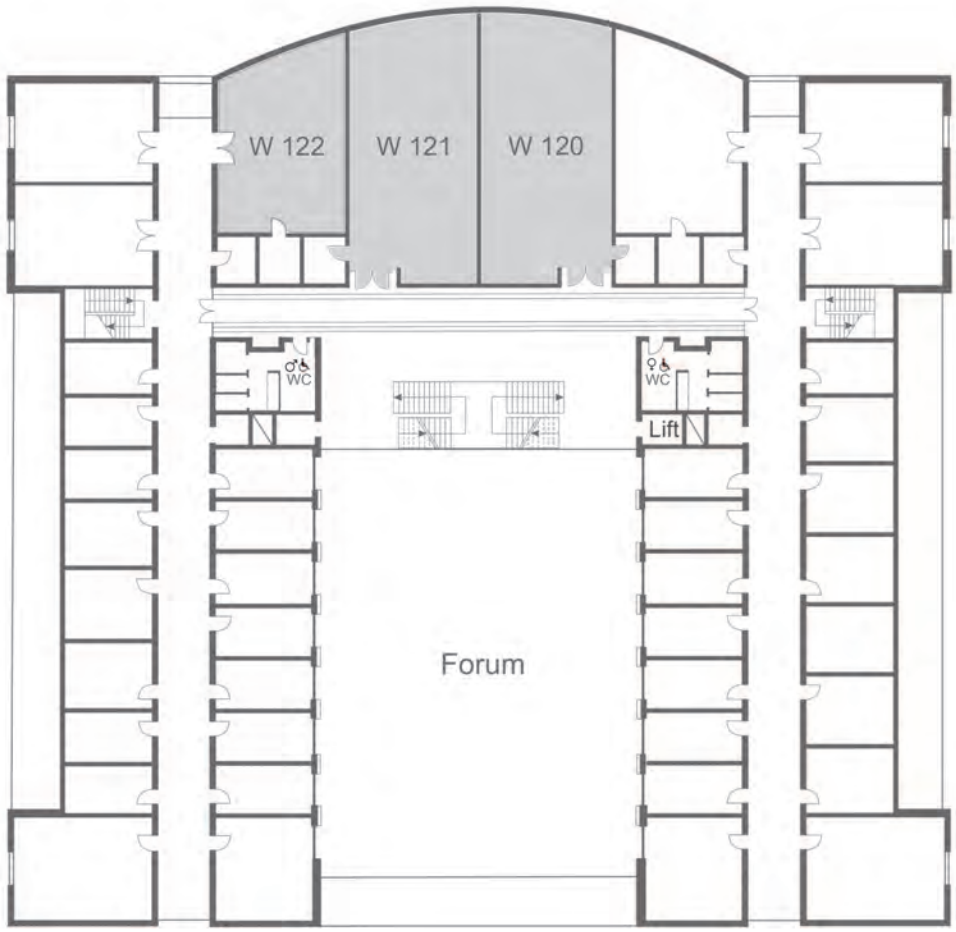


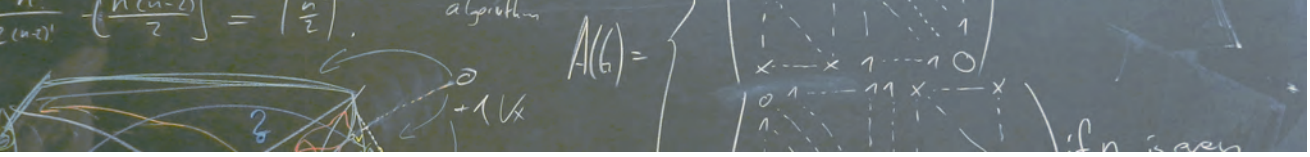
ESA1: Erdgeschoß / Ground Floor



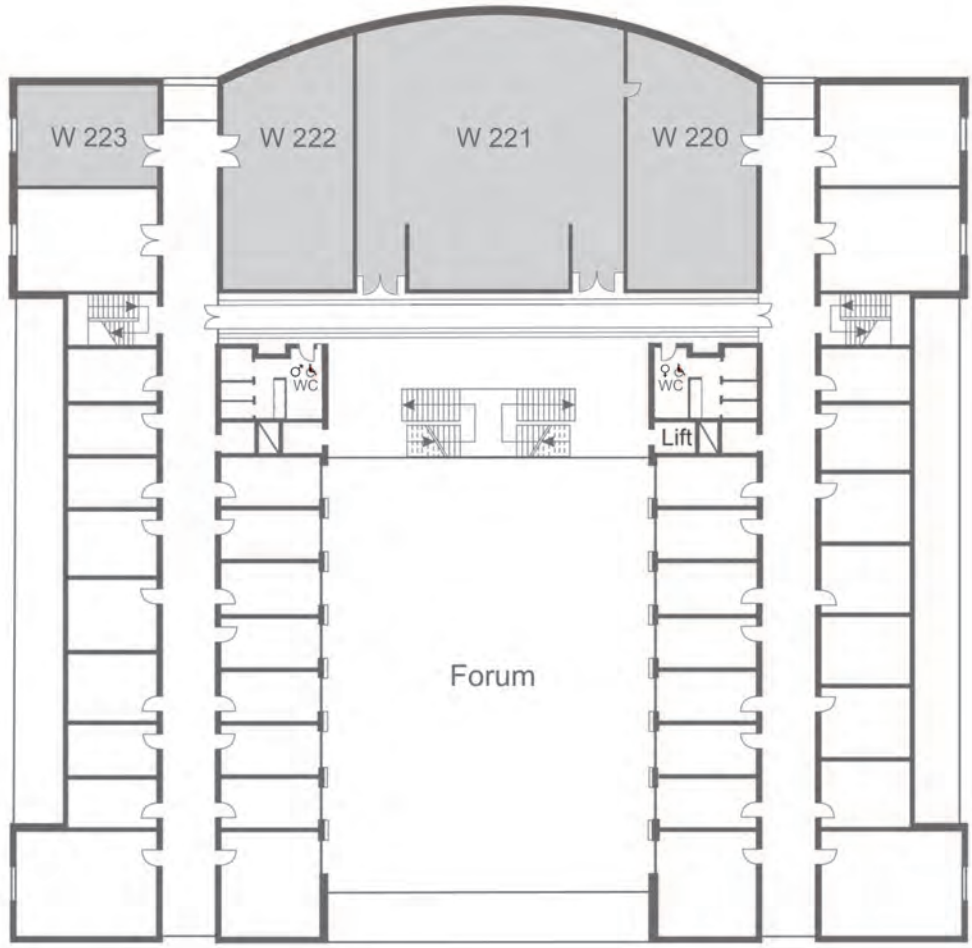


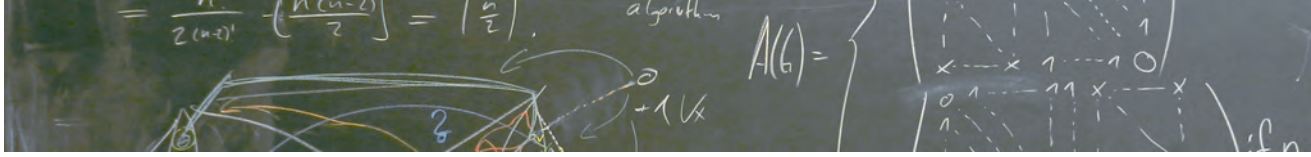
ESA1W: 1. Obergeschoß / First Floor



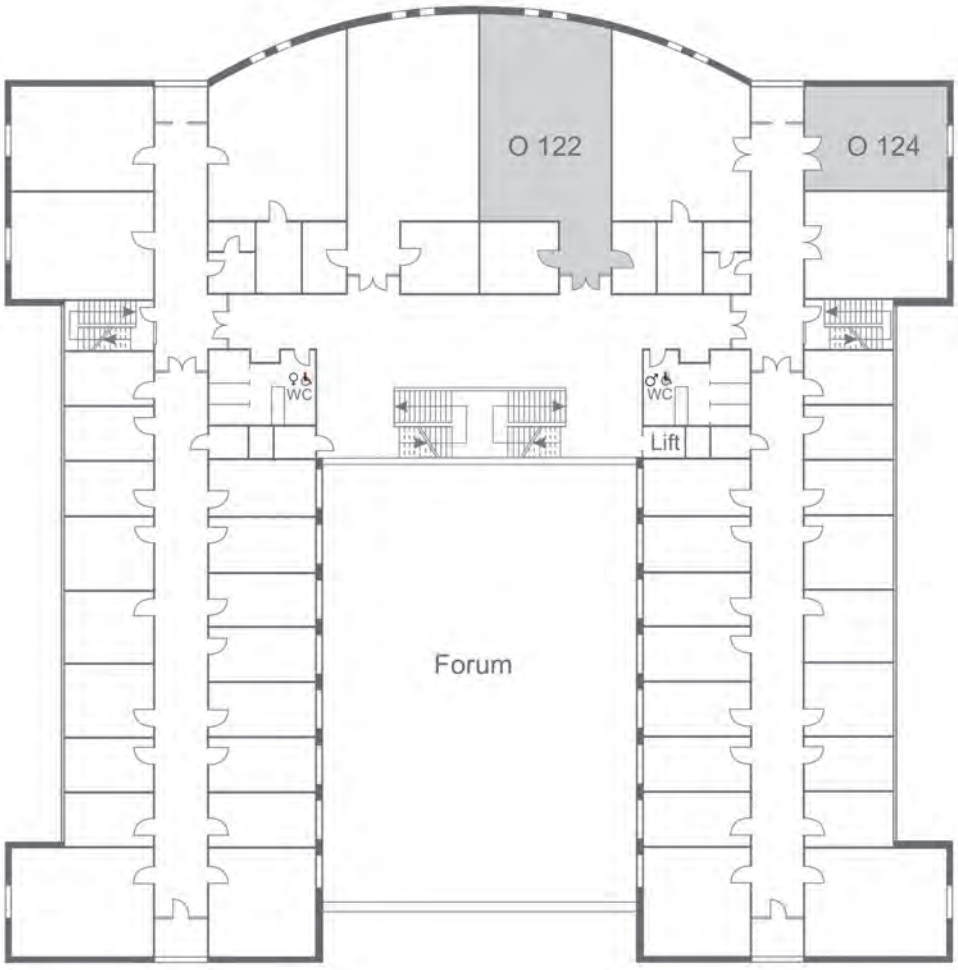


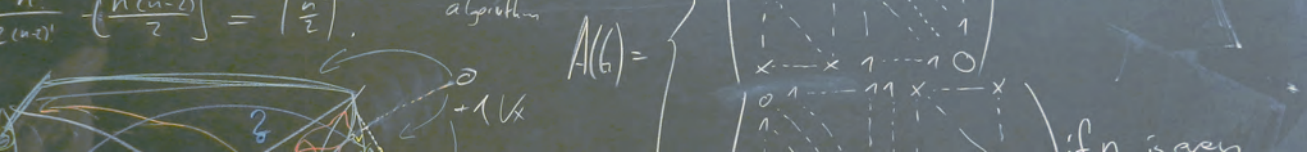
ESA1W: 2. Obergeschoß / Second Floor





ESA1O: 1. Obergeschoß / First Floor





ESA1O: 2. Obergeschoß / Second Floor