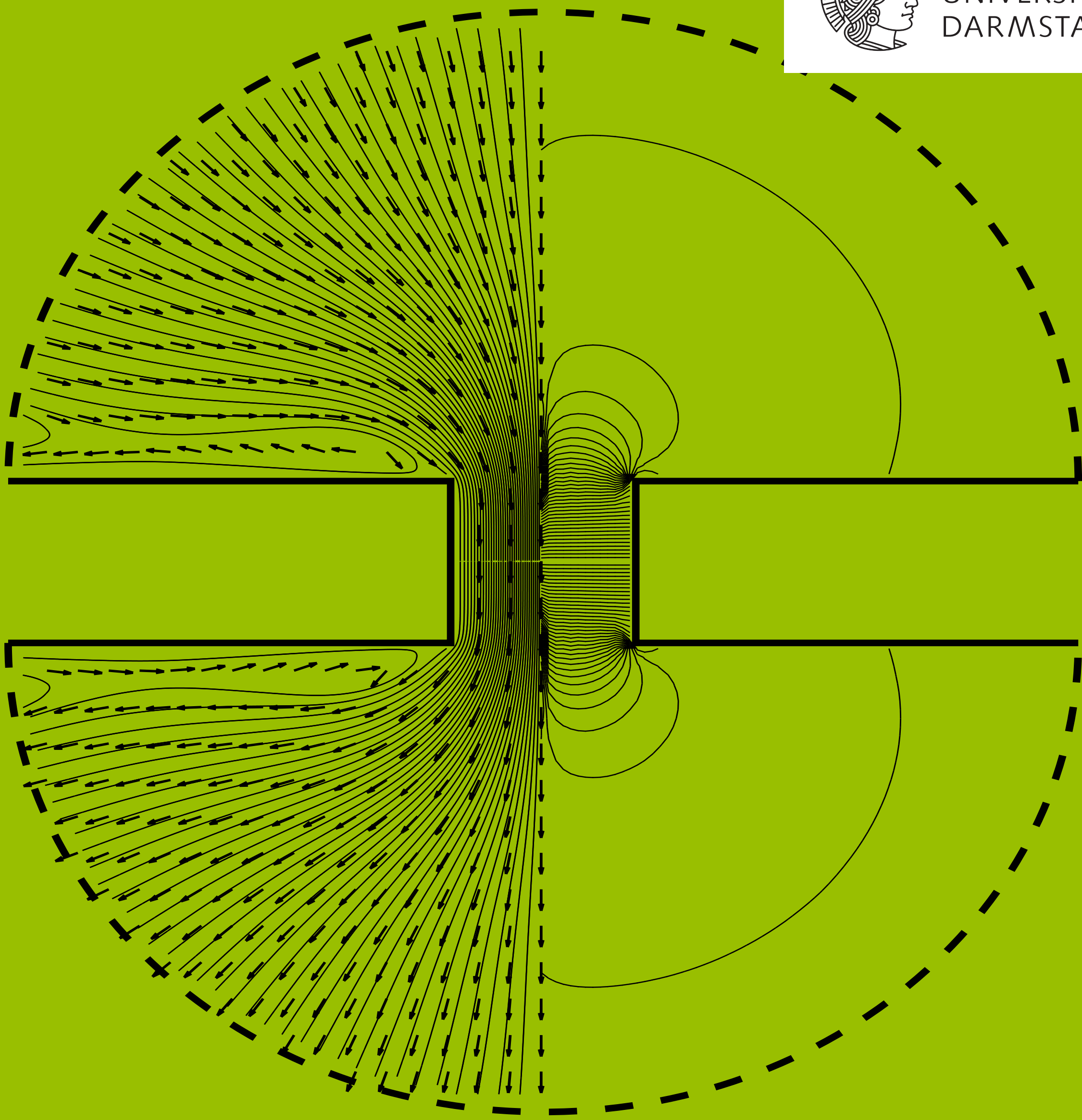
Biannual Report

Department of Mathematics
2017 and 2018



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On the cover page the velocity and pressure profile in the vicinity of one opening of a perforated wall within a visco-acoustic model is illustrated. It is obtained in the project "Impedance conditions for visco-acoustic models" (see page 65).

Dear reader,

this biannual report provides a comprehensive overview of the research and teaching activities at the Department of Mathematics at TU Darmstadt during the years 2017 and 2018.
A characteristic of our department is the broad area of topics that are covered both in research and teaching. This is, for instance, reflected by the organization into eight diverse working groups: Algebra, Analysis, Applied Geometry, Didactics and Pedagogics of Mathematics, Logic, Numerical Analysis and Scientific Computing, Optimization and Stochastics. The research activities are demonstrated by several joint research endeavors like Collaborative Research Centers, Graduate Schools, LOEWE centers, and, last but not least, a large number of personal contacts. In particular, inter-disciplinary work, for instance in cooperation with mechanical and electrical engineering, is one of the main pillars of research at our department. We are also very well connected to other research groups – at the TU Darmstadt, in the Rhein-Main-Neckar area, within Germany, and far beyond. As such, our department is one of the largest and strongest departments of mathematics in Germany.
The wealth of research areas is also represented in the different teaching activities. On the one hand, we provide several well established degrees in mathematics and additionally the new English master in mathematics. On the other hand, our department offers a significant number of courses for thousands of students in each semester, mostly coming from other departments at the TU Darmstadt. In all of the these courses, we are dedicated to excellent and innovative teaching.
The present report is meant to provide information about all research and teaching activities, about publications and prizes, presentations and events, from every single graduation thesis to our activities for high schools, and many other details that taken together represent our work in the last two years. We hope that this report forms an interesting and enjoyable reading experience.

With kind regards,

Prof. Dr. Marc Pfetsch
(Dean of the department)

Contents

1 Research Groups

This section gives a brief overview of the research done in the eight research groups.

1.1 Algebra

The main research areas of this group are algebraic geometry, number theory and conformal field theory.
We are interested in Shimura varieties and automorphic forms and their applications in geometry and arithmetic. For example we investigate intersection and height pairings of special algebraic cycles on Shimura varieties and their connection to automorphic L-functions. We also study the relation between the representation theory of conformal field theories and automorphic forms.

Members of the research group

Professors

Jan Hendrik Bruinier, Yingkun Li, Anna von Pippich, Nils Scheithauer, Torsten Wedhorn

Retired professors

Karl-Heinrich Hofmann

Postdocs

Moritz Dittmann, Jolanta Marzec, Michalis Neururer, Brandon Williams

Research Associates

Patrick Bieker, Johannes Buck, Timo Henkel, Jens Hesse, Patrick Holzer, Paul Kiefer, David Klein, Jennifer Kupka, Priyanka Majumder, Sebastian Opitz, Maximilian Rössler, Thomas Spittler, Fabian Völz

Secretaries

Ute Fahrholz, Anja Spangenberg

Project: Regularized theta lifts

In this project we study regularized theta lifts of harmonic Maass forms and meromorphic modular forms.
The Shimura correspondence connects modular forms of integral weights and half-integral weights. One of the directions is realized by the Shintani lift, where the inputs are holomorphic differentials and the outputs are holomorphic modular forms of half-integral weight. In joint work with Funke, Imamoglu and Li, we generalize this lift to meromorphic differentials of the third kind on modular and Shimura curves. As an application we obtain a modularity result concerning the generating series of winding numbers of closed geodesics on modular curves.
In joint work with M. Schwagenscheidt we express the coefficients of mock theta functions of weight $1/2$ and $3/2$ in terms of traces of certain weakly holomorphic modular forms of weight 0 for $\Gamma_0(N)$. As an application we obtain rationality results for these coefficients and explicit formulas for Weyl vectors of Borcherds products.

Partner: J. Funke, Durham University; O. Imamoglu, ETH Zürich; Y. Li, TU Darmstadt

Support: DFG

Contact: J. H. Bruinier, Y. Li, M. Schwagenscheidt

References

[1] C. Alfes-Neumann and M. Schwagenscheidt. On a theta lift related to the Shintani lift. *Advances in Mathematics*, 328:858–889, 2018.

[2] J. H. Bruinier, J. Funke, and O. Imamoglu. Regularized theta liftings and periods of modular functions. *Journal für die reine und angewandte Mathematik*, 703:43–93, 2015.

[3] J. H. Bruinier, J. Funke, O. Imamoḡlu, and Y. Li. Modularity of generating series of winding numbers. *Research in the Mathematical Sciences*, 5:23pp., 2018.

[4] J. H. Bruinier and M. Schwagenscheidt. Algebraic formulas for the coefficients of mock theta functions and Weyl vectors of Borcherds products. *Journal of Algebra*, 478:38–57, 2017.

Project: Arithmetic intersection theory on Shimura varieties

We study special cycles on integral models of Shimura varieties associated with unitary similitude groups of signature $(n-1,1)$. In joint work with Howard and Yang we construct an arithmetic theta lift from harmonic Maass forms of weight $2-n$ to the first arithmetic Chow group of a toroidal compactification of the integral model of the unitary Shimura variety, by associating to a harmonic Maass form f a suitable linear combination of Kudla-Rapoport divisors, equipped with the Green function given by the regularized theta lift of f. Our main result expresses the height pairing of this arithmetic Kudla-Rapoport divisor with a CM cycle in terms of a Rankin-Selberg convolution L-function of the cusp form of weight n corresponding to f and the theta function of a positive definite hermitian lattice of rank $n-1$. The proof relies on a new method for computing improper arithmetic intersections (among other things).
In more recent work with Howard, Kudla, Rapoport, and Yang we prove that the generating series of arithmetic Kudla Rapoport divisors is an elliptic modular form of weight n with values in the arithmetic Chow group. This can be used to define an arithmetic theta lift from weight n cusp forms to the arithmetic Chow group. As applications, one obtains Gross-Zagier type formulas for heights of CM cycles in this setting as well as a proof of the Colmez conjecture in cases where the CM field is the compositum of a totally real field and an imaginary quadratic field.

Partner: B. Howard, Boston College; S. Kudla, University of Toronto; M. Rapoport, Universität Bonn; T. Yang, University of Wisconsin at Madison

Support: DFG, NSF, AIM

Contact: J. H. Bruinier, Y. Li

References

[1] J. H. Bruinier, B. Howard, S. Kudla, M. Rapoport, and T. Yang. Modularity of generating series of divisors on unitary Shimura varieties. Preprint, 2017.

[2] J. H. Bruinier, B. Howard, S. Kudla, M. Rapoport, and T. Yang. Modularity of generating series of divisors on unitary Shimura varieties II: arithmetic applications. Preprint, 2017.

[3] J. H. Bruinier, B. Howard, and T. Yang. Heights of Kudla-Rapoport divisors and derivatives of L-functions. *Inventiones Mathematicae*, 2015.

[4] J. H. Bruinier and Y. Li. Heegner divisors in generalized Jacobians and traces of singular moduli. *Algebra and Number Theory*, 2016.

Project: Arithmetic Siegel-Weil formulas

Let V be a rational quadratic space of signature $(m, 2)$. A conjecture of Kudla relates the arithmetic degrees of top degree special cycles on an integral model of a Shimura variety associated with $\mathrm{SO}(V)$ to the coefficients of the central derivative of an incoherent Siegel Eisenstein series of genus $m + 1$.

In joint work with T. Yang we prove this conjecture for the coefficients of non-singular index T when T is not positive definite. We also prove it when T is positive definite and the corresponding special cycle has dimension 0. To obtain these results, we establish new local arithmetic Siegel-Weil formulas at the archimedean and non-archimedian places.

Partner: T. Yang, University of Wisconsin at Madison

Support: DFG, LOEWE

Contact: J. H. Bruinier

References

[1] J. H. Bruinier and M. Westerholt-Raum. Kudla's modularity conjecture and formal Fourier-Jacobi series. *Forum of Mathematics, Pi*, 3:30pp., 2015.

[2] J. H. Bruinier and T. Yang. Arithmetic degrees of special cycles and derivatives of Siegel Eisenstein series. Preprint, 2018.

[3] S. S. Kudla. Special cycles and derivatives of Eisenstein series. In *Heegner points and Rankin L-series*, volume 49 of *Math. Sci. Res. Inst. Publ.*, pages 243–270. Cambridge Univ. Press, Cambridge, 2004.

Project: Arithmetic Riemann-Roch theorem for singular metrics

A fundamental result in arithmetic intersection theory is the arithmetic Riemann–Roch theorem for arithmetic varieties by Gillet and Soulé. This theorem developed from previous versions by Faltings and Deligne, who treated the case of arithmetic surfaces. Deligne's isometry and the arithmetic Riemann-Roch theorem both require the vector bundles to be endowed with smooth hermitian metrics. However, many cases of arithmetic interest do not satisfy this assumption. This research project with G. Freixas i Montplet aims at establishing an arithmetic Riemann–Roch theorem for a certain type of singular metrics. Furthermore, we aim at deriving arithmetic application from this theorem, for instance, we want to compute special values of the Selberg zeta function. These values are very difficult to compute in general and they cannot (yet) be computed by purely analytical methods. In the recent article [1], we developed a new method of extending Deligne's Riemann–Roch isometry to cusp compactifications of orbicurves of the form $\Gamma\backslash\mathbb{H}$, for $\Gamma \subset \mathrm{PSL}_2(\mathbb{R})$ a Fuchsian subgroup of the first kind, having both parabolic and elliptic elements. One arithmetic application of the theorem consists in an exotic analytic class number formula for the Selberg zeta function for the modular group. In the next step, we plan to apply the developed method to more general situations. We start by considering flat unitary vector bundles with finite monodromies at the cusps.

Partner: G. Freixas i Montplet, CNRS Paris

Contact: A.-M. von Pippich

References

[1] G. F. i Montplet and A.-M. von Pippich. Riemann–Roch isometries in the non-compact orbifold setting. *J. Eur. Math. Soc. (JEMS)*, to appear.

Project: Generalized Eisenstein series

Eisenstein series are an essential ingredient in the theory of automorphic forms with numerous applications to number theory and arithmetic geometry. This joint research project concerns the generalization of elliptic and hyperbolic Eisenstein series to more general settings. Here, one direction of research has been devoted to the study of special values of these Eisenstein series and to establish an analogue of Kronecker's limit formula. In a recent work, jointly with V. Völz and M. Schwagenscheidt, we realized averaged versions of these Eisenstein series for as regularized Borcherds lifts and we proved that the special value at $s = 0$ is given in terms of the corresponding Borcherds product. In the next step, we plan to define and study generalized Eisenstein series associated to special cycles for the orthogonal group, and we aim at realizing theses series in a similar way as generalized regularized theta lifts.

Partner: D. Klein (TU Darmstadt); M. Schwagenscheidt (Universität zu Köln)

Contact: A.-M. von Pippich

Project: Jensen–Rohrlich type formulas for hyperbolic spaces

The classical Jensen's formula is a well-known theorem of complex analysis which characterizes, for a meromorphic function f on the unit disc, the value of the integral of $\log|f(z)|$ on the unit circle in terms of the zeros and poles of f inside the unit disc. An important theorem of Rohrlich establishes a version of Jensen's formula for modular functions f with respect to the full modular group $\mathrm{PSL}_2(\mathbb{Z})$ and expresses the integral of $\log|f(z)|$ over a fundamental domain in terms of special values of Dedekind's eta function. In this joint project, we plan to establish analogues of the Jensens's formula in higher dimensions. In the recent article [1], we were able to prove a Jensen–Rohrlich type formula for the hyperbolic 3-space.

Partner: S. Herrero (University of Gothenburg); Ö. Imamoḡlu (ETH Zürich); Á. Tóth (Eötvös Loránd University, Budapest)

Contact: A.-M. von Pippich

References

[1] S. Herrero, O. Imamoglu, A.-M. von Pippich, and A. Tóth. A jensen–rohrlich type formula for the hyperbolic 3-space. *Trans. Amer. Math. Soc.*, 371(9):6421–6446, 2019.

Project: Summer school *Faszination Mathematik* for secondary school students

In this yearly summer school, scientists from the mathematics department of TU Darmstadt work with groups of six mathematically talented secondary school students from Hesse on a subject that is based on mathematics taught at school, but goes far beyond this knowledge and connects with university mathematics. The daily work of the groups consists of three hours in the morning and three hours in the afternoon. Under the advice of the scientists, the secondary school students work together independently and also have to study mathematical literature. At the end of the week, every group gives a LaTex-beamer presentation on the results achieved. The scientists are available for questions and discussions during the whole summer school.

The project summer school *Faszination Mathematik* is lead by A.-M. v. Pippich. In 2017, the summer school took place from June 20 to June 23 in Heidelberg and was organized by A.-M. v. Pippich and F. Völz. Six scientists (J. Bitterlich, M. Buck, A.-M. v. Pippich, S. Schwinn, P. Tolksdorf, F. Völz) and 21 selected students from 10 secondary schools from Hesse participated and worked together on topics ranging from stochastics and logic to number theory. In 2018, the summer school took place from June 15 to July 19 in Darmstadt and was organized by A.-M. v. Pippich and F. Völz. Six scientists (J. Bitterlich, M. Neururer, R. Neururer, A.-M. v. Pippich, M. Schwagenscheidt, F. Völz) and 16 selected students from 11 secondary schools from Hesse participated and worked together on topics ranging from logic and informatics to number theory. Further information is available on the webpage

`www.mathematik.tu-darmstadt.de/sommerschule-faszination-mathematik`

Contact: A.-M. von Pippich

Project: Classification of automorphic products of singular weight

Borcherds' singular theta correspondence is a map from modular forms for the Weil representation of $\mathrm{SL}_2(\mathbb{Z})$ to automorphic forms on orthogonal groups. Since these automorphic forms have nice product expansions at the rational 0-dimensional cusps they are called automorphic products. They have found various applications in algebra, geometry and arithmetic.
The smallest possible weight of a non-constant, holomorphic automorphic form on $O_{n,2}(\mathbb{R})$ is $(n-2)/2$. Forms of this so-called singular weight are particularly interesting because their Fourier coefficients are supported only on isotropic vectors.
Holomorphic automorphic products of singular weight seem to be very rare. The few known examples are all related to infinite-dimensional Lie superalgebras, i.e. are given by the denominator functions of generalised Kac-Moody superalgebras. One of the main open problems in the theory of automorphic forms on orthogonal groups is to classify holomorphic automorphic products of singular weight.
In [1], [3] and [2] holomorphic automorphic products of singular weight on lattices of squarefree level with reflective divisors, i.e. zeros of order 1 along hyperplanes orthogonal to roots, are classified. Now the more general case without condition on the zeros shall be investigated. In particular the question whether there are automorphic products of singular weight on $O_{n,2}(\mathbb{R})$ for $n > 26$ shall be studied.

Contact: N. Scheithauer

Partner: M. Dittmann

References

[1] M. Dittmann. Reflective automorphic forms on lattices of squarefree level. *To appear in Trans. Amer. Math. Soc.*

[2] N. Scheithauer. On the classification of automorphic products and generalized Kac-Moody algebras. *Invent. Math.*, 164:858 – 877, 2006.

[3] N. Scheithauer. Automorphic products of singular weight. *Compositio Math.*, 153:1855–1892, 2017.

Project: Construction and uniqueness of holomorphic vertex operator algebras

Vertex algebras give a mathematically rigorous description of 2-dimensional quantum field theories. A prominent example is the moonshine module constructed by Frenkel, Lepowsky and Meurman as (-1)-orbifold of the vertex operator algebra associated with the the Leech lattice. This vertex operator algebra carries an action of the largest sporadic group, the monster. Borcherds showed that the corresponding twisted traces are modular functions for genus 0 groups.

The construction of the moonshine module can be generalised as follows. Let V be a holomorphic vertex operator algebra and g a finite order automorphism of V. Then the fixed point subalgebra V^g can be extended to a holomorphic vertex operator algebra $V^{\mathrm{orb}(g)}$ [1]. Furthermore the orbifold $V^{\mathrm{orb}(g)}$ possesses an automorphism h such that $(V^{\mathrm{orb}(g)})^{\mathrm{orb}(h)} = V$ [1].

We want to study the classification problem for holomorphic vertex operator algebras of central charge 24 using these results. It shall be shown that such a vertex operator algebra can be constructed as an orbifold of the vertex operator algebra associated with the Leech lattice and, in the case $V_1 \neq 0$, is uniquely determined by the Lie algebra structure of its V_1-subspace. Some cases are covered in [2].

Contact: N. Scheithauer

Partner: J. van Ekeren, S. Möller

References

[1] J. van Ekeren, S. Möller, and N. Scheithauer. Construction and classification of holomorphic vertex operator algebras. *To appear in J. Reine Angew. Math.*

[2] J. van Ekeren, S. Möller, and N. Scheithauer. Dimension formulae in genus 0 and uniqueness of vertex operator algebras. *To appear in Int. Math. Res. Not.*

1.2 Analysis

The research group Analysis consists of six professors, D. Bothe, R. Farwig, R. Haller-Dintelmann (apl.), M. Hieber, M. Kyed, S. Roch (apl.) and Ch. Stinner as tenured Privatdozent, and about 35 assistants as state employees or paid by third party funding. The field of research of this group covers theory and applications of partial differential equations and of integral equations as well as mathematical modeling. Having close contact to the departments of engineering and natural sciences, the analysis group at TU Darmstadt is open to new mathematical problems and scientific challenges.

One focal point of research activities is the investigation of the nonlinear equations of fluid mechanics including an enhanced analysis of linear model problems which are solved by methods of evolution equations, maximal regularity and harmonic analysis. A famous open problem concerning the existence of smooth solutions of the so-called Navier-Stokes equations is one of the seven Millennium Problems of Clay Mathematics Institute.

A second point is put on the mathematical modeling and computational analysis of complex flow problems, in particular two-phase flows and transport processes occurring at fluid interfaces. The research builds on continuum mechanical modeling employing and further developing sharp-interface models with increasing levels of physico-chemical interface properties. For a deep understanding of the elementary transport and transfer processes, direct numerical simulations with the Volume-of-Fluid method are employed.

Further focal points concern the analysis and numerical approximation techniques for singular integral equations which can be applied in fluid mechanics, computer tomography and image processing, the analysis of elliptic and parabolic equations on non-smooth domains with mixed boundary conditions as well as the investigation of various chemotaxis models.
The research group Analysis presents two "Open Seminars" on a regular weekly basis, introductory seminars on functional analytic tools in the theory of partial differential equations as well as graduate seminars on recent questions in the above-mentioned fields of research. In addition to basic courses on mathematics for engineers, the research group offers lectures on analysis for majors in mathematics as well as advanced courses on partial differential equations and on related fields for graduate students.
Moreover, the research group jointly organizes several workshops per year within the International Research Training Group on "Mathematical Fluid Dynamics". The venues alternately take place at the TU Darmstadt or Waseda University, Tokyo, Japan.
Several members of the research group Analysis are Principal Investigators of the International Research Training Group (IRTG 1529) (Internationales Graduiertenkolleg) "Mathematical Fluid Dynamics" funded by DFG and JSPS and associated with TU Darmstadt, Waseda University in Tokyo and the University of Tokyo. The program seeks to combine methods from several mathematical disciplines such as analysis, stochastics, geometry and optimization to pursue fundamental research in Fluid Dynamics. Dieter Bothe acts further as a Principal Investigator in various research networks such as CRC 1194 and 75 and SPP 1506 and 1740 funded by DFG.

Members of the research group

Professors

Dieter Bothe, Reinhard Farwig, Rogert-Haller Dintelmann, Matthias Hieber, Mads Kyed, Steffen Roch

Tenured Positions Christian Stinner

Postdocs

Jorge Cardona, Anupam Pal Choudhury, Karoline Disser, Holger Marschall, Martin Saal, Amru Hussein, Jonas Sauer, Patrick Tolksdorf

Research Associates

Björn Augner, Sebastian Bechtel, Aday Celik, Xingyuan Chen, Daniel Deising, Thomas Eiter, Manuel Falcone, Mathis Fricke, Mathis Gries, Dirk Gründing, Dennis Hillenband, Klaus Kress, Johannes Kromer, Tomislav Maric, Jens Möller, Matthias Niethammer, Chiara Pesci, Andreas Schmidt, Anton Seyfert, Katharina Schade, Tobias Tolle, Paul Weber, David Wegmann, André Weiner, Marc Wrona

Secretaries

Renate Driessler, Anke Meier-Dörnberg, Kerstin Schmitt

Project: Interconnection structures for infinite-dimensional systems of port-Hamiltonian type

Starting from the 1960s *port-based* modelling and analysis has been introduced to treat complex, multi-physics systems within a unified framework. These usually consist of many subsystems of mechanical, electrical or thermal type etc., which can be described by their inner dynamics, usually a system of ODEs or PDEs, and which may interact with other subsystems via ports, i.e. input and output variables. For *port-Hamiltonian systems* the notion of energy is highlighted, and usually subsystems are required to be either energy-preserving or energy-dissipating. We investigate well-posedness and stability properties for this class of systems, especially the effects of non-autonomous perturbations and of the structure of the system on existence, uniqueness and long-time behaviour of solutions.

Partner: Birgit Jacob (Bergische Universität Wuppertal), Hafida Laasri (Bergische Universität Wuppertal)

Contact: Björn Augner

Project: Thermodynamically consistent modelling and analysis of bulk-surface systems

We consider bulk-surface systems in which chemical substances adhere to an active surface, where they may diffuse and chemically react. Based on the conservation laws, the molar fluxes (e.g. via Maxwell-Stefan relations), the chemical reaction rates (e.g. mimicking standard mass-action-kinetics) and the sorption rates have to be included based on realistic models (e.g. Henry, Langmuir or Freundlich model) for the chemical potentials. For these models to be physically relevant, consistency with thermodynamics has to be ensured: An entropy principle needs to be fulfilled and the structure of the constitutive relations has to ensure positive invariance for the concentrations. Similarly, when considering a maximal capacity on the surface, the vacancy density needs to be positive as well. We address the problems of well-posedness, positive invariance and global existence for strong and weak solutions.

Partner: Karoline Disser, Christian Stinner, Josef Malek (Charles University Prague)

Contact: Björn Augner, Dieter Bothe

Project: Modelling and VOF based Simulation of transfer processes at dynamic contact lines

Many applications in the engineering sciences require a profound understanding of the physical processes in multiphase flows, i.e. flows with multiple components. A *contact line* arises when three thermodynamic phases come together to form a complex system. A typical example is a liquid droplet sitting (or moving) on a wall, surrounded by the ambient air. A possible approach to describe such a system is continuum physics, where the microscopic structure of matter is not explicitly resolved. Therefore, one has to formulate *effective boundary conditions* to incorporate the relevant small scale physics. In particular, the interplay of the local transport of momentum, heat and mass close to the contact line is addressed in this project.

As a first result, a fundamental kinematic evolution equation describing the evolution of *contact angle* (i.e. the angle of intersection between the fluid-fluid interface and the solid wall) and the transporting fluid velocity field [2],[3] is proven. From this result, it is shown that physical solutions to one of the "standard models" of dynamic wetting are (at least weakly) singular at the moving contact line. The latter statement holds in a quite general setting and extends the knowledge about the broadly discussed "moving contact line singularity".

Numerical methods based on the *geometrical Volume-of-Fluid method*, which is extended to allow for the simulation of dynamic wetting, have been developed. The numerical methods are validated in realistic test cases together with experimentalists within DFG CRC 1194 and the Profile Area Thermo-Fluids & Interfaces. In particular, the rise of liquid in a capillary and the breakup of droplets on chemically patterned surfaces have been investigated. Future research will investigate the thermocapillary migration of droplets on a solid wall based on [1].

Partner: Matthias Köhne (HHU Düsseldorf), Peyman Rostami, Günter Auernhammer (Leibniz-Institut für Polymerforschung, Dresden)

Support: DFG SFB 1194 (Project B01)

Contact: Mathis Fricke, Dieter Bothe

References

[1] A. Fath and D. Bothe. Direct numerical simulations of thermocapillary migration of a droplet attached to a solid wall. *International Journal of Multiphase flow*, 77:209 – 221, 2015.

[2] M. Fricke, M. Köhne, and D. Bothe. A kinematic evolution equation for the dynamic contact angle and some consequences. *Physica D: Nonlinear Phenomena*.

[3] M. Fricke, M. Köhne, and D. Bothe. On the kinematics of contact line motion. *Proc. Appl. Math. Mech.*, 2018.

Project: Direct numerical simulation of locally coupled interface transport processes near the contact line in dynamic wetting processes

In this project, an arbitrary Lagrangian Eulerian approach, implemented in OpenFOAM, is used to solve the system of partial differential equations describing multi-phase flows. The unique property of this method - a mesh that coincides with the boundary of the liquid domain - is used to consider additional physical effects such as surfactants which are always present in a realistic experimental setup. The existing implementation is extended to handle the interaction of a liquid with a solid surface. Such an interaction is relevant for a wide variety of industrial processes such as, e.g., coating, casting and printing [1]. A team effort within the DFG CRC1194 has executed a numerical benchmark evaluating the rise of a liquid in a capillary. The compared implementations are based on an arbitrary Lagrangian-Eulerian (ALE) approach, a discontinuous Galerkin method, and a geometric as well as a algebraic volume of fluid method. Moreover, a suitable reference solution has been developed. Future investigations will include the local influence of changing surface tension in close proximity to the contact line.

Partner: Max-Planck Institut for Polymer Research, Mainz

Support: DFG SFB 1194 (Project B02)

Contact: Dirk Gründing, Holger Marschall, Dieter Bothe

References

[1] D. Gründing, D. Bothe, and H. Marschall. Wetting phenomena with ALE interface tracking. *PAMM*, 18(1), 2018.

Project: Development and application of a numerical method for reactive transport processes in bubble systems

In this project the reactive mass transfer at single rising bubbles is investigated by means of an Arbitrary Lagrangian-Eulerian Interface Tracking Method, implemented in OpenFOAM. The accurate prediction of mass transfer is a crucial step in many engineering applications, e.g. gas-liquid reactions in bubble column reactors. The transport of chemical species close to the gas-liquid interface of a rising bubble is typically characterized by strong convection along the interface and molecular diffusion normal to the interface. Consequently, very thin boundary layers form whose resolution is computationally very expensive. To reduce the computational cost and enable three-dimensional simulations of realistic systems, e.g. air bubbles rising in water, sub-grid scale models are utilized.
In [1] a new, flexible approach based on statistical analysis and machine learning is introduced. A major advantage of this approach is that - at least in principle - there is no limitation to include complex reaction systems or other physical phenomena like surfactant influence into the model. With this new numerical strategy the influence of fluid dynamics on gas-liquid reactions for predefined reaction systems will be investigated for freely rising bubbles and Taylor bubbles. The aim is to validate the numerical simulations against experimental results from other research groups. Furthermore, the important influence of surfactants will be included to improve the knowledge of such complex interacting systems and the accuracy of numerical simulations for realistic fluids.

Support: DFG SPP 1740

Contact: Dennis Hillenbrand, Andre Weiner, Holger Marschall, Dieter Bothe

References

[1] A. Weiner, D. Hillenbrand, H. Marschall, and D. Bothe. Data-driven subgrid-scale modeling for convection-dominated concentration boundary layers. Preprint, TU Darmstadt, 2019.

Project: Highly accurate computation of volume fractions using differential geometry

For the numerical treatment of two-phase flows it is required to identify the spatial regions occupied by the respective phases. One way to achieve this consists in introducing a marker field $f(\vec{x})$ which, say, is 1 in the first phase and 0 in the second phase. In a discretized domain, each cell is assigned an average value of f, a so-called volume fraction, providing the conceptual foundation of the well-known Volume-of-Fluid (VOF) method introduced by [1]. To solve an initial value two-phase flow problem, the above mentioned volume fractions need to be computed for a given domain and hypersurface separating the two phases. If accurate initial values are required, this task becomes particularly challenging for curved hypersurfaces, but also for seemingly simple ones like ellipsoids. Within the project, we developed a numerical method based on (i) the application of divergence theorems to reduce the problem dimension and (ii) differential geometry, which allow to achieve fourth-order spatial convergence for both locally and globally convex and non-convex hypersurfaces on Cartesian grids; cf. [2]. The enhanced accuracy in the computation of the volume fractions also allows to signifcantly reduce spurious currents, emerging from errors in the computation of discrete curvature, which on its part is by twice numerically differentiating the volume fractions.

Support: DFG TRR 75

Contact: Dieter Bothe, Johannes Kromer

References

[1] C. W. Hirt and B. D. Nichols. Volume of fluid (VOF) method for the dynamics of free boundaries. *Journal of Computational Physics*, 39:201–225, 1981.

[2] J. Kromer and D. Bothe. Highly accurate numerical computation of implicitly defined volumes using the Laplace-Beltrami operator. *Journal of Computational Physics*, (submitted), 2018.

Project: Un-split geometrical Volume-of-Fluid Method

The geometrical Volume-of-Fluid (VoF) method is widely used for multiphase flow simulation because of its inherent volume (mass) conservation property. Many different variants of the geometrical VoF method have been developed over the years. The vast majority of the methods were developed for equidistant Cartesian discretization of the solution domain. This project extends the application of the geometrical un-split VoF method to unstructured domain discretization. The extension is complicated by the geometrical operations needed for the reconstruction of the geometrical flux accross the boundaries of non-overlapping, possibly non-convex polyhedral cells, whose union is the unstructured domain discretization. Within this project, new geometrical and numerical algorithms for the reconstruction of the fluid interface and its advection are developed. Initial publications show that the numerical method has the potential to increase the accuracy of the interface advection on unstructured meshes and, consequently in the future, the accuracy of multiphase simulations in complex technical systems.

Support: DFG SFB 1194 (Project Z-INF)

Partner: Douglas Brian Kothe (Oak Ridge National Laboratory)

Contact: Tomislav Marić, Dieter Bothe

References

[1] T. Marić, H. Marschall, and D. Bothe. An enhanced un-split face-vertex flux-based VoF method. *Journal of Computational Physics*, 371:967–993, 2018.

Project: Hybrid Level Set / Front Tracking method

Methods for multiphase flow simulations can be categorized into two main groups: Level Set, Front Tracking and Volume-of-Fluid methods. Recent developments have shown that combining numerical algorithms from the three main method categories may be beneficial, in the sense of using the strenghts and avoiding the weaknesses of individual methods. One such hybrid approach is the hybrid Level Set / Front Tracking method. The goal of this project is the development of a hybrid Level Set / Front Tracking method (LENT) that supports unstructured discretization of the solution domain. This will enable simulations of geometrically complex technical applications. Multiple objectives are researched currently to achieve this goal. An interpolation used for the signed distance of the Level Set method is under development. The new interpolation will serve as a basis for the new triangulation of the geometrical fluid interface (the Front), resulting in a better numerical approximation of surface tension forces. The advection algorithm of the LENT is also under development in terms of the computational efficiency and parallel algorithm implementation.

Support: DFG SFB 1194 (Project Z-INF)

Partner: Damir Juric (Laboratoire d'Informatique pour la Mécanique et les Sciences de l'Ingénieur, CNRS, France)

Contact: Tomislav Marić, Tobias Tolle, Dieter Bothe

References

[1] T. Marić, H. Marschall, and D. Bothe. Lentfoam - a hybrid level set/front tracking method on unstructured meshes. *Comput. Fluids*, 2015.

Project: Direct numerical simulation of wetting processes using diffuse interface models

The numerical solution of diffusive interface models for two incompressible immiscible fluids at high density and viscosity ratios is demanding. The project is devoted to two-phase Navier-Stokes Cahn-Hilliard and Allen-Cahn type phase-field models, where a unified diffuse interface model framework has been derived. The numerical solution procedure uses a second-order finite-volume method on unstructured meshes of general topology. For efficient simulations on parallel computer architectures local dynamic adaptive mesh refinement and dynamic load balancing have been adapted. The method has been further developed with respect to the numerical treatment of the non-linear term in the chemical potential. Here special emphasis has been put on Eyre linearisation methods which result into unconditional stable and optimal dissipative schemes. The treatment of such terms has been accomplished in a consistent manner both for bulk transport equations and for boundary conditions. The method has been used for several application-driven research projects.

Contact: Holger Marschall

References

[1] X. Cai, M. Wörner, H. Marschall, and O. Deutschmann. CFD simulation of liquid back suction and gas bubble formation in a circular tube with sudden or gradual expansion. *Emission Control Science and Technology*, 3(4):289–301, 2017.

[2] V. Fink, X. Cai, A. Stroh, R. Bernard, J. Kriegseis, B. Frohnapfel, H. Marschall, and M. Wörner. Drop bouncing by micro-grooves. *International Journal of Heat and Fluid Flow*, 70:271 – 278, 2018.

Project: Direct numerical simulation of interfacial species transfer in the algebraic VOF framework

The numerical solution of interfacial species transfer in the context of algebraic Volume-Of-Fluid methods is challenging, since these methods typically do not rely on a geometric interface representation. The challenge in simulating interfacial species transfer processes relates to the steep species concentration gradients and discontinuous concentration jumps occurring at fluid interfaces. For accurate simulations of interfacial species transfer we have devised a suitable numerical modelling and finite volume discretisation strategy to transfer sharp interface transmission and jump conditions into a single-field model formulation. In particular, the method has been found to be virtually void of artificial species transfer. The numerical method has been further enhanced by implicit correction of both non-orthoganility and non-conjunctionality errors due to skewness when using unstructured meshes of general topology for complex flow domains.

Partner: Daniel Deising (ENGYS Deutschland)

Contact: Holger Marschall

References

[1] D. Deising, D. Bothe, and H. Marschall. Direct numerical simulation of mass transfer in bubbly flows. *Computers & Fluids*, 172:524 – 537, 2018.

[2] S. Hill, T. Acher, R. Hoffmann, J. Ferstl, D. Deising, H. Marschall, S. Rehfeldt, and H. Klein. Numerical simulation of two-phase flow and interfacial species transfer in structured packings. *Chemical Engineering Transactions*, 69:337–342, Oct. 2018.

[3] S. Hill, D. Deising, T. Acher, H. Klein, D. Bothe, and H. Marschall. Boundedness-preserving implicit correction of mesh-induced errors for vof based heat and mass transfer. *Journal of Computational Physics*, 352:285 – 300, 2018.

Project: Direct numerical simulation of viscoelastic flows

Numerical methods in CFD are prone to numerical stability issues above some limiting degree of fluid elasticity, characterised by a critical Weissenberg number. The loss of convergence beyond the crirical Weissenberg number is referred to as the so-called high Weissenberg number problem. This project deals with the numerical stabilization of highly viscoelasic flows. To stabilize numerical simulations, many methods have been developed in the past; among them the log-conformation approach and the square-root-conformation approach. These methods are extended in the present work, such that they can be applied to further rheological equations for viscoelastic fluids. A novel generic numerical stabilization framework is implemented into a finite volume method on general unstructured meshes. The convergence properties of different stabilization methods are investigated in a comprehensive numerical benchmark study. New benchmark results are computed at high Weissenberg numbers [3, 2]. The Volume-of-Fluid (VoF) method is extended for the direct numerical simulation of viscoelastic two-phase flows. The extended VoF method uses the numerical stabilization framework for the constitutive equations of the stress. A closure of the extended VoF equations is derived for two-phase systems consisting of one viscoelastic and one Newtonian fluid. A new numerical scheme is proposed for the discretization of the stress terms at the fluid interface. By means of the three-dimensional DNS of rising single bubbles in a viscoelastic medium it is shown that the VoF method captures characteristic flow phenomena such as the discontinuity in the steady-state rise velocity as the bubble volume exceeds a critical value or the so-called negative wake [1].

Support: BASF SE; Freudenberg SE; DFG SFB 1194

Partner: Günter Brenn (TU Graz, Austria)

Contact: Matthias Niethammer, Holger Marschall, Dieter Bothe

References

[1] M. Niethammer, G. Brenn, H. Marschall, and D. Bothe. An extended volume of fluid method and its application to single bubbles rising in a viscoelastic liquid. *Journal of Computational Physics*, 2019.

[2] M. Niethammer, H. Marschall, and D. Bothe. Robust direct numerical simulation of viscoelastic flows. *Chemie Ingenieur Technik*, 2019.

[3] M. Niethammer, H. Marschall, C. Kunkelmann, and D. Bothe. A numerical stabilization framework for viscoelastic fluid flow using the finite volume method on general unstructured meshes. *International Journal for Numerical Methods in Fluids*, 86(2):131–166, 2018.

Project: Computational analysis of fluid interfaces influenced by soluble surfactant

This project is concerned with continuum physical and numerical modelling of two-phase flows under the influence of surfactant. Direct Numerical Simulation (DNS) are performed to obtain valuable information about interfacial transport processes in two-phase systems with surfactant which would not be easily accessible through experimental investigations. An Arbitrary Lagrangian Eulerian (ALE) Interface-Tracking method is employed. The model equations are discretized by means of collocated Finite Volume/Finite Area Methods for transport processes in the bulk and on the interface, [3]. The method supports a moving computational mesh with automatic mesh deformation. Particular attention is given to surfactants diffusing and adsorbing at the interface. The description of the transport of surfactant in the bulk and on the interface is included in the model. To account for sorption processes, several sorption models are included. After a through validation and verification of the numerical method, the simulation results for single rising bubbles in contaminated solutions are compared to the experimental ones from [1]. The discussion of the numerical results is reported in the publication [2]. The next step involves the study of the influence of surfactant on species transfer from single rising bubbles. Preliminary studies have been done in this direction [4] (in collaboration with the project DFG-SPP1740 BO1879/13-2).

Contact: Dieter Bothe, Chiara Pesci

References

[1] C. Pesci, H. Marschall, V. Ulaganathan, T. Kairaliyeva, R. Miller, and D. Bothe. Experimental and computational analysis of fluid interfaces influenced by soluble surfactant. In D. Bothe and A. Reusken, editors, *Transport Processes at Fluidic Interfaces*, Advances in Mathematical Fluid Mechanics, chapter 15. Springer International Publishing, AG Cham, 2017.

[2] C. Pesci, A. Weiner, H. Marschall, and D. Bothe. Computational analysis of single rising bubbles influenced by soluble surfactant. *Journal of Fluid Mechanics*, 856:709–763, 2018.

[3] Z. Tuković and H. Jasak. A moving mesh Finite Volume Interface Tracking method for surface tension dominated interfacial fluid flow. *Computers & Fluids*, 55:70–84, 2012.

[4] A. Weiner, J. Timmermann, C. Pesci, J. Grewe, M. Hoffmann, M. Schlüter, and D. Bothe. Experimental and numerical investigation of reactive species transport around a small rising bubble. *Chemical Engineering Science: X*, 1:100007, 2019.

Project: Surface tension driven flows in complex domains with LENT

The aim of this project is to improve the hydrodynamics of the LENT method, a hybrid level set / front tracking method for the simulation of two-phase flows on unstructured meshes consisting of arbitrary polyhedral cells. Major working points to achieve this goal are the modelling of surface tension, approximation of the interface curvature, treatment of discontinuous quantities in interface cells and a solution algorithm for the pressure-velocity system suitable for two-phase systems. For each of these points their accuracy and robustness are of interest. However, since a significant surface tension creates a closed feedback loop in the solution algorithm, the interrelationship between the different sub-algorithms has to be investigated to evaluate the overall accuracy and robustness. The explicit interface representation by the front provides geometrical information which may enable new approaches to the difficulties described above.

Partner: Damir Juric (Laboratoire d'Informatique pour la Mécanique et les Sciences de l'Ingénieur, CNRS, France)

Support: German Research Association (DFG)

Contact: Tobias Tolle, Tomislav Marić, Dieter Bothe

Project: Numerical simulation of mass transfer at rising bubbles

The primary goal of this project is to supplement experimental groups within the priority program SPP 1740 with insightful simulation data, which help to understand transport processes in bubbly flows. One of the main challenges in comparing experimental and numerical results of the mass transfer at rising bubbles is the so-called high-Schmidt number problem. The main statement of this problem is that the transport of a diluted species, for example, the dissolved gas, happens on much smaller length scales than the momentum transport in the liquid phase. This leads to the formation of extremely thin boundary layers at the gas-liquid interface, which cannot be resolved directly with classical numerical methods. One way to mitigate the resolution requirements at the interface is the application of subgrid-scale models, which accurately approximate the species transport based on analytical solutions or machine learning models of simplified substitute problems. Over the last two years, such subgrid-scale models have been successfully applied to investigate the interplay between surface active agents, bubble hydrodynamics and reactive mass transfer. Future work will be concerned with the development and deployment of our models in even more complex scenarios like pseudo swarms of multiple bubbles.

Support: DFG SPP 1740

Contact: Andre Weiner, Dieter Bothe

References

[1] C. Pesci, A. Weiner, H. Marschall, and D. Bothe. Computational analysis of single rising bubbles influenced by soluble surfactant. *Journal of Fluid Mechanics*, 856:709–763, 2018.

[2] A. Weiner and D. Bothe. Advanced subgrid-scale modeling for convection-dominated species transport at fluid interfaces with application to mass transfer from rising bubbles. *Journal of Computational Physics*, 347:261 – 289, 2017.

[3] A. Weiner, J. Timmermann, C. Pesci, J. Grewe, M. Hoffmann, M. Schlüter, and D. Bothe. Experimental and numerical investigation of reactive species transport around a small rising bubble. *Chemical Engineering Science: X*, 1:100007, 2019.

Project: The structure of continuum thermodynamical diffusion fluxes

Multicomponent diffusion in fluid systems is commonly modeled via the Fick-Onsager or the generalized Maxwell-Stefan approach. The latter approach has the advantage that the resulting fluxes are consistent with non-negativity of the partial densities for non-singular and non-degenerate Maxwell-Stefan diffusivities. On the other hand, this approach requires computationally expensive matrix inversions since the fluxes are only implicitly given. We explore a novel and more direct closure which avoids the inversion of the

Maxwell-Stefan equations. It is shown that all three closures are actually equivalent under natural positivity requirements, thus revealing the general structure of continuum thermodynamical diffusion fluxes. One additional aim is to provide a rigorous fundament for recent extensions of the Darken equation from so-called weakly associated constituents to the case of general mixtures.

Contact: Dieter Bothe

Project: Mathematical modeling of the influence of adsorbed surfactant onto mass transfer across fluid interfaces

Fluid interfaces in technical or industrial processes are often contaminated with surface active agents (surfactants), either on purpose or due to impurities. This has a strong influence on mass transfer because of (i) the back-effect of the adsorbed surfactant onto the hydrodynamics via changes in interfacial tension and (ii) the local hindrance of mass transfer due to interface coverage. We develop and investigate mathematical models which quantitatively capture these phenomena in a thermodynamically consistent way. Depending on the desciption of the interfacial free energy, these models can incorporate Langmuir's energy barrier effect in a consistent and local manner.

Partner: Akio Tomiyama

Contact: Dieter Bothe

Project: Resonance in hyperbolic-parabolic coupled systems

We investigate how resonance can be avoided in hyperbolic-parabolic coupled systems with periodic forcing. A periodic forcing of a hyperbolic system typically leads to resonance due to energy conservation. However, if the hyperbolic system is coupled with a parabolic system that has energy dissipation, sufficient energy can in theory be dissipated via the parabolic part to avoid resonance. Our primary aim is to develop a mathematical framework that can be used to characterize the conditions under which resonance does not occur. In [1] we showed for one of the model equations in nonlinear acoustics, namely the Blackstock-Crighton equation, that the damping mechanism is sufficient to avoid resonance in the nonlinear (hyperbolic) wave equation. In [2] we investigated the fully inhomogeneous Stokes system with a time-periodic forcing term and proved existence of time-periodic solutions, which is the first steps towards the study of a coupled fluid-structure system.

Contact: Mads Kyed, Aday Celik

References

[1] A. Celik and M. Kyed. Nonlinear acoustics: Blackstock-Crighton equations with a periodic forcing term. *arXiv:1710.06457*, 2017.

[2] A. Celik and M. Kyed. Time-periodic Stokes equations with inhomogeneous Dirichlet boundary conditions in a half-space. *arXiv:1809.02424*, 2017.

Project: Optimal elliptic and maximal parabolic regularity in rough settings

The modelling of technological processes and devices is often characterized by the presence of edges and corners, abrupt changes in material properties and substantial nonlinearities. The associated PDEs exhibit low boundary regularity, mixed and dynamic boundary conditions, spatial and temporal degeneracy and discountinuity of coefficients. In this project, we develop and study functional analytic frameworks for these equations that preserve optimal elliptic and maximal parabolic regularity of the associated linear PDEs and their adaptation to relevant nonlinear settings.

Partner: Joachim Rehberg (WIAS Berlin), Hannes Meinlschmidt (RICAM Linz), Tom ter Elst (University of Auckland), Moritz Egert (University of Paris Sud), Patrick Tolksdorf (University of Paris Est - Créteil)

Contact: Sebastian Bechtel, Karoline Disser, Robert Haller-Dintelmann

References

[1] S. Bechtel and M. Egert. Interpolation theory for Sobolev functions with partially vanishing trace on irregular open sets. submitted.

[2] K. Disser and J. Rehberg. The 3D transient semiconductor equations with gradient-dependent and interfacial recombination. Technical report, WIAS Preprint 2507, 2018.

[3] K. Disser, A. ter Elst, and J. Rehberg. On maximal parabolic regularity for non-autonomous parabolic operators. *J. Differential Equations*, 262:2039 – 2072, 2017.

[4] R. Haller-Dintelmann, H. Meinlschmidt, and W. Wollner. Higher regularity for solutions to elliptic systems in divergence form subject to mixed boundary conditions. *Ann. Math. Pura Appl.* to appear.

[5] A. ter Elst, R. Haller-Dintelmann, J. Rehberg, and P. Tolksdorf. On the L^p-theory for second order elliptic operators in divergence form with complex coefficients. in preparation.

Project: Modelling and analysis of fluid-structure interaction

Based on the analysis of Zhukovskii's Conjecture [1], we study the modelling and analysis of systems coupling the dynamics of rigid or elastic structures with a Newtonian fluid. Our focus is on qualitative behaviour of solutions, scaling limits with respect to flow and geometry parameters [3], and extensions to non-Newtonian fluids [2].

Partner: T. Takahashi (University of Nancy).

Support:

Contact: K. Disser.

References

[1] K. Disser, G. Galdi, G. Mazzone, and P. Zunino. Inertial motions of a rigid body with a cavity filled with a viscous liquid. *Arch. Rat. Mech. Anal.*, 221:487–526, 2016.

[2] M. Geissert, K. Götze, and M. Hieber. L^p-theory for strong solutions to fluid-rigid body interaction in Newtonian and generalized Newtonian fluids. *Trans. Amer. Math. Soc.*, 365:1393–1439, 2013.

[3] A. Silvestre and T. Takahashi. The motion of a fluid-rigid ball system at the zero limit of the rigid ball radius. *Arch. Rat. Mech. Anal.*, 211:991–1012, 2014.

Project: Kolmogorov's two-equation model for turbulence

Kolmogorov's two-equation model for turbulence includes the Navier-Stokes equations with a viscosity that depends on a local turbulent energy variable k and a transport and diffusion equation for k that is fed by gradients of the flow velocity. First results on existence and weak regularity of solutions were established recently [1]. In this project, we want to extend the analysis and aim at a qualitative understanding of the scaling properties and algebraic decay of the system near non-trivial equilibria.

Partner: A. Mielke (WIAS and HU Berlin), SFB 910, project A5.

Support:

Contact: K. Disser.

References

[1] A. Mielke and J. Naumann. Global-in-time existence of weak solutions to Kolmogorov's two-equation model of turbulence. *C. R. Math. Acad. Sci. Paris*, 353:321–326, 2015.

Project: Analysis of dissipative dynamics in multiple components and scales

The aim of this project is to develop mathematical tools for the analysis of dissipative systems acting across multiple scales, combining concepts and ideas from both classical PDE theory and the calculus of variations. With the discovery of the rigorous entropic gradient structures of both diffusion [5] and chemical reaction processes [6], variational concepts like Gamma-convergence become increasingly applicable to multiscale dynamics. Special cases are the modelling and analysis of reaction-diffusion across volume and surface, e.g. for surfactants [1, 3], and the fast reaction limit or quasi-steady-state approximation for reaction-(cross-)diffusion systems [2, 4].

Partner: M. Thomas (WIAS Berlin), D. Bothe

Support:

Contact: K. Disser.

References

[1] D. Bothe, M. Koehne, S. Maier, and J. Saal. Global strong solutions for a class of heterogeneous catalysis models. *J. Math. Anal. Appl.*, 445:677–709, 2017.

[2] D. Bothe, M. Pierre, and G. Rolland. Cross-diffusion limit for a reaction-diffusion system with fast reversible reaction. *Comm. Partial Differential Equations*, 37:1940–1966, 2012.

[3] K. Disser. Global existence, uniqueness and stability for nonlinear dissipative bulk-interface interaction systems. Preprint, arXiv:1703.07616, 2017.

[4] K. Disser, M. Liero, and J. Zinsl. On the evolutionary Gamma-convergence of gradient systems modeling slow and fast chemical reactions. *Nonlinearity*, 31:3689–3706, 2018.

[5] R. Jordan, D. Kinderlehrer, and F. Otto. The variational formulation of the Fokker-Planck equation. *SIAM J. Math. Anal.*, 29:1–17, 1998.

[6] M. Liero and A. Mielke. Gradient structures and geodesic convexity for reaction-diffusion systems. *Philos. Trans. R. Soc. Lond. Ser. A*, 371:20120346, 28 pp., 2013.

Project: Time-periodic Navier–Stokes equations

We investigate the partial differential equations governing the time-periodic flow of an incompressible Navier–Stokes fluid around an obstacle. An overview of various approaches to the time-periodic Navier–Stokes equations can be found in [3]. The investigation of a flow past an obstacle leads naturally to the Navier–Stokes equations in an exterior domain. A comprehensive analysis of this particular problem can be found in [4] and [5]. One of our goals is to further develop an approach based on time-periodic Fourier multipliers introduced by Mads Kyed; see [1]. An important outcome hereof has been the identification in [6, 2] of a time-periodic fundamental solution to both the Stokes and Oseen linearization of the Navier–Stokes equations.

Partner: G.P. Galdi (University of Pittsburgh); M. Kyed (Hochschule Flensburg)

Contact: Thomas Eiter

References

[1] T. Eiter and M. Kyed. *Particles in Flows (edited by Tomas Bodnar, Giovanni P. Galdi and Sarka Necasova)*, chapter Time-Periodic Linearized Navier–Stokes Equations: An Approach Based on Fourier Multipliers, pages 77–137. Springer International Publishing, 2017.

[2] T. Eiter and M. Kyed. Estimates of Time-Periodic Fundamental Solutions to the Linearized Navier–Stokes Equations. *Journal of Mathematical Fluid Mechanics*, 20:517–529, 2018.

[3] G. P. Galdi and M. Kyed. *Time-Periodic Solutions to the Navier-Stokes Equations*, pages 1–70. Springer International Publishing, Cham, 2016.

[4] G. P. Galdi and M. Kyed. Time-periodic flow of a viscous liquid past a body. 452:20–49, 2018.

[5] G. P. Galdi and M. Kyed. Time-periodic solutions to the Navier-Stokes equations in the three-dimensional whole-space with a non-zero drift term: asymptotic profile at spatial infinity. 710:121–144, 2018.

[6] M. Kyed. A fundamental solution to the time-periodic Stokes equations. *J. Math. Anal. Appl.*, 437(1):708–719, 2016.

Project: Time-periodic motion of liquid drops

We investigate the motion of a viscous liquid drop emerged into another viscous fluid, both modeled by the Navier–Stokes equations. Physical experiments show that when the system is only affected by gravity and the corresponding Reynolds number is small, the drop moves steadily. However, if the Reynolds number exceeds a certain threshold, the drop undergoes a periodic motion despite the absence of an external time-periodic force. To be able to give a rigorous mathematical proof of the existence of this Hopf bifurcation, we first study the steady fall of a liquid drop, i.e., the case of small Reynolds number, and the corresponding time-periodic system. The analysis of the linearized time-periodic equations is carried out with the help of the concept of $\mathscr{R}$-boundedness, which has many applications in the context of initial-value problems and is appropriately transferred to the present time-periodic setting.

Partner: M. Kyed (Hochschule Flensburg); Y. Shibata (Waseda University, Tokyo)

Contact: Thomas Eiter

Project: Decay of solutions to the Navier-Stokes system with nonvanishing boundary data

The aim of the project is to analyze the rate of decay of weak solutions to the Navier-Stokes system in bounded and unbounded domains with nonvanishing Dirichlet boundary data. This problem is well understood in the case of vanishing boundary data for many years; in particular, the optimal rate of decay is known for bounded and exterior domains, and for the whole and half space. For nonvanishing Dirichlet boundary data and the exterior domain case, the existence of weak solutions satisfying the strong energy inequality was recently found by R. Farwig and H. Kozono (Tokyo), see J. Differential Equations (2014). For nonvanishing Dirichlet boundary data, in a first step a solution of the linear Stokes problem, E, with the given boundary data is constructed. Subtracting E from the solution of the Navier-Stokes problem, a perturbed Navier-Stokes problem with vanishing boundary data is to be analyzed. By this technique, the problem is divided into two almost independent subproblems. Then rates of decay for weak solutions of the perturbed Navier-Stokes problem are found by generalizing known tools to this more involved case. For bounded domains, the decay is exponentially fast as in the case of zero boundary conditions. However, for exterior domains, the rate of decay is only algebraic, but optimal in the sense that it is as close as possible to the optimal rate for the unperturbed case.

Partner: H. Kozono (Waseda University, Tokyo); D. Wegmann (TU Darmstadt).

Contact: R. Farwig.

References

[1] R. Farwig, H. Kozono, and D. Wegmann. Decay of non-stationary Navier-Stokes flow with nonzero Dirichlet boundary data. *Indiana Univ. Math. J.*, 66:2169–2185, 2017.

[2] R. Farwig, H. Kozono, and D. Wegmann. Maximal regularity of the Stokes operator in an exterior domain with moving boundary and application to the Navier-Stokes equations. *Math. Anal.*, 2018.

Project: The Navier-Stokes system in moving time-dependent exterior domains

The construction of strong solutions of the Navier-Stokes system in a time-dependent domain with prescribed motion is carried through by a reduction to the time-independent case by a t-dependent coordinate transform. By this means, a highly perturbed Navier-Stokes system with t-dependent coefficients will appear such that the resulting system is non-autonomous even in the leading term. To construct local or global in time strong solutions this problem requires an analysis in the framework of maximal regularity combined with perturbation arguments. Whereas the first problem had been considered by J. Saal (J. Math. Soc. Japan, 58, 617–641 (2006)) mainly for bounded domains, perturbation arguments applicable to non-autonomous systems were developed by Y. Giga–M. Giga–H. Sohr (Proc. Japan Acad. Ser. A Math. Sci., 67, 197–202 (1991)) for finite time intervals and under relatively strong assumptions. The main idea to construct even global in time strong solutions for exterior domains in which the Stokes operator is no longer invertible compared to the bounded domain case is to combine both aforementioned methods in a suitable way.

Partner: H. Kozono (Waseda University, Tokyo); D. Wegmann (TU Darmstadt).

Contact: R. Farwig.

References

[1] R. Farwig, H. Kozono, and D. Wegmann. Maximal regularity of the Stokes operator in an exterior domain with moving boundary and application to the Navier-Stokes equations. *Math. Anal.*, 2018.

Project: Global attractors for the surface quasi-geostrophic equations in 2D

The surface quasi-geostrophic equation (SQGE) on $\mathbb{R}^2$ is a nonlinear and nonlocal equation for the so-called potential temperature with fractional dissipation. It is used in oceanography and atmospheric sciences as a model of fluid flow in the case of small Rossby and

Ekman numbers. The nonlinear and nonlocal terms are due firstly to a transport term with a velocity which depends on the solution by Riesz transforms, and secondly due to a fractional Laplacian $(-\Delta)^{\alpha/2}$ acting as diffusion. Whereas the case $\alpha = 1$ has great similarity with the 2D Navier-Stokes system, the case $\alpha = \frac{1}{2}$ resembles the 3D Navier-Stokes system and the inviscid case $\alpha = 0$ poses difficulties as the 3D Euler system. The aim is the study of the long-time behavior of solutions of (SQGE) in the subcritical case $\frac{1}{2} < \alpha < 1$. To this end we investigate the global well-posedness and global attractor for (SQGE) in Bessel potential spaces via commutator estimates for nonlinear terms, a new iterative technique for estimates of higher order derivatives and with the help of a nonlocal damping term of convolution type. Due to the unboundedness of the domain $\mathbb{R}^2$ and lack of compactness the solution semigroup is only asymptotically compact so that for a priori estimates the problem is decomposed into a first part on bounded balls and a second part in exterior domains on which smallness estimates for solutions are to be derived. Besides, by using the fractional Lieb-Thirring inequality, estimates of finite Hausdorff and fractal dimensions of the global attractor can be found.

Partner: Chenyin Qian (Zhejiang Normal University, Jinhua, China).

Contact: Reinhard Farwig

References

[1] R. Farwig and C. Qian. Asymptotic behavior for the quasi-geostrophic equations with fractional dissipation in $\mathbb{R}^2$. *J. Differential Equations*, 2018.

Project: Quasi-optimal initial values for weak solutions of the Navier-Stokes equations

Quasi-optimal initial values for weak solutions of the Navier-Stokes equations are initial values close to the optimal initial value condition where u_0 is contained in the Besov space $B^{-1+3/q}_{q,s_q}$ with $\frac{2}{s_q} + \frac{3}{q} = 1$ (Serrin condition) and admits a local in time strong solution on an initial interval $[0, t)$. Here, we construct weak solutions in bounded domains $\Omega \subset \mathbb{R}^3$ for initial values satisfying a Serrin-type integrability which due to a power weight in time, t^α, $\alpha > 0$, is valid only on intervals excluding the origin. To be more precise, for the initial value u_0 either the integral $\int_0^\infty \left(t^\alpha \|e^{-tA}u_0\|_q\right)^s dt$ when $s < \infty$, or the weighted ess $\sup_{t\in(0,\infty)} t^\alpha \|e^{-tA}u_0\|_q$ when $s = \infty$, is finite. This condition can equivalently be described in the class of scale invariant Besov spaces $B^{-1+3/q}_{q,s}(\Omega)$ where $\frac{2}{s} + \frac{3}{q} = 1 - 2\alpha$, $0 < \alpha < \frac{1}{2}$, i.e., $s_q < s \leq \infty$. The corresponding solution space is the weighted space $L^s_\alpha(0, T; L^q(\Omega))$, $s_q \leq \infty$ with power weight t^α with respect to time. In this project we consider the limit case with initial values in the Banach space $B^{-1+3/q}_{q,\infty}(\Omega)$. Since this Besov space is non-separable, smallness assumptions are needed to get satisfactory results. Another idea is to work in the continuous interpolation space $\mathring{B}^{-1+3/q}_{q,\infty}(\Omega)$ which is separable and can be approximated by smooth, compactly supported functions. The proof is based on the construction of a mild solution by the variation of constants formula as fixed point of a nonlinear integral equation via Banach's Fixed Point Theorem.

Partner: Prof. Dr. Yoshikazu Giga, (University of Tokyo), Dr. Pen-Yuan Hsu (University of Tokyo)

Contact: Reinhard Farwig

References

[1] R. Farwig, Y. Giga, and P.-Y. Hsu. The Navier-Stokes equations with initial values in Besov spaces of type $B^{-1+3/q}_{q,\infty}$. *J. Korean Math. Soc.*, 54:1483–1504, 2017.

Project: Uniqueness of weak solutions of the Navier-Stokes equations with quasi-optimal initial values

Quasi-optimal initial values for weak solutions of the Navier-Stokes equations are initial values close to the optimal initial value condition where u_0 is contained in the Besov space $B^{-1+3/q}_{q,s_q}$ with $\frac{2}{s_q}+\frac{3}{q}=1$ (Serrin condition). In this project we consider weak solutions in bounded domains $\Omega\subset\mathbb{R}^3$ for initial values which have less regularity than those leading to local strong solutions in an initial interval $[0,T)$. In that case, Serrin's uniquenesss theorem yields the weak-strong uniqueness, i.e., a weak solution satisfying the energy inequality is unique within its class provided there exists a local strong solution in the Serrin class $L^{s_q}(0,T;L^q(\Omega))$ for the same initial data. To be more precise, the initial values are supposed in the class of scaling invariant Besov spaces $B^{-1+3/q}_{q,s}(\Omega)$ where $\frac{2}{s}+\frac{3}{q}=1-2\alpha$, $0<\alpha<\frac{1}{2}$, i.e., $s_q<s\leq\infty$. This Besov space can be characterized by the integrability $\int_0^\infty\left(t^\alpha\|e^{-tA}u_0\|_q\right)^s dt$ when $s<\infty$, or $\operatorname{ess\,sup}_{t\in(0,\infty)}t^\alpha\|e^{-tA}u_0\|_q$ is finite when $s=\infty$. Unfortunately, the classical proof of Serrin to prove uniqueness does not work for weak solutions in the class $L^s_\alpha(0,T;L^q(\Omega))$ of functions with weight t^α, the corresponding solution class for initial values in $B^{-1+3/q}_{q,s}(\Omega)$. The idea to circumvent this drawback is to consider weak solutions together with the way how they have been constructed, either by a semigroup approach with Yosida approximation operators or by the Galerkin method. If the construction method is in a certain sense compatible with the solution space $L^s_\alpha(0,T;L^q(\Omega))$, weak-strong uniqueness still holds although the solution is a strong one only for $t>0$. It is proved that the semigroup approach with Yosida approximation is an admissible method for all pairs (s,q), whereas the Galerkin method can be proved to be admissible only for $3<q\leq 4$. It is worth to be noted that in the whole space case where the machinery of Littlewood-Paley theory is available for the analysis of Besov spaces the above-mentioned restrictions can be avoided, see *T. Barker: Uniqueness Results for Weak Leray-Hopf Solutions of the Navier-Stokes System with Initial Values in Critical Spaces. J. Math. Fluid Mech. (2017)*.

Partner: Prof. Dr. Yoshikazu Giga, (University of Tokyo), Dr. Pen-Yuan Hsu (University of Tokyo)

Contact: Reinhard Farwig

References

[1] R. Farwig and Y. Giga. Well-chosen weak solutions of the instationary Navier-Stokes system and their uniqueness. *Hokkaido Math. J.*, 47:373–385, 2018.

Project: The Klein-Gordon equations on a star-shaped network

We consider the Klein-Gordon equations on n copies of the interval $(0,\infty)$ glued together at the origin with usual Kirchhoff (or other) transmission conditions in the vertex. In earlier work we already established a spectral representation of the corresponding operator and, based on this, an explicit solution formula.

Exploiting this formula, we intend to understand in a quantitative manner effects related to the tunnel effect like retarded reflection and advanced transmission. Furthermore, we study the L^∞-time decay of the solutions and apply this to non-linear eqations.

Partner: Felix Ali Mehmeti, Virginie Régnier (University of Valenciennes, France)

Contact: Robert Haller-Dintelmann

References

[1] F. Ali Mehmeti, R. Haller-Dintelmann, and V. Régnier. Multiple tunnel effect for dispersive waves on a star-shaped network: an explicit formula for the spectral representation. *J. Evol. Equ.*, 12(3):513–545, 2012.

[2] F. Ali Mehmeti, R. Haller-Dintelmann, and V. Régnier. Energy flow above the threshold of tunnel effect. In A. Almeida, L. Castro, and F.-O. Speck, editors, *Advances in Harmonic Analysis and Operator Theory*, volume 229 of *Oper. Theory Adv. Appl.*, pages 65–76. Birkhäuser, Basel, 2013.

Project: Extension operators for mixed boundary conditions

We aim for a result in the spirit of the Jones Theorem for the extension of Sobolev functions on domains to the whole space adapted for mixed boundary conditions. For this we want to take full advantage of the fact that the extension over the Dirichlet part of the boundary should be possible without any boundary regularity, while all known results need some regularity near the interface between the boundary parts.

Partner: Russell Brown, University of Kentucky, USA and Patrick Tolksdorf, University of Paris-Est

Contact: Robert Haller-Dintelmann

References

[1] P. W. Jones. Quasiconformal mappings and extendability of functions in Sobolev spaces. *Acta Math.*, 147:71–88, 1981.

Project: Primitive equations in L^p spaces

The primitive equations for the ocean and atmosphere are considered to be a fundamental model for geophysical flows derived from classical Navier-Stokes equations assuming an hydrostatic balance. Unlike for Navier-Stokes equations, for the three dimensional primitive equations global strong well-posedness results are known. So, these results are obtained mostly within the L^2 framework. Our strategy is to study the primitive equations in the more general L^p setting in order to relax the assumption on the initial conditions, and also to achieve additional information on the regularity of global solutions. Moreover we we investigate the validity of the hydrostatic approximation, the primitive equations with only horizontal viscosity

Partner: Yoshikazu Giga, Takahito Kashiwabara (both University of Tokyo), Mathis Gries, Matthias Hieber, Martin Saal, Marc Wrona and Amru Hussein

Contact: A. Hussein.

References

[1] Y. Giga, M. Griesa, M. Hieber, A. Hussein, and T. Kashiwabara. Analyticity of solutions to the primitive equations. *Mathematische Nachrichten*, to appear.

Project: Primitive equations with linearly growing data

The primitive equations for the ocean and atmosphere are considered to be a fundamental model for geophysical flows derived from classical Navier-Stokes equations assuming an hydrostatic balance. The global atmospheric rotating or straining flows can be modeled by linearly glowing initial data. The linear part of this model is an Ornstein-Uhlenbeck type operator which is not the generator of an analytic semigroup. However, the associated semigroup has certain smoothing properties which admits the construction of local mild solutions for the non-linear problem with linearly glowing initial data.

Partner: Okihiro Sawada (Gifu University, Japan) and Martin Saal

Contact: A. Hussein

References

[1] A. Hussein, M. Saal, and O. Sawada. Primitive equations with linearly growing initial data. *Annali della Scuola Normale Superiore di Pisa - Classe di Scienze*, to appear.

Project: Analysis of Models for Nematic Liquid Crystals

Liquid crystals are materials which behave with some respects like a liquid and with others like a solid crystal, and they have become present in everyday life by their practical application in liquid crystal displays (LCD). The Ericksen-Leslie theory is a continuum theory for liquid crystals coupling a fluid equation to an equation for the director field which describes the orientation of the rod-like crystals.

The simplified Ericksen-Leslie model has been studied in great detail so far, and finite-time blow-up has been proven when the initial data for the director fields is non-homotop to constant maps. We investigated the well-posedness of the simplified Erickson-Leslie model in critical spaces in Lipschitz domains based on semigroup methods. We also started the analysis of the full Erickson-Leslie model with general Ericksen stress.

Partner: Anupam Pal Choudhury (Linz) and Patrick Tolksdorf

Contact: A. Hussein

References

[1] A. P. Choudhury, A. Hussein, and P. Tolksdorf. Nematic liquid crystals in lipschitz domains. *SIAM J. Math. Anal.*, 50 (4):4282–4310, 2018.

Project: Operator theory and numerical analysis

On the operator theory side, our actual interest is in axiomatic and asymptotic aspects of Toeplitz and Hankel operators. These operators occur in many applications, e.g. in numerical analysis for singular integral equations. We characterize Toeplitz and Hankel operators in an axiomatic way which allows us to treat several classes of concrete Toeplitz and Hankel operators (e.g., the classical Toeplitz and Hankel operators on l^p and on Hardy spaces as well as Wiener-Hopf integral operators on L^p) at once. This approach is closely related to Barria and Halmos' asymptotic Toeplitz operators and to Feintuch's asymptotic

Hankel operators. Second part: For the numerical solution of an operator equation on an infinite-dimensional space, one discretizes the operator to obtain a sequence of $n \times n$ matrices A_n. Interesting asymptotic properties of the sequence (A_n) can be studied by embedding this sequence into an appropriate C^*-algebra and by studying the structure of that algebra. Of particular interest are algebras of matrix sequences which own the following (self-similarity) property: Every sequence in the algebra can be rediscovered from each of its infinite subsequences modulo a sequence tending to zero in the norm. Examples of such algebras arise, for instance, from the finite sections method for Toeplitz or singular integral operators. Sequences (A_n) in self-similar algebras are distinguished by their excellent asymptotic properties: for example, the pseudospectra of the A_n converge with respect to the Hausdorff metric. A basic tool to analyse algebras of matrix sequences is a Fredholm theory of sequences, which has also found interesting applications: a proof of the Arveson dichotomy for self-adjoint sequences, a proof of the index formula for band-dominated operators, and the creation of an algorithm to determine partial indices of matrix functions numerically, for instance. We derived results along these lines for spatial discretizations of several classes of C^*-algebras including Cuntz algebras, reduced group C^*-algebras and algebras generated by truncated Toeplitz operators on model spaces, and we (still) plan to extend them to multi-dimensional disk algebras and other algebras generated by isometries.

Partner: Bernd Silbermann

References

[1] S. Roch. Beyond fractality: piecewise fractal and quasifractal algebras. *Operator Theory: Advances and Applications*, 268:413–428, 2018.

[2] S. Roch. Extension-restriction theorems for algebras of approximation sequences. *Operator Theory: Advances and Applications*, 267:261–284, 2018.

[3] S. Roch and B. Silbermann. Toeplitz and Hankel algebras - axiomatic and asymptotic aspects. *Operator Theory: Advances and Applications*, 267:285–315, 2018.

Contact: Steffen Roch

Project: Band-dominated operators, their Fredholm theory and finite sections

A band-dominated operator is the norm limit of a sequence of band operators, i.e., of operators which have a band matrix as their representation with respect to a fixed basis. For example, pseudodifferential operators on $L^2(\mathbb{R}^N)$ with symbols in $S^0_{0,0}$ and several classes of convolution operators own this property. Fredholm properties of band-dominated operators can be studied via their limit operators, which reflect the behaviour of the operator at infinity. A typical result says that a band-dominated operator is Fredholm if and only if each of its limit operators is invertible and if the norms of their inverses are uniformly bounded. Also the index of a Fredholm band dominated operator (on $l^2(\mathbb{Z})$) can be expressed in terms of (local) indices of its limit operators. The last years have seen tremendous progress in the field of general band-dominated operators. Lindner and Seidel solved one of the big questions in this field by showing that the condition of *uniform* boundedness of the inverses of the limit operators is indeed redundant - a fact that was conjectued for a long time and that was known before for special cases only. The proof of Lindner and Seidel worked for band-dominated operators on the additive group $\mathbb{Z}^N$. Their result was generalized to band-dominated operators acting on quite general groups by Spakula and

Willett in 2014. It would be fascinating to investigate the consequences of these results to the operator theory and numerical analysis for concrete band-dominated operators. Another goal of the project is to use the above methods to study the Fredholm properties of Schrödinger operators (and other operators of mathematical physics) and the decay of their eigenfunctions. A third line of research concerns the Fredholm theory and numerical analysis of discretized differential operators acting on periodic nano-structures (like honeycomb structures and nano-tubes). Third, as we observed only recently, the above sketched methods seem to apply to study diffraction by ($\mathbb{Z}^1$- or $\mathbb{Z}^2$-) periodic graphs for second order elliptic equations. In general, the study of the solvability of pseudodifferential operators on a periodic graph rises serious difficulties because the graph is a singular manifold with an infinite set of singular points. We are mainly interested in a setting where the graph is periodic, but the coefficients of the operator and in the transmission conditions are not (such that the standard Floquet method does not apply).

Partner: Vladimir S. Rabinovich

References

[1] V. Rabinovich and S. Roch. Finite sections of band-dominated operators on discrete groups. *Oper. Theory: Adv. Appl.*, 220:239–253, 2012.

[2] V. Rabinovich and S. Roch. Pseudodifferential operators on periodic graphs. *Integral Equations Oper. Theory*, 72:197–217, 2012.

Contact: S. Roch

Project: Multiscale models for tumor cell migration

Tumor cell migration is influenced by a plethora of processes taking place at different spatial scales which range from the subcellular level (microscopic scale) via the mesoscopic scale of cell interactions and up to the macroscopic scale of cell and tissue populations. We develop multiscale models based on the rather new approach of micro-macro models. In these models a system of partial differential equations for cell and tissue populations on the macroscopic scale is coupled to ordinary differential equations modeling particular aspects of subcellular dynamics. We model e.g. the influence of cell contractivity or acidity on tumor cell migration and show how this can be used to model therapy approaches. Thereby we combine modeling, analysis, and numerical simulations. Basic properties of the solutions to these models are proved analytically, while the precise behavior is illustrated by numerical simulations.

Partner: C. Surulescu (TU Kaiserslautern), M. Lukácová (Universität Mainz), N. Sfakianakis (Universität Heidelberg).

Contact: C. Stinner.

References

[1] G. Meral, C. Stinner, and C. Surulescu. A multiscale model for acid-mediated tumor invasion: therapy approaches. *J. Coupled Syst. Multiscale Dyn.*, 3:135–142, 2015.

[2] G. Meral, C. Stinner, and C. Surulescu. On a multiscale model involving cell contractivity and its effects on tumor invasion. *Discrete Contin. Dyn. Syst. Ser. B*, 20:189–213, 2015.

[3] C. Stinner, C. Surulescu, and G. Meral. A multiscale model for pH-tactic invasion with time-varying carrying capacities. *IMA J. Appl. Math.*, 80:1300–1321, 2015.

[4] C. Stinner, C. Surulescu, and A. Uatay. Global existence for a go-or-grow multiscale model for tumor invasion with therapy. *Math. Models Methods Appl. Sci.*, 26:2163–2201, 2016.

Project: Blow-up in Keller-Segel models

We study the behavior of solutions to a class of quasilinear parabolic-parabolic Keller-Segel models. Concerning the existence of solutions, three cases can occur. Either the solution exists globally in time and is uniformly bounded or it exists globally in time and becomes unbounded in the large time limit (blow-up in infinite time) or it becomes unbounded after a finite time (blow-up in finite time). Thereby, our main interest is to distiguish between blow-up in finite and infinite time. With respect to certain parameters of the model we aim to find the optimal border which separates the two blow-up types.

Partner: T. Cieślak (Polish Academy of Sciences)

Contact: C. Stinner.

References

[1] T. Cieślak and C. Stinner. New critical exponents in a fully parabolic quasilinear Keller-Segel system and applications to volume filling models. *J. Differential Equations*, 258:2080–2113, 2015.

Project: Extinction in diffusive Hamilton-Jacobi equations

We study a class of Hamilton-Jabobi equations with singular diffusion. For some ranges of parameters the phenomenon of extinction in finite time occurs, meaning that a nonnegative solution becomes identially zero after a finite time although the initial value is not the zero function. We aim to describe the extinction behavior by studying e.g. extinction rates, extinction profiles, and extinction sets.

Partner: Ph. Laurençot (University of Toulouse)

Contact: C. Stinner.

References

[1] R. G. Iagar, P. Laurençot, and C. Stinner. Instantaneous shrinking and single point extinction for viscous Hamilton-Jacobi equations with fast diffusion. *Math. Ann.*, 368:65–109, 2017.

1.3 Applied Geometry

The research group “Geometry and Approximation” investigates geometric objects, typically surfaces, and ways to approximate them.

Classical *Differential Geometry* and *Geometric Analysis* studies surfaces minimizing geometric functionals for which examples arise in the sciences and engineering. In the simplest case, say for a biological cell, a bounding surface encloses a given volume in such a way that the area is minimized. Other interfaces minimize functionals involving curvatures, for instance the Willmore functional. Critical points are characterized by Euler equations, which are non-linear partial differential equations. The mathematical goal is to establish new solutions or properties of solutions, not only in Euclidean 3-space but also in other Riemannian ambient spaces, using methods of analysis and Riemannian Geometry.

In *Geometric Modeling*, mathematical tools for the explicit description of geometric objects are developed and analyzed. Here the focus is on complex structures, as they arise in various applications: One may think of a car body, a piece of cloth, or a dinosaur in an animated film. The surfaces considered in Differential Geometry and Geometric Modeling typically have a fairly complicated structure. For processing, it is necessary to approximate them in a function space of reduced complexity, say a spline space. For that reason, the development of tools for efficient approximation of geometric objects is an important task, giving rise to interesting mathematical questions in the field of multivariate approximation theory.

Members of the research group

Professors

Karsten Große-Brauckmann, Elena Mäder Baumdicker (starting 4/19), Ulrich Reif

Postdocs

Brice Loustau, Florian Martin

Research Associates

Jerome Alex, Kai Bouaraba, Ba-Duong Chu, Alexander Dietz, Lars-Benjamin Maier, Arthur Windemuth

Secretary

Tanja Douglas

Project: Triply periodic Steiner trees

The Steiner Tree problem is a problem of combinatorial optimization. Given a set of points, interconnect them by a network of shortest length, where the length is the sum of the lengths of all edges. In order to reduce the length of the spanning network, new vertices and edges may be introduced. The Steiner tree problem has applications in circuit layout or network design. Periodic Steiner Trees are used to describe various multi-atomic structures and their molecular configurations.

Contact: J. Alex

Project: Surfaces in homogeneous 3-manifolds

Minimal and constant mean curvature surfaces are a traditional subject in Euclidean space, in hyperbolic space, or in the 3-sphere. The case of homogeneous 3-manifolds as ambient spaces is a further prominent case studied more recently. By considering these spaces as Riemannian fibrations and either using a direct Plateau method or the Daniel sister construction we investigate minimal and constant mean curvature surfaces in these spaces. This includes new examples of minimal surfaces for the particularly prominent case of the 3-sphere. Building on previous work of PhD theses, e.g. by Vrzina [1], work in progress is on symmetric minimal surfaces in homogeneous spaces of higher dimension.

Partner: Rob Kusner (Amherst, MA), Arthur Windemuth (TU Darmstadt)

Contact: K. Große-Brauckmann

References

[1] M. Vrzina. Cylinders as left invariant CMC surfaces in Sol_3 and $E(\kappa,\tau)$-spaces diffeomorphic to R^3. *Differential Geometry and its Applications*, 58:141–176, 2018.

Project: Networks and interfaces

Surfaces which are periodic in Euclidean space $\mathbb{R}^n$ under a lattice Λ play for $n = 3$ an important role for the modelling of various naturally occuring interfaces. Certain symmetric surfaces have been described in terms of networks N. A surface feature significant for the area or Willmore energy is encoded in the ratio L^3/V, where L is the length of the network quotient N/Λ and V the volume of $\mathbb{R}^3/\Lambda$. In [1] we begin a study of the minimization problem for L^3/V under certain natural restrictions such as prescribed degree of the network. An open question is if the space of lattices has a good parameterization in terms of networks minimizing L^3/V for the lattice, where a given combintorics is assumed.

Contact: K. Große-Brauckmann

Partner: J. Alex (TU Darmstadt), J. Sullivan (TU Berlin)

References

[1] J. Alex and K. Grosse-Brauckmann. Periodic Steiner networks minimizing length. Technical report, arXiv:1705.02471.

Project: Trimmed NURBS with low order boundaries

Non-Uniform Rational B-Splines (NURBS), the standard of industrial modeling, reveal severe drawbacks. In particular, the contact of neighboring patches is in general discontinuous due to the complicated structure of trimming curves. In this project, we develop new methods to represent G1 and even G2 continuous composite surfaces for industrial use. A patent application is in preparation.

Partner: Dr. Florian Martin

Contact: U. Reif

Project: PDEs on manifolds

The approximation of intrinsic partial differential equations on manifolds is difficult for two reasons. First, it is complicated to evaluate and discretize differential operators like the Laplace-Beltrami. Second, function spaces for approximation other than piecewise linears are extremely difficult to construct. Based on the concept of Ambient B-Splines, we develop a new framework for high order approximation using an extension of the given PDS to embedding space.

Partner: Dr. Lars-Benjamin Maier

Contact: U. Reif

Project: Geometric Hermite Subdivision

In this project we develop and analyze nonlinear subdivision algorithms which generate smooth curves from point and normal data. Such schemes are useful in applications with highest demands concerning the fairness of the curves to be constructed, as appearing for instance in the automotive industry.

Partner: Prof. Andreas Weinmann

Contact: U. Reif

Project: Relation between Coxeter Groups and Minimal Surfaces in Homogeneous Manifolds

A simple convex polytope in a homogeneous manifold tiles the manifold by reflection on its codimensional-one faces, if the dihedral angle between the facets are submultiples of π. The induced reflection group is naturally a Coxeter group. We construct a Jordan curve which consists of edges of the initial polytope. The Plateau solution of the curve can now be reflected across the edges by the Schwarz reflection principle to construct periodic minimal surfaces. The group arising from the Schwarz reflection principle can be understood as a subgroup of the Coxeter group and the index gives information about whether the minimal surfaces is embedded.

Contact: Arthur Windemuth

1.4 Didactics and Pedagogics of Mathematics

The working group on subject didactics accommodates two lines of research
The working group on subject didactics with Regina Bruder considers their focus to be on theoretically and empirically founded concepts of course development for secondary levels I and II. Through academic monitoring of several long-term projects on course development in various German federal states - particularly on a concept-based use of technology and on internal differentiation within secondary level II and, since 2014, also on long-term capacity building at secondary levels, as well as on the implementation of secondary school leaving examination standards in the form of guidelines for teaching staff.
Due to participation in various working groups of the GDM [Society for Didactics of Mathematics], major book projects, and through extensive teacher training activities, inter alia, at the DZLM [German Centre for Mathematics Teacher Education], subject didactics has built a strong network throughout the German-speaking areas.
The implementation of preliminary mathematics courses (online and blended-learning) at the commencement of the engineering degree courses in four departments (VEMINT project in cooperation with Kassel, Paderborn and Hannover) the project leadership of MINTplus connected with the center of teacher education (ZFL) in Darmstadt demonstrate the broad networking and anchoring of the working group on subject didactics at TU Darmstadt.
The further grown international connections led to a two year DAAD- project with the ACU in Brisbane (Australia) and Iresha Ratnayake from Sri Lanka works with us as a postdoctorand in the DAMS since summer 2018.

Research Group in Operator Algebras and Mathematical Physics
Quantum probability is an extension of classical probability theory that allows to treat also probabilistic effects of quantum systems. Operator algebras allow a unified treatment of both cases, classical probability as well as probability in quantum systems. All basic notions of probability like expectations, random variables, stochastic processes, martingales, etc. can be formulated in the language of operator algebras in such a way that they reduce to the notions of classical probability whenever the operator algebra is commutative.
Our **research interests** range from theoretical mathematical investigations to physical applications. Consequently, the members of our research group as well as our research partners range from pure mathematicians to physicists.
Common to most of our research is its focus on certain **dynamical behaviour**, be it the dynamics of classical and quantum stochastic processes (Markov processes, noise, quantum trajectories, filtering, etc.), be it the dynamics generated by completely positive maps (ergodic and spectral properties, existence and numerical computation of equilibrium states, quantum state preparation, etc.). The coupling representation of a Markov process has also opened the door to a scattering theory for such processes and to research on quan-

tum coding. It links quantum probability in a new and unexpected way with the fields of quantum information and quantum control.
Recently the **geometry of entangled states** came into the focus of our research interests, in particular entanglement on infinite systems, multipartite entanglement, and criteria for entanglement by methods from convex algebraic geometry.

Members of the research group
Professors
Regina Bruder, Burkhard Kümmerer

Research Associates
Malte Brandy, Felix Johlke, Thomas Klein, Albrun Knof, Barbara Krauth, Sandra Lang, Ulrike Roder, Marcel Schaub, Insa Schreiber, Felix Voigt

Secretaries
Sigrid Hartmann, Heike Müller

Project: MINTplus (BMBF)

Within the scope of the 'Qualitätsoffensive Lehrerbildung'(BMBF) the project MINTplus 2015-2018 was approved.
The center of teacher education (ZfL) of the TU Darmstadt puts the aim to profile both courses for teacher students (LaG, LaB) with certified suitability consultation, specific profession-related, interdisciplinary study offers as well as graded practise phases at extracurricular learning places and at school. The teacher students should be strengthened in identification with the planned career and with the elective fields of teaching equally. They should be perceived as especially competent tutors at the university as knowledge mediators and be esteemed. With the interlinking area planned for all professional combinations innovative attempts are pursued in the study entrance phase. The common study entrance prepares the teacher students for the specialist demands in the subsequent semesters and supports them with the construction of a professional-connecting identification with the MINT fields.
`https://www.qualitaetsoffensive-lehrerbildung.de/de/projekte-16.php`

Support: Federal Ministry of education and research (BMBF)

Contact: R.Bruder (project leader), C. Preuss, Y. Bachmann
Details: https://www.zfl.tu-darmstadt.de/projekte_2/mintplus/projekt_mintplus.de.jsp

Project: Examination questions in Lower Saxony (TANS - Testaufgaben Niedersachsen) 2016-2017

By order of the state of Lower Saxony, the TANS project was established dealing with the didactical analysis of examination tasks in mathematics for secondary schools (main school and middle school/Hauptschule und Realschule) in the period from 2010 to 2016. The aim is to describe trends regarding the fit between the tasks and the standards in the curriculum as well as regarding the requirements with differentiated criteria. Therefore the examination tasks are classified with regard to different criteria like the occurrence of content- and process-related competencies, the structure of the questions in detail, complexity in language and the parameters for difficulties in formalization, complexity and the

effort for execution.
In autumn of 2016 the analyzing concept was developed and a prototypical analysis of the examination tasks of the years 2015 and 2016 was made. For the beginning of the year of 2017 the remaining tests of the period of 2010-2014 will be finished. In collaboration with the responsible persons a study will be designed to do a profound causal analysis to find out reasons for the variation within the results of different counties.

Support: Ministry of education and cultural affairs of Lower Saxony

Contact: R. Bruder, F. Johlke, I. Schreiber

Project: ELMA (Factors of influence on achievement success in mathematics)

The aim of the ELMA project was to find possible causes for the phenomenon, that there are large performance differences in the central written exam in mathematics for the completion of secondary school in different regions of Lower Saxony. To this end, 15 schools with widely scattering examination results were examined. In the evaluation, qualitative and quantitative approaches were combined in order to obtain, within the framework of a reconstructive description paradigm, as holistic a picture as possible of the complex problem area of 'influencing factors on performance success'.
In order to check the fit of the 4 to 5 class tests per class with the curricular standards and the final central examination, the tasks were examined with regard to the content-related and process-related competences required therein. The task quality of the class tests was described by an analysis of the task structure and the cognitive requirements. This is a prognosis of the expected empirical task difficulty due to the presumed solution approaches. The degree of formalisation F, the degree of complexity K and the execution effort A of the individual tasks are included in the weighted assessment of the empirical task difficulty.
The analyses show that a broader spectrum of competences is addressed in the class tests of the classes that pass the 2018 examination more successfully than in the classes that tend to score worse.

Support: Ministry of Education Lower Saxony

Contact: R. Bruder, F. Johlke, U. Roder

References

[1] F. Johlke, U. Roder, and R. Bruder. Projekt ELMA – Eine Untersuchung von Einflussfaktoren auf Leistungserfolge im Realschulabschluss Mathematik mit Hilfe der Analyse von Klassenarbeiten der Abschlussklassen. In *Beiträge zum Mathematikunterricht*. WTM-Verlag Münster, 2019 (in press).

Project: bf VEMINT (since 2007) - Virtual Entrance Tutorial for MINT- course of studies

This project is a cooperation of the universities of Darmstadt, Hannover, Kassel and Paderborn, who created and develop virtual learning materials for students at the beginning of their studies.
The aim of the project is to make the transition from school to university easier for the students. The knowledge, skills and abilities of students at the beginning of their studies are very heterogeneous: A part of the students start their studies directly after school, but for

other students the schooldays are far away. The level of understanding as well as the time investment of certain content of mathematics can be very different at university compared to mathematics at school.
In Darmstadt the learning materials of the VEMINT project are used as an e-learning course about 5 weeks. This course is not obliging for the participants and lies shortly before the beginning of the first semester. To increase the participation of the course and the interaction between the students, we use the plugin 'Moodle Peers' from the cooperating project with the same name. With the help of this plugin we can divide the students into actually working learning groups - with the help of well-chosen personality qualities ('big five').
In the winter semester 2018/19 we offered a new version of the preparation course for computer science students. In this course we also used the e-learning part, but also face-to-face lectures and exercises. An extensive Evaluation is a part of the project VEMINT.
Details: www.vemint.de

Partner: Wolfram Koepf (Universität Kassel), Hendrikje Schmidtpott-Schulz (Universität Kassel), Rolf Bieler (Universität Paderborn), Silvia Becher (Universität Paderborn), Tobias Mai (Universität Paderborn), Thomas Wassong (Universität Paderborn), Reinhard Hochmuth (Universität Hannover)

Support: Daniel Haase (MINT-Kolleg Baden-Württemberg)

Contact: R. Bruder, M. Schaub

References

[1] M. Schaub and U. Roder. Arbeit mit optimierten Lerngruppen im Online-Vorkurs VEMINT. In *Beiträge zum Mathematikunterrich*, pages 841–844. WTM-Verlag Münster, 2017.

Project: DDTA- Digital Diagnostic Test Exercises (since 2014)

This project is a cooperation of the universities of Bochum, Darmstadt, Flensburg and Münster. The aim of the project is to research and to optimize digital diagnostic test items. With our understanding of this project a digital diagnostic test item includes a digital task, which refers to one or more content elements about one or more actions. The aim is the automated generation of an individual learn-supporting feedback through a differentiated error detection. The base is an analyse of the answers in live-time, which be performed by diagnostic distractors in closed item-format and with the help of a CAS in open item-format. Depending on the complexity of an item, it follows an elementarizied loop, that can identify missing elementary building blocks and typical errors in elementary building blocks. This project unites various concepts of digital diagnostic testing. In the focus of the research is the interaction of these different concepts and the layout and structure of the feedback.

Partner: Kathrin Winter (Universität Flensburg), Christoph Neugebauer (Universität Münster), Sebastian Krusekamp (Universität Münster), Michael Kallweit (Ruhr-Universität Bochum), Nora Feldt-Caesar (former TU Darmstadt)

Contact: R.Bruder, M. Schaub

References

[1] R. Bruder, N. Feldt-Caesar, M. Kallweit, S. Krusekamp, C. Neugebauer, M. Schaub, and K. Winter. Digital Diagnostic Testing Tasks (DDTA) - Theoretical Design and interactive example. In

B. Kaur, W. K. Ho, and T. L. Toh, editors, *Proc. 41th Conf. of the Int. Group for the Psychology of Mathematics Education (Vol. 2)*. PME, 2017.

[2] M. Kallweit, M. Schaub, N. Feldt-Caesar, R. Bruder, S. Krusekamp, C. Neugebauer, and K. Winter. Digitale Diagnostische Testaufgaben – Theoretisches Design und interaktives Beispiel. In *Beiträge zum Mathematikunterricht*, pages 1423 – 1424. WTM-Verlag Münster, 2017.

Project: WTT Serious Games Information Center for technology and knowledge transfer between research, business and society in the field of Serious Games

Serious games are games that not only entertain, but also make a playful contribution to education or health. In the WTT Serious Games project at the TU Darmstadt, knowledge about the characteristics of high-quality Serious Games is acquired, recorded and transferred to small and medium-sized enterprises (SMEs) such as game developers, IT service providers and users by means of studies, publications, recommendations for action and events in interdisciplinary cooperation. Targeted measures to promote start-ups are also intended to motivate young people to get involved in the serious games market with their innovative ideas. Overall, the project aims to sustainably strengthen Hessen as a games location and to establish Hessen nationwide as #1 in the serious games market with the TU Darmstadt as the first point of contact for research and teaching in the field of serious games. Our project contribution here consists in the research and presentation of serious games in the field of education.
Details: http://www.wtt-serious-games.de

Partner: Dr. Stefan Göbel (project leader), Prof Dr. Josef Wiemeyer (TU Darmstadt), Sonja Bergsträßer (TU Darmstadt), Polona Casermann (TU Darmstadt), Philipp Müller (TU Darmstadt), Katrin Hoffmann (TU Darmstadt), Katharina Straßburg (TU Darmstadt), Thomas Lenz (TU Darmstadt)

Contact: R. Bruder, M. Schaub

Project: DCOMT - Designing Challenging Online Mathematical Tasks - strengthening mathematical knowledge in pre-service teacher education

The purpose of the 2-year DAAD-project 2017 and 2018 between the Australian Catholic University Brisbane, Vince Geiger, and the TU Darmstadt, Regina Bruder, was to strengthen pre-service teachers' mathematical knowledge, particularly higher order thinking capabilities such as mathematical problem solving - a significant issue in Australian and German education. Several conference contributions in 2019 and articles were prepared for international journals.

Contact: R. Bruder and U. Roder

Partner: Vince Geiger, Jodie Miller, Jill Wells (ACU Brisbane) and Iresha Ratnayake (TU Darmstadt)

Project: Knowing how to reflect on linear algebra at the level of secondary education

When focusing on competence orientation, one sometimes loses sight of subject-specific knowledge and skills as prerequisite for competence. However, it is known that subject-specific knowledge is the most important individual factor for successful learning processes. Different institutions such as universities or training companies complain about deficient pre-knowledge of high school graduates. Due to the aforementioned reasons, representatives of mathematical education sectors started to discuss about basic knowledge or basic competences in terms of minimum standards. The Didactic and Pedagogy Working group is researching on this topic in different projects with the goal to develop a concept of mathematical basic knowledge and basic skills. The respective research is based on action theory. Mathematical basic knowledge and basic skills comprises all kinds of mathematical knowledge and skills, abilities as well as capabilities that exist on a long-term basis and independent of situations at the end of both secondary levels; especially without the use of any auxiliary means. The demands and requirements resulting from a pragmatic point of (vocational training) employers have to be complemented by subject-specific viewpoints and the educational viewpoints of schools.

In the German speaking research communities of didactics or pedagogy, an interesting construct is currently being discussed with the term 'reflective knowledge'. This construct allows a broadening of the basic knowledge and basic skills perspective with regard to educational demands. In this project, a concept of reflective knowledge has been developed and substantiated for the secondary level of high school in linear algebra used for the construction and selection of tasks that are especially suitable for the development of reflection. Based on activity theory a concept to construct teaching units has been developed. Examples for this concept have been given for the topics algorithm, formalization, mathematical modelling and argumenatation. These examples are set in the context of linear algebra in secondary education. The potential of this context for the named topics are also elaborated in the project.

Contact: O. Schmitt

References

[1] O. Schmitt. *Reflexionswissen zur linearen Algebra in der Sekundarstufe II*. Springer Spektrum Wiesbaden.

Project: LEMAMOP – Learning opportunities for mathematical argumentation, modelling and problem solving

The basic idea of LEMAMOP is the support of the gradual acquisition of intelligent knowledge for a long-term construction of the central competence mathematical argumentation, modelling and problem solving considering the protection of basic mathematical knowledge. Moreover suitable training aids should be developed. In this draught it is about three specific, from the core curricula resultant learning opportunities per school year, to so-called 'competence trainings'. Each of these learning opportunities has an extent of about 4 teaching hours.

The challenge for the project LEMAMOP consists in promoting available knowledge and skill in particular about the mathematical argumentation, but also about the modelling and problem solving.

A theoretical draught of these 'competence trainings' is concretised by experienced professional teachers of mathematics for the grade 5 to 12 in the form of teaching modules, is documented and tested in the lessons.

LEMAMOP began in the 2013 and applied for a duration of 3.5 years. A total of 15 schools took part, other 14 schools have a related status.

A concern of LEMAMOP is to qualify the teachers involved in the project for multipliers,

as well as to incorporate the professional boards early in this qualification process.
LEMAMOP is integrated into the further education system from Lower Saxony for the field of mathematics in high schools, the network MUT.
LEMAMOP ties on to the successful pilot experiments from Lower Saxony CAliMERO and MABIKOM.

Contact: R. Bruder, U.-H. Krüger

Support: Ministry of education and cultural affairs of Lower Saxony, DZLM

References

[1] R. Bruder, B. Grave, U.-H. Krüger, and D. Meyer. *LEMAMOP - Lerngelegenheiten für Mathematisches Argumentieren, Modellieren und Problemlösen. Lehrermaterialien und Lösungen (9 Bände)*. Westermann, 2017.

[2] R. Bruder and U.-H. Krüger. Lerngelegenheiten für Mathematisches Argumentieren, Modellieren und Problemlösen (LEMAMOP). In *Mathematikfortbildungen professionalisieren. Konzepte, Beispiele und Erfahrungen des Deutschen Zentrums für Lehrerbildung Mathematik*, pages 225–248. Springer Wiesbaden, 2018.

Project: MAKOS 2014-2017

The project MAKOS (technology supported mathematics classes with a competency development that considers individual student differences in upper secondary school) is based on the results of the school trials CALiMERO and MABIKOM. MAKOS is a joint project between the Universität Kassel, the TU Darmstadt and the seminar for trainees in Darmstadt and Kassel. After the introduction of the standards for general qualification for university entrance, it is necessary to concretize these standards in new curricula. Therefore, the aim of the MAKOS project was to develop supplementary material, which considers the heterogeneity in learning groups and is based on the KMK-Standards for general qualification for university entrance. These materials were designed to support the introduction of the new curriculum in upper secondary school in Hesse. The project was supported by the DZLM (German Centre for Mathematics Teacher Education) and the Hessian Ministry of Education (HKM). Teachers and trainees from 21 project schools have created the materials in workshops (four workshops a year) and afterwards the materials have been tested in class. The MAKOS concept of internal differentiation is based on the teaching concept of MABIKOM (2008-2012) that is adequate for daily use and appropriate for considering individual differences in mathematics classes. The quality in the context of material development was assured first by testing in the classroom and second by the scientific monitoring of development and testing process at the two universities. The project was completed in September 2016 and the results will be published in Summer 2017. Furthermore training sessions for teachers and trainees are scheduled and take use of the project results.
Details: www.makos.info

Partner: Werner Blum (Universität Kassel), Kerstin Krimmel (Universität Kassel), Andreas Eichler (Universität Kassel), Karl-Friedrich Gründer (Studienseminar Kassel), Alexander Best (Studienseminar Darmstadt), Frank Dill (Studienseminar Darmstadt), Ulrike Roder (TU Darmstadt)

Support: DZLM Deutsches Zentrum für Lehrerbildung Mathematik, Hessisches Kultusministerium, Landesschulamt, Studienseminare für berufliche Schulen und Gymnasien in Darmstadt und Kassel, Universität Kassel

Contact: R. Bruder, U. Roder, I. Bausch

Project: Knowledge qualities for mathematical proof processes in the field of analysis in the first semester

The project is located in the research area on the transition between school and university with a focus on the influence of mathematical knowledge and its quality on proving processes. The objectives of the project are the description and further development of the knowledge qualities derived from activity theory, which have already been adapted by Nora Feldt-Caesar and Oliver Schmitt for basic knowledge and basic skills, as well as conclusions for diagnostic instruments and acquisition materials for knowledge on the corresponding quality. An exemplary implementation of these instruments and materials is envisaged for one mathematical concept and one theorem. Based on theoretical considerations and known quantitative and qualitative studies on the influence of these qualities on evidence processes, the instruments and materials will be tested in a qualitative investigation, and the influence of the diagnosed knowledge qualities on proving processes will be examined more closely.

Contact: I. Apel

References

[1] I. Schreiber. Befragungsergebnisse zu Phänomenen am Übergang Schule-Hochschule bei Mathematikstudierenden. In *Beiträge zum Mathematikunterrich*, 2018.

Project: EOM (E-Feedback to overcome Misconceptions)

The aim of the dissertation project EOM (E-Feedback to overcome Misconceptions) is the optimization of feedback in digital online learning environments. Digitally designed, automated and error-adaptive feedback elements are intended to trigger learning processes among pupils. Current studies and research work from feedback theory as well as media pedagogy and psychology are included.

This e-Feedback is used to take individual learning preferences into account and thus to increase the effectiveness of the feedback elements, as individual learning preferences can influence the acceptance and thus also the effect of feedback.

In addition, the project directly follows on from existing research work and dissertation projects of the Didactics Working Group (cf. CODI by Nitsch, R.). The focus here was on finding systematic errors. These structural misconceptions are now to be overcome with the help of Conceptual Change Theory. Feedback is the central interface between the diagnosis of student performance and follow-up materials (routers, etc.).

Contact: F. Johlke

References

[1] F. Johlke. Project EoM - The use of digital tools for an activation of Conceptual-Change-processes at mathematical misconceptions. In A. L. M. Louis Gómez Chova and I. C. Torre, editors, *Edulearn 17. Conference proceedings. Barcelona: IATED Academy (EDULEARN proceedings (Internet))*, pages 828–833, 2017.

[2] F. Johlke. Einsatz digitaler Werkzeuge zur Aktivierung von Conceptual-Change-Prozessen bei Fehlvorstellungen. In *Beiträge zum Mathematikunterricht*. Institut für Mathematik der Universität Potsdam (Hg.), 2017.

[3] F. Johlke. Fehlvorstellungen durch E-Feedback überwinden. Vorstellung eines Dissertationsprojekts. In G. Pinkernell and F. Schacht)., editors, *Arbeitstagung des Arbeitskreises Mathematikunterricht und digitale Werkzeuge in der Gesellschaft für Didaktik der Mathematik vom 22. - 24. September 2017 in Heidelberg*. Franzbecker Hildesheim, 2018.

[4] F. Johlke. Digitale (interaktive) und individuelle Feedbackvarianten zu Fehlern Lernender bei digital gestellten Mathematikaufgabenn. In F. D. der Mathematik der Universität Paderborn (Hg)., editor, *Beiträge zum Mathematikunterrich*, pages 891–894. WTM-Verlag Münster, 2018.

Project: Basics2go

Following on from the BASICS-Mathematics project (Roder, U.) and the concept of mixed mental training exercises (Bruder, 2008) for keeping basic knowledge and basic skills alive in the long term, a web app is being developed in the project with the support of the Bachelor internship in Computer Science. With this app, teachers can plan, compile and carry out mixed mental training exercises in everyday school life using a centrally developed task database based on didactic content definitions and considerations of suitable task criteria. On the one hand, the web app enables teachers to have mental training exercises generated automatically and at the same time it offers the freedom to make extensive individual adaptions. The development of an app for pupils (Basics2play) is planned for summer 2019, which allows a purely digital implementation of the mental training exercise concept and automated evaluation and at the same time it offers students the possibility to solve further tasks independently. In the long term, a connection to the Basics-Mathematics project is planned, so that pupils can also be recommended supporting learning materials.

Contact: I. Apel, F. Johlke

References

[1] U. Roder, I. Apel, and F. Johlke. Förderung von Grundwissen und Grundkönnen. In *Beiträge zum Mathematikunterrich*. WTM-Verlag Münster, 2019 (in print).

details: http://www.basics2go.de/

Project: Quantum Control: Approach based on Scattering Theory for Non-commutative Markov Chains and Multivariate Operator Theory

The aim of this project is to explore genuinely non-commutative versions of control theory with a view toward direct applications to the emergent discipline of quantum control.
A basic idea of this project is to make use of recent developments in multivariate operator theory. While in classical operator theory a single operator is analysed, in multivariate operator theory the joint action of a family of operators is studied. These operators may not commute with each other. Nevertheless, there are analogues to classical results in complex analysis such as the idea of multi-analytic operators. In fact, many of the operator results which are relevant for classical control theory can be extended to this setting. We develop these tools with applications to quantum control. Scattering theory for non-commutative Markov chains is a theory about open quantum systems with many connections to operator

theory. Recently the wave operator occurring in this theory has been rewritten as a multi-analytic operator. On the other hand it is possible to interpret this theory as a version of open-loop control, for example it has been successfully applied to the preparation of states in a micromaser interacting with a stream of atoms.

Hence it is very natural to start here to develop the methods of multivariate operator theory as applied to the problems in quantum control. Once the bridge between quantum control and multivariate operator theory is understood in the specific directions described above we speculate that a considerable amount of related mathematics becomes available for engineering applications.

Partner: R. Gohm, J. Gough, Aberystwyth University; H. Maassen, University of Nijmegen

Support: Engineering and Physical Sciences Research Council (EPSRC), GB.

Contact: B. Kümmerer

References

[1] R. Gohm, F. Haag, and B. Kümmerer. Universal Preparability of States and Asymptotic Completeness. *Communications in Mathematical Physics*, 352 (1):59–94, 2017.

[2] R. Gohm, B. Kümmerer, and T. Lang. Noncommutative Symbolic Coding. *Ergodic Theory and Dynamical Systems*, 26:1521 – 1548, 2006.

[3] B. Kümmerer and H. Maassen. Scattering Theory for Generalized Markov Chains. *Infinite Dimensional Analysis, Quantum Probability, and Related Topics*, 3:161 – 176, 2000.

Project: A Coupling Method for Quantum Markov Processes

In the theory of Markov processes it is important to obtain information on their long time behaviour. Markov processes with finite state space always have a stationary distribution and for irreducible aperiodic processes there are various ways to estimate the speed of convergence to the equilibrium distribution.

On an infinite state space, however, a Markov process in general does not admit a stationary distribution. In the recent decade the coupling method has established as a tool to investigate their asymptotic behaviour. In particular, the coupling inequality plays a major role for estimating the distance between two initial distributions after long times.

In this project we succeeded in developing coupling techniques for quantum or non-commutative Markov chains. In particular, a coupling inequality is derived for such processes. The lack of the notion of a diagonal in this setting drives us to find an approach different from the classical one. In particular, the commutant of an operator algebra and Tomita-Takesaki-Theory comes in. It may be interesting to note that our approach links couplings to the decay of entanglement of certain quantum states, a subject of great interest in quantum information.

Contact: B. Kümmerer, K. Schwieger

References

[1] B. Kümmerer and K. Schwieger. Diagonal couplings of quantum Markov chains. *Infinite Dimensional Analysis, Quantum Probability and Related Topics*, 19 (2):1650012 (21 pages, 2016.

Project: Universal Preparability for Quantum Input-Output-Systems

For a class of quantum input-output-systems we introduce a notion of universal preparability for a normal state on a von Neumann algebra. It describes a situation where from an arbitrary initial state it is possible to prepare a target state with arbitrary precision by a repeated interaction with a sequence of copies of another system. For $\mathscr{B}(\mathscr{H})$ we develop criteria sufficient to ensure that all normal states are universally preparable which can be verified for a class of non-commutative birth and death processes realized by the interaction of a micromaser with a stream of atoms. As a tool the theory of tight sequences of states and of stationary states is further developed and we show that in the presence of stationary faithful normal states universal preparability of all normal states is equivalent to asymptotic completeness, a notion studied earlier in connection with the scattering theory of non-commutative Markov processes.

Partner: R. Gohm, J. Gough, Aberystwyth University

Contact: B. Kümmerer, A. Knof

References

[1] R. Gohm, F. Haag, and B. Kümmerer. Universal Preparability of States and Asymptotic Completeness. *Communications in Mathematical Physics*, 352 (1):59–94, 2017.

[2] R. Gohm, B. Kümmerer, and T. Lang. Noncommutative Symbolic Coding. *Ergodic Theory and Dynamical Systems*, 26:1521 – 1548, 2006.

[3] B. Kümmerer and H. Maassen. Scattering Theory for Generalized Markov Chains. *Infinite Dimensional Analysis, Quantum Probability, and Related Topics*, 3:161 – 176, 2000.

Project: Stationary States, Recurrence and Transience for Quantum Dynamics

Probabilistic Markovian behavior is described by semigroups of transition matrices or, more generally, by transition kernels. In quantum probability, this generalizes to semigroups of completely positive operators on the algebra of observables. As in classical probability, existence, uniqueness, and convergence to stationary states—states generalize probability distributions – are an important issue whenever one is interested in the long time behavior of such a dynamics. For finite systems a Perron-Frobenius type theory is available, for infinite systems, notions of recurrence and transience become crucial.

Starting from a noncommutative version of the Riesz decomposition theorem we develop a coherent approach to recurrence and transience. It leads to a classification of idempotent Markov operators, thereby identifying concretely the Choi-Effros product, and to an abstract Poisson integral. The paradigmatic case of semigroups on the algebra $\mathscr{B}(\mathscr{H})$ of all bounded operators on a Hilbert space was studied in more detail. These may be viewed as a quantum version of Markovian semigroups on countably many states.

Current activities regard the decomposition of the dynamics on finite system into irreducible components. A structure theorem for the asymptotically non-vanishing observables was derived by applying the aforementioned Perron-Frobenius theory. This leads to a transfer of the above results from the projection on the fix space to the projection on the space of non-decaying observables. Future work may include further understanding of the concrete applications of this new decomposition and the possibilities of generalizing to infinite systems.

Partner: R. Gohm (Aberystwyth)

Contact: M. Brandy, B. Kümmerer

References

[1] A. Gärtner and B. Kümmerer. A Coherent Approach to Recurrence and Transience for Quantum Markov Operators. Preprint arXiv:1211.6876, TU Darmstadt, 2012.

Project: Ergodic Properties of Quantum Birth and Death Chains

In this project we study a class of quantum Markov processes that, on the one hand, is inspired by the micromaser experiment in quantum optics and, on the other hand, by classical birth and death processes. We study their geometric properties and ergodic properties like irreducibility. Furthermore, we analyse the ergodic properties of the corresponding transition operators. It turns out that for homogeneous birth and death rates these can be fully determined by explicit calculation. As for classical birth and death chains we obtain a rich yet simple class of quantum Markov chains on an infinite space, which allow only local transitions while having divers ergodic properties.

Contact: B. Kümmerer, F. Voigt

References

[1] D. Bücher, A. Gärtner, B. Kümmerer, and et al. Birth and Death Chains. Preprint, TU Darmstadt, 2013.

Project: Measures of Entanglement and Norms on Tensor Products

It is one of the basic problems of quantum information to measure degrees of entanglement for quantum states.

A quantum system is described by a state on a Hilbert space, i. e. a non-negative trace class operator with trace one. For the description of composed quantum systems one has to use a state on the tensor product of the corresponding Hilbert spaces. For example, a tensor product of states describes a joining of independent quantum systems. Since the state space of a quantum system is a convex set one can consider the convex hull of the product states: The set of *separable states*. But not all states on the tensor product Hilbert space are separable. Such states are called *entangled*. Experiments show that only entangled states behave truely quantum mechanically as they may violate Bell's inequalities and can be used for quantum cryptography and quantum computation.

There exist various notions in the literature of how to measure the degree of entanglement: it should measure the usability of an entangled state for true quantum effects. But most of these notions are bound to bi-partite or finite dimensional systems. Recently, W. Arveson established a universal measure of entanglement which is geometrically motivated and may attain the value "infinity" for certain states. However, in the finite case this measure equals the maximal or projective tensor norm previously proposed by O. Rudolph. In this project we aim to gain a deeper understanding of the structure of Arveson's measure of entanglement. For example, we try to compute its value for some interesting states on multipartite systems or give better bounds for it. Moreover, we intend to apply Arveson's measure to more general notions of physical entanglement such as entanglement of fermionic or bosonic particles, genuine multipartite entanglement and others. Due to the existence of "infinitely entangled states" we also address the problem of explicitly characterizing this set and try to find concrete physical examples for such states.

More recently, by using methods from convex algebraic geometry we find new criteria for entanglement.

Contact: B. Kümmerer, S. Lang, F. Sokoli

References

[1] F. Sokoli and G. Alber. Generalized Schmidt decomposability and its relation to projective norms in multipartite entanglement. *J. Phys. A*, 47, 2013.

[2] F. Sokoli and B. Kümmerer. Entanglement of Indistinguishable Particles and its Quantification. Preprint arXiv:1507.04615v1, TU Darmstadt, 2015.

Project: Stationary Quantum Stochastic Processes, Unitary Cocycles, and Their Cohomology

We resume an older project on the structure of stationary quantum stochastic processes. A stationary quantum stochastic process with values in the $n \times n$-matrices M_n is given by a quadruple $(\mathscr{A}, \varphi, (T_t)_t, i)$, where $\mathscr{A}$ is a von Neuman algebra with a faithful normal state φ, $(T_t)_t$ is a stationary group of automorphisms of $(\mathscr{A}, \varphi)$ with time parameter $t \in \mathbb{Z}$ or $t \in \mathbb{R}$ (in the latter case we assume continuity in the pointwise strong operator topology), $i : M_n \to \mathscr{A}$ is a *-homomorphism such that there exists the conditional expectation from $(\mathscr{A}, \varphi)$ onto $i(M_n)$. The random variables are then given by the family $(i_t)_t$ with $i_t := T_t \circ i$. It follows that for every t there is a unitary $u_t \in \mathscr{A}$ such that $i_t(x) = u_t^* i(x) u_t$ for $x \in M_n$. Two problems are considered:
1. Under which conditions can u_t be chosen in the centralizer of $(\mathscr{A}, \varphi)$?
2. In the case of continuous time, i.e. $t \in \mathbb{R}$, under which conditions can we choose the unitaries $(u_t)_t$ such that they form a strongly continuous cocycle of the automorphism group $(T_t)_t$, i.e., such that $u_{s+t} = u_s \cdot T_s(u_t)$?
If both conditions are fullfilled, then the automorphism group $(T_t)_t$ can be considered as a perturbation of an evolution $(S_t)_t$ of $(\mathscr{A}, \varphi)$ with $S_t(x) := u_t T_t(x) u_t^*$. It leaves the subalgebra $i(M_n) \subseteq \mathscr{A}$ pointwise fixed and hence can be considered as a *free evolution* of the relative commutant of $i(M_n)$ in $\mathscr{A}$ which may be considered as a heat bath. If the stochastic process has the Markov property then the free evolution becomes a white noise.

Contact: B. Kümmerer, F. Voigt

References

[1] B. Kümmerer. Stochastic Processes with Values in Mn as Couplings to Free Evolutions. Preprint, University of Tübingen, 1993.

Project: Asymptotic Completeness and Synchronizing Words

Given finite sets A and C then a surjective map $\gamma : A \times C \to A$ may be identified with a road-coloured directed graph with vertices A and C a set of colours labeling its edges with a road-colouring. A probability distribution on C induces transition probabilities between the vertices of A. Dually, γ induces an injective *-homorphism $i : \mathscr{A} \to \mathscr{A} \otimes \mathscr{C}$ where $\mathscr{A}$ and $\mathscr{C}$ denote the commutative algebras of functions on A and C. Iterating the map i leads to an algebraic version of the Markov process for the given transition probabilities. In [2] we have shown that it is asymptotically complete if and only if the road coloured-graph admits a synchronizing word. Presently, the following two problems are considered:
1. For infinite sets A and B an analogous approach suggests the notion of synchronizing words for infinite graphs which is presently studied.
2. Admitting also non-commutative algebras $\mathscr{A}$ and $\mathscr{C}$ then an injective *-homomorphism $i : \mathscr{A} \to \mathscr{A} \otimes \mathscr{C}$ may be interpreted as a non-commutative version of a road-coloured graph, but the notion of asymptotic completeness makes still sense. A criterion for asymptotic completeness is provided by regularity of an associated extended transition operator ([2], [1]). Classically (i.e., for commutative algebras), this translates into regularity of

the adjacency matrix of the road-colored graph's label product with itself. In this case the transition operator corresponds to a sum of tensor products and it exhibits strong positivity properties. The question arises, whether this structure can be transferred to the non-commutative case.

Partner: R. Gohm, Aberystwyth University

Contact: A. Knof, B. Kümmerer

References

[1] R. Gohm, F. Haag, and B. Kümmerer. Universal Preparability of States and Asymptotic Completeness. *Communications in Mathematical Physics*, 352 (1):59–94, 2017.

[2] R. Gohm, B. Kümmerer, and T. Lang. Noncommutative Symbolic Coding. *Ergodic Theory and Dynamical Systems*, 26:1521 – 1548, 2006.

[3] B. Kümmerer and H. Maassen. Scattering Theory for Generalized Markov Chains. *Infinite Dimensional Analysis, Quantum Probability, and Related Topics*, 3:161 – 176, 2000.

Project: Mathematics: The Common Language of Natural Sciences (Mathematik als gemeinsame Sprache der Naturwissenschaften)

In this project we develop an innovative multidisciplinary lecture course to be attended by all teacher students who study at least one of the subjects mathematics, physics, chemistry, biology, or informatics. It is a building block of the recently founded "interlinking area" ("Vernetzungsbereich"), which is established as a part of the MINTplus initiative of the Technical University Darmstadt to profile the teachers education at our university. It is financially supported by German Bundesministerium für Bildung und Forschung as a part of the "Qualititätsoffensive Lehrerbildung".
The course supports the usage of mathematical language and the handling of mathematical formulas in the respective subjects, thereby reflecting the role of mathematics as common language of natural sciences, in particular, possibilities and limitations of mathematical modelling in natural sciences. The common mathematical language provides a link between different natural sciences and fosters crossover cooperations in school teaching. Examples from the history of mathematics illuminate the mutual dependence between the developments of mathematics and of natural sciences.

Support: BMBF (Bundesministerium für Bildung und Forschung, Ministry for Education and Research)

Contact: B. Kümmerer, S. Lang

Project: Opportunities and limits of digital diagnosis at the transition from school to university (since 2014)

This doctoral project is about the opportunities and limits of digital diagnosis at the transition from school to university with the focus of Moodle. In this project two methods are the most important ones: The adaptive test method 'elementarizing testing' that analyses in which domains the problems lie and digital testing with STACK, that use a CAS in the background. The aim of this project is to give students a learn-supporting feedback for learning at the end of a digital diagnostic test.
The new theoretical results will be transferred to the VEMINT-test, so it will be possible to evaluate the results in 2017 till 2019. In first results typical errors could be identified and

combining both methods increases the proportion of clarification of errors.
This project is based by results of the dissertation of Nora Feldt-Caesar and the project DDTA.

Contact: M. Schaub

References

[1] M. Schaub. Zur Entwicklung eines förderwirksamen online-Feedbacks zum VEMINT-Eingangstest. In *Beiträge zum Mathematikunterrich*, pages 829–832. WTM-Verlag Münster, 2017.

[2] M. Schaub. Einsatz des Elementarisierenden Testens im Ein- und Ausgangstest des online-Vorkurses VEMINT. In *Beiträge zum Mathematikunterrich*, pages 1567–1570. WTM-Verlag Münster, 2018.

1.5 Logic

The research group in *Mathematical Logic and Foundations of Computer Science* represents the subject area of Mathematical Logic viewed as an applied foundational discipline between mathematics and computer science. Research activities focus on the application of proof theoretic, recursion theoretic, category theoretic, algebraic and model theoretic methods from mathematical logic to mathematics and computer science.
Beside classical mathematical logic (represented with proof theory, recursion theory and model theory) this involves constructive type theory, categorical logic, universal algebra, domain and lattice theory, finite model theory and complexity theory.
Within mathematics, a primary field of applications in the proof- and recursion-theoretic setting is the extraction of new information from proofs in classical mathematics (proof mining: Kohlenbach). This concerns qualitative aspects (e.g., independence of existence assertions from certain parameters) as well as quantitative aspects of computability and complexity of solutions, extraction of algorithms and bounds from proofs, and links with exact real arithmetic and computational mathematics (Kohlenbach, Streicher). Model theoretic investigations make intra-mathematical links with algebra and discrete mathematics, e.g. graphs and hypergraphs (Otto).
Concerning Logic in Computer Science and the mathematical foundations of computer science, major activities revolve around issues of semantics. On the one hand, this involves the mathematical foundation of the semantics and the logic of programming languages (Keimel, Streicher); on the other hand, logics and formal systems are investigated in the sense of model theoretic semantics, w.r.t. expressiveness and definability, with an emphasis on computational aspects (algorithmic and finite model theory, descriptive complexity: Otto). Besides specific application domains in computer science, as, e.g., verification, data bases and knowledge representation, there is work on foundational issues in the areas of computability and complexity, as well as type theory and category theory (Streicher).
Overall, the logic group forms an internationally well connected cluster of expertise, with a characteristic emphasis on the connections that mathematical logic has to offer, both w.r.t. other areas within mathematics and w.r.t. the 'logic in computer science' spectrum.
The logic group takes part (with PI Kohlenbach) in the IRTG 1529 'Mathematical Fluid Dynamics'.
A research group on *Formal Concept Analysis* focuses on graphical logic systems for concept analysis in knowledge acquisition and processing applications (Burmeister, Wille). Rooted

in the *General Algebra and Discrete Mathematics* group (former AG1) this research is being pursued in particular in co-operation with the ‘Ernst Schröder Zentrum für Begriffliche Wissensverarbeitung e.V.’

Members of the research group

Professors

Ulrich Kohlenbach, Martin Otto, Thomas Streicher

Retired professors

Peter Burmeister (†), Christian Herrmann, Klaus Keimel (†), Rudolf Wille (†)

Lecturers

Kord Eickmeyer

Postdocs

Ulrik Buchholtz, Anton Freund, Angeliki Koutsoukou-Argyraki, Thomas Powell, Andrei-Valentin Sipoş, Florian Steinberg

Research Associates

Julian Bitterlich, Felix Canavoi, Jonathan Weinberger

Secretaries

Betina Schubotz

Project: Proof Mining in Convex Optimization

This Project aims at using proof-theoretic methods from logic for the extraction of new data (such as effective bounds, ‘proof mining’) from prima facie noneffective proofs in convex optimization and related areas. We tailor the proof-theoretic methods to the specific domain of applications and will then apply them for the extraction of rates of asymptotic regularity, metastability (in the sense of T. Tao) and convergence of central iterative procedures used in convex optimization. In particular, we study convergence proofs which make use of facts from the abstract theory of set-valued operators (e.g. maximally monotone operators).

Partner: G. Lopéz-Acedo (U Sevilla), A. Nicolae (U Sevilla), A. Sipoş (TU Darmstadt)

Support: DFG Project KO 1737/6-1

Contact: U. Kohlenbach.

References

[1] U. Kohlenbach. On the reverse mathematics and Weihrauch complexity of moduli of regularity and uniqueness. *Computability*, 2019. To appear.

[2] U. Kohlenbach. A polynomial rate of asymptotic regularity for compositions of projections in Hilbert space. *Foundations of Computational Mathematics*, 2019. To appear.

[3] U. Kohlenbach, G. Lopéz-Acedo, and A. Nicolae. A quantitative analysis of the ‘lion-man’ game. Preprint, arxiv:1806.04496, submitted, TU Darmstadt, 2018.

[4] U. Kohlenbach, G. López-Acedo, and A. Nicolae. Moduli of regularity and rates of convergence for fejer monotone sequences. *Israel Journal of Mathematics*, 2019. To appear.

[5] U. Kohlenbach and A. Sipoş. The finitary content of sunny nonexpansive retractions. Preprint, arxiv:1812.04940, submitted, TU Darmstadt, 2018.

Project: Proximal mappings with Young functions

It is well known in convex analysis that proximal mappings on Hilbert spaces are 1-Lipschitz. In this project we showed ([1]) that proximal mappings on uniformly convex Banach spaces are uniformly continuous on bounded sets. Moreover, we introduced a new general proximal mapping whose regularization term is given as a composition of a Young function and the norm, and formulate our results at this level of generality. This led to an explicit modulus of uniform continuity explicitly in terms of a modulus of uniform convexity of the norm and of moduli witnessing properties of the Young function. We also derived several quantitative results on uniform convexity, which are of interest on their own.

Partner: Miroslav Bačák

Contact: U. Kohlenbach.

References

[1] M. Bacak and U. Kohlenbach. On proximal mappings with Young functions in uniformly convex banach spaces. *Journal of Convex Analysis*, 25:1291–1318, 2018.

Project: Kreisel's 'shift of emphasis', proof mining and proof-theoretic tameness

This projects discusses the roots of the ongoing 'proof mining' paradigm in Kreisel's proposals to re-orient proof theory from the focus on foundational issues, such as consistency strength, to applications of methods that had been developed in this line of research to the analysis of proofs in core mathematics. Kreisel's ideas had an enormous impact on the modern development of proof mining which, however, also differs in important respects from Kreisel's 'unwinding of proofs'. Whereas e.g. Kreisel was sceptical about the possibility of general logical metatheorems which would be useful for specific unwindings, 'proof mining' has shown that many features in concrete proofs can be seen as instances of such logical metatheorems which provide an important guidance in finding promising applications and how to carry these out. The success of 'proof mining' is also related to the fact that proofs in ordinary mathematics usually display a proof-theoretic tameness by which the theoretically to be expected huge complexities of extractable data such as bounds in practice virtually never occur.

Contact: U. Kohlenbach.

Support: Georg Kreisel Institut für Wissenschaftstheorie Salzburg, IHPST Paris

References

[1] U. Kohlenbach. Kreisel's 'shift of emphasis' and contemporary proof mining. In M. Marfori and M. Petrolo, editors, *Intuitionism, Computation, and Proof: Selected themes from the research of G. Kreisel.* Springer, 2019.

[2] U. Kohlenbach. Local formalizations in nonlinear analysis and related areas and proof-theoretic tameness. In P. Weingartner, editor, *Kreisel's Interests. On the Foundations of Logic and Mathematics. A conference in honour of Georg Kreisel.* College Publications, 2019.

Project: Construction and Analysis in Hypergraphs of Controlled Acyclicity

Acyclicity conditions play an important role as tractability criteria for various issues of model theory and computational logic. Full acyclicity is often available through processes of unfolding (e.g ., of transition systems or game graphs into trees), albeit typically unavailable in settings where only finite structures are admissible. This project puts at the centre the development of constructions and methods suggested by [4], with a view to a more systematic understanding and to extending the reach of corresponding model-theoretic techniques to further application domains. At the level of basic research the project is geared to draw on logical and model-theoretic methods as well as on new connections with techniques from discrete mathematics (e.g., permutation groups, combinatorial and algebraic methods for graphs and hypergraphs). The project was completed in 2018; it substantially supported the doctoral research of Julian Bitterlich [1] and Felix Canavoi [2].

Support: DFG

Contact: M. Otto

References

[1] J. Bitterlich. *Investigations into the Universal Algebra of Hypergraph Coverings and Applications*. PhD thesis, TU Darmstadt, 2019.

[2] F. Canavoi. *Cayley Structures and the Expressiveness of Common Knowledge Logic*. PhD thesis, TU Darmstadt, 2018.

[3] F. Canavoi and M. Otto. Common knowledge & multi-scale locality analysis in Cayley structures. In *ACM/IEEE Logic in Computer Science, LICS 2017*, 2017.

[4] M. Otto. Highly acyclic groups, hypergraph covers and the guarded fragment. *Journal of the ACM*, 59, 2012.

1.6 Numerical Analysis and Scientific Computing

The research focus of the group for *Numerical Analysis and Scientific Computing* lies in the development, analysis, and implementation of novel, efficient, accurate, and reliable numerical methods for the solution of complex problems of practical interest. This includes the derivation and simplification of models, their analysis, the construction of appropriate numerical schemes for their simulation, the analysis of these numerical methods, the derivation of a-posteriori error estimates, the adaptive solution, and the consideration of related optimization and inverse problems.

The long-term goal of the group is to contribute to the fundamental research topics in the area of numerical mathematics and scientific computing, but also to provide software and expertise for the tackling of specific problems in engineering and the natural sciences. The group is currently engaged in projects in various application areas, e.g., in computational medicine and biology, in simulation and optimal control of gas and water supply networks, in inverse problems for fluid dynamics and non-destructive testing, in modeling and simulation of radiative transfer phenomena, in acoustic and optical tomography, in multiscale modeling and numerical approximation of soft matter systems, in simulation of transient acoustic and electromagnetic phenomena, in modeling and simulation in energy science and in modeling and simulation of compressible single- and multi-phase flows.

Particular research directions in the area of numerical mathematics that are pursued along these applications are, e.g., the development and numerical analysis of novel discretization schemes, the design and analysis of *a posteriori* error estimates, the uncertainty quantification for problems with variable inputs, and the structure preserving model reduction as well as the design and the analysis of model-adaptive schemes.

The research group *Numerical Analysis and Scientific Computing* has been and is engaged among others in various coordinated research activities, e.g., in the Graduate Schools (Excellence Initiative) GSC 233 Computational Engineering and GSC 1070 Energy Science and

Engineering, the Transregional Collaborative Research Centers (Transregio/SFB) TRR 154 Mathematical Modelling, Simulation and Optimization Using the Example of Gas Networks and TRR 146 Multiscale Simulation Methods for Soft Matter Systems, the International Research Training Group IGK 1529 Mathematical Fluid Dynamics, the German Research Foundation (DFG) Priority Program SPP 1748 Reliable Simulation Techniques in Solid Mechanics — Development of Non-Standard Discretisation Methods, Mechanical and Mathematical Analysis, and the Funding Program "Future-oriented Technologies and Concepts for an Energy-efficient and Resource-saving Water Management - ERWAS" of the Federal Ministry of Education and Research (BMBF) (`http://www.bmbf.nawam-erwas.de/en`). In addition, the group has various industry partners, including cooperations with Robert Bosch GmbH Stuttgart, BASF Ludwigshafen, and Infineon München.

Members of the research group

Professors

Herbert Egger, Christoph Erath, Jan Giesselmann, Martin Kiehl, Jens Lang

Retired professors

Peter Spellucci

Postdocs

Jürgen Dölz, Pia Domschke, Sofia Eriksson, Alf Gerisch, Michelle Lass, Hadi Minbashian, Christopher Müller, Kersten Schmidt, Adrien Semin, Sebastian Ullmann, Mirjam Walloth

Research Associates

Anke Böttcher, David Frenzel, Hrishikesh Joshi, Thomas Kugler, Axel Lukassen, Pascal Mindt, Bogdan Radu, Moritz Schneider, Lucas Schöbel-Kröhn, Robert Schorr, Tobias Seitz, Christopher Spannring, Philipp Steinbach, Elisa Strauch, Zhen Sun, Gabriel Teschner, Lisa Wagner, Dimitrios Zacharenakis

Secretaries

Elke Dehnert, Dagmar Thies

Project: Numerical approximation of phase field models in elastic bodies

Phase field transformations occur in different nature contexts. Phases can, for instance, differ in aggregate state or material properties. In this project we study partial differential equations describing phase transitions in solid elastic bodies. We show that solutions of the phase field equations, namely the Allen-Cahn and the hybrid model, are connected to an associated free energy. The idea of the gradient flow is to describe the time derivative of the order parameter indicating the particular phase as the gradient flow of the free energy. Convergence and asymptotic stability of numerical schemes are investigated.

Contact: Anke Böttcher, Herbert Egger

References

[1] A. Böttcher and H. Egger. Energy stable discretization of Allen-Cahn type problems modeling the motion of phase boundaries. *arXiv:1703.02778*, 2017.

Project: Adaptive dynamical multiscale methods

The aim of this project is the development of an integrated, dynamic multiscale approach for the numerical solution of the compressible instationary Euler equations on network structures. These methods will be used for the description of the stochastic behavior of practically relevant outputs relative to randomized parameters in hyperbolic differential equations (quantification of uncertainty), the construction of reduced order models and an adaptive multilevel optimization for gas networks.
In the first project period, modelling aspects and the development of adaptive discretizations were of primary importance. Adaptive spatial and temporal discretizations are controlled and combined with models from a newly established model hierarchy such that an efficient simulation of gas networks over the whole time horizon relative to a prescribed tolerance becomes available.
In the second project period, the influence of dynamic market fluctuations, which can be described by randomized initial and boundary values, on objective functions and scopes for the optimal control of gas networks in the framework of an uncertainty quantification will be investigated. Therefore, adaptive stochastic collocation methods with multilevel-like strategies for the reduction of the variance will be used. The integrated application of multilevel methods in space, time, and model as well as stochastic components lead to a reduction of computing time if resolution hierarchies in the corresponding approximations (space, time, model, stochastics) are employed. The stochastic collocation is realised by means of anisotropic sparse Smolyak grids. The inherent sampling strategy allows for the use of reduced, structure-preserving models in order to further reduce the computing time even perspectively for large scaled networks. It is the goal to combine adaptive grid and model refinements with adaptive collocation methods to improve the multilevel methods and to achieve rigorous quality requirements for expectation and variances of solution functionals for the uncertainty quantification at reduced computing time.

Support: Project B01 within DFG TRR 154

Contact: Pascal Mindt, Elisa Strauch, Pia Domschke, Jens Lang

References

[1] P. Domschke, B. Hiller, J. Lang, and C. Tischendorf. Modellierung von Gasnetzwerken: Eine Übersicht. Preprint 2717, Fachbereich Mathematik, TU Darmstadt, 2017.

[2] J. Lang and P. Mindt. Entropy-preserving coupling conditions for one-dimensional Euler systems at junctions. *Networks & Heterogeneous Media*, 13(1):177, 2018.

[3] P. Mindt, J. Lang, and P. Domschke. Entropy-preserving coupling of hierarchical gas models. arXiv:1812.05927, 2018.

Project: Mathematical modelling and numerical methods for time-dependent PDE problems arising in mathematical biology

Biological processes like the invasion of tissue by cancer cells, the adhesion-driven reorganization of tissue, and the cascade of steps in fracture healing can be modeled as time-dependent PDEs. We develop structured-population models for the dedicated modelling of cellular surface-bound processes at the tissue scale and justify continuous non-local adhesion models from a spatial stochastic random walk. For the reliable, efficient and accurate simulation of these models, dedicated numerical schemes are required. We focus on general methods for taxis-diffusion-reaction systems and on particular schemes for the evaluation of the spatially nonlocal terms in models of cellular adhesion. In our approach, we follow the method of lines with finite volumes in space and linearly-implicit methods in time.

Partner: Mark A. J. Chaplain (University of St. Andrews, UK); Kevin J. Painter (Heriot-Watt University, Edinburgh, UK); Dumitru Trucu (University of Dundee, UK); Andreas Buttenschön (University of British Columbia, Canada); Thomas Hillen (University of Alberta, Canada)

Contact: Alf Gerisch, Pia Domschke

References

[1] A. Buttenschön, T. Hillen, A. Gerisch, and K. Painter. A space-jump derivation for non-local models of cell-cell adhesion and non-local chemotaxis. *J. Math. Biol.*, 76:429–456, 2018.

[2] P. Domschke, D. Trucu, A. Gerisch, and M. A. J. Chaplain. Structured models of cell migration incorporating molecular binding processes. *Journal of Mathematical Biology*, 75(6-7):1517–1561, 2017.

[3] A. Hodgkinson, M. A. J. Chaplain, P. Domschke, and D. Trucu. Computational approaches and analysis for a spatio-structural-temporal invasive carcinoma model. *Bulletin of Mathematical Biology*, 80(4):701–737, 2018.

Project: Adaptive refinement strategies for the simulation of gas flow in networks using a model hierarchy

A model hierarchy that is based on the one-dimensional isothermal Euler equations of fluid dynamics is used for the simulation and optimisation of natural gas flow through a pipeline network. Adaptive refinement strategies have the aim of bringing the simulation error below a prescribed tolerance while keeping the computational costs low. While spatial and temporal stepsize adaptivity is well studied in the literature, model adaptivity is a new field of research. The problem of finding an optimal refinement strategy that combines these three types of adaptivity is a generalisation of the unbounded knapsack problem. A refinement strategy that is currently used in gas flow simulation software is compared to two novel greedy-like strategies. Both a theoretical experiment and a realistic gas flow simulation show that the novel strategies significantly outperform the current refinement strategy with respect to the computational cost incurred.

Partner: Volker Mehrmann, Jeroen Stolwijk (TU Berlin)

Support: DFG TRR 154

Contact: Pia Domschke, Jens Lang

References

[1] P. Domschke, A. Dua, J. J. Stolwijk, J. Lang, and V. Mehrmann. Adaptive refinement strategies for the simulation of gas flow in networks using a model hierarchy. *Electronic Transactions on Numerical Analysis*, 48:97–113, 2018.

Project: Optimal control for instationary gas transport

The stable operation of gas networks requires the modeling, simulation, and optimization of gas transport on networks. In this project, we investigate the optimal control of instationary gas transport on pipeline networks with continuous and discrete controls. The mathematical formulation of such problems leads to PDE-constrained optimization problems with control and state-constraints and discrete decisions. For the numerical solution, we consider continuous minimization algorithms based on gradient information leading to locally optimal controls, as well as a first-discretize-then-optimize approach resulting in mixed integer nonlinear programs whose solutions are global optima for the considered problem.

Partner: Robert Burlacu, Alexander Martin, Matthias Sirvent, Lars Schewe (Universität Erlangen-Nürnberg); Martin Groß (University of Waterloo, Canada); Martin Skutella (TU Berlin); Marc Pfetsch, Winnifried Wollner (AG Optimierung, TU Darmstadt)

Support: DFG TRR 154

Contact: Herbert Egger

References

[1] R. Burlacu, H. Egger, M. Groß, A. Martin, M. E. Pfetsch, L. Schewe, M. Sirvent, and M. Skutella. Maximizing the storage capacity of gas networks: a global MINLP approach. *Optimization and Engineering*, pages 1–31, 2018.

[2] H. Egger, T. Kugler, and W. Wollner. Numerical optimal control of instationary gas transport with control and state constraints. *TRR154 Report No. 214*, 2017.

Project: Analysis and numerical solution of coupled volume-surface reaction-diffusion systems with application to cell biology

We consider the numerical solution of coupled volume-surface reaction-diffusion systems having a detailed balance equilibrium. Based on the conservation of mass, an appropriate quadratic entropy functional is identified and an entropy-entropy dissipation inequality is proven. This allows us to show exponential convergence to equilibrium by the entropy method. We then investigate the discretization of the system by a finite element method and an implicit time stepping scheme including the domain approximation by polyhedral meshes. Mass conservation and exponential convergence to equilibrium are established on the discrete level by arguments similar to those on the continuous level, and we obtain estimates of optimal order for the discretization error which hold uniformly in time. Some numerical tests are presented to illustrate these theoretical results. The analysis and the numerical approximation are discussed in detail for a simple model problem. The basic arguments, however, apply also in a more general context. This is demonstrated by the investigation of a particular volume-surface reaction-diffusion system arising as a mathematical model for asymmetric stem cell division.

Partner: Klemens Fellner, Bao Quoc Tang (TU Graz); Jan-Frederik Pietschmann (TU Chemnitz)

Support: DFG IGK 1529

Contact: Herbert Egger

References

[1] H. Egger, K. Fellner, J.-F. Pietschmann, and B. Q. Tang. A finite element method for volume-surface reaction-diffusion systems. *Appl. Math. Comput.*, 336:351–367, 2018.

Project: Energy stable discretization for compressible flow on networks

The transport of gas in pipeline networks is described by the Euler equations of gas dynamics. The friction at the pipe walls leads to a strong damping of oscillations and exponential stability of the evolution. The goal of this project is to devise and analyze new numerical schemes that preserve these properties during the discretization process.

Support: DFG TRR 154

Contact: Herbert Egger

References

[1] H. Egger. A robust conservative mixed finite element method for isentropic compressible flow on pipe networks. *SIAM J. Sci. Comput.*, 40:A108–A129, 2017.

[2] H. Egger, T. Kugler, and B. Liljegren-Sailer. Stability preserving approximations of a semilinear hyperbolic gas transport model. arXiv:1812.03726, 2018.

[3] H. Egger, T. Kugler, and V. Shashkov. An inexact Petrov-Galerkin approximation for gas transport in pipeline networks. arXiv:1811.05215, 2018.

Project: Structure preserving approximation of nonlinear evolution problems

Nonlinear evolution problems are often governed by energy conservation or dissipation which describe basic principles of thermodynamics. The goal of this project is to devise numerical discretization strategies that allow to guarantee corresponding properties after discretization in space and time.

Partner: Volker Mehrmann, Riccardo Morandin (TU Berlin)

Support: DFG TRR 154, GSC 233

Contact: Herbert Egger, Vsevolod Shashkov

References

[1] H. Egger. Energy stable Galerkin approximation of Hamiltonian and gradient systems. arXiv:1812.04253, 2018.

[2] H. Egger. Structure preserving approximation of dissipative evolution problems. arXiv:1804.08648, 2018.

Project: Spinodal decomposition of polymer-solvent systems

The goal of the project is to obtain stable and consistent descriptions of flow dynamics on multiple scales in a class of systems exhibiting highly complex non-equilibrium dynamics, namely phase-separating polymer solutions. This is done by combining (i) the derivation, analysis, and simulation of macroscopic two-fluid models describing the dynamics of viscoelastic phase separation, (ii) the mesoscopic simulation of viscoelastic phase separation by extension of a coupled Lattice-Boltzmann / Molecular Dynamics method, and (iii) the calibration of the macroscopic models to results from mesoscopic simulations by means of parameter estimation and inverse problems methodology.

Partner: Mária Lukácová-Medvidová, Paul Strasser (Universität Mainz); Burkhard Dünweg, Dominic Spiller (Max-Planck-Institut für Polymerforschung Mainz)

Support: DFG TRR 146

Contact: Herbert Egger, Oliver Habrich

Project: Numerical methods for radiative transfer

Radiative transfer is modelled by the linear Boltzmann equation, i.e., an integro-partial differential equation in 7 dimensional phase space. In this project, we investigate efficient numerical methods for the simulation of radiative transfer phenomena, e.g., the propagation of heavy ions through biological tissue or the transfer of heat by radiation.

Partner: Matthias Schlottbom (University of Twente, The Netherlands); Simon Arridge, Samuel Powell (UCL London, UK)

Support: DFG GSC 233

Contact: Herbert Egger

References

[1] H. Egger and M. Schlottbom. A perfectly matched layer approach for radiative transfer in highly scattering regimes. arXiv:1802.08305, 2018.

Project: Optimal convergence rates for adaptive algorithms

We analyze different adaptive mesh refinement strategies and prove optimal convergence rates. In particular, we are interested in optimal convergence rates for finite volume schemes for general elliptic PDEs. Furthermore, we consider the finite element scheme with an SUPG stabilisation for convection dominated problems and prove convergence with optimal rates of an adaptive algorithm. The third part of this project investigates several a posteriori estimates of $h-h/2$ type for a finite element discretization with an analysis of the adaptive strategy with respect to optimal convergence rates.

Partner: Dirk Praetorius (TU Wien)

Contact: Christoph Erath

References

[1] C. Erath, G. Gantner, and D. Praetorius. Optimal convergence behavior of adaptive FEM driven by simple $(h-h/2)$-type error estimators. arXiv:1805.00715, 2018.

[2] C. Erath and D. Praetorius. Céa-type quasi-optimality and convergence rates for (adaptive) vertex-centered FVM. In *Finite Volumes for Complex Applications VIII - Hyperbolic, Elliptic and Parabolic Problems*, volume 199, pages 210–223. Springer International Publishing, 2017.

[3] C. Erath and D. Praetorius. Adaptive vertex-centered finite volume methods for general second-order linear elliptic PDEs. *IMA J. Numer. Anal.*, published online, 2018.

[4] C. Erath and D. Praetorius. Optimal adaptivity for the SUPG finite element method. arXiv:1806.11000, 2018.

Project: WENO schemes in optimal control of nonlinear hyperbolic conservation laws

Many problems in natural science can be modeled with hyperbolic differential equations such as traffic modeling and fluid mechanics. The main difficulty of these equations is that solutions may become discontinuous even if the initial data and boundary conditions are smooth. In many applications we are interested in optimizing a given objective through optimal control. The main issue is that the control-to-state mapping is not differentiable with respect to common variational concepts. However, it can be shown that the control-to-state mapping is shift-differentiable. This concept implies the Fréchet-differentiability of objective functionals and yields adjoint-based formulas for their derivative. We investigate the numerical treatment of these optimal control problems by using weighted essentially non-oscillatory (WENO) schemes. We derive the discretization of the adjoint scheme by the first-optimize-then discretize approach. Furthermore, the consistency of the adjoint discretization is analyzed and numerical examples are presented.

Partner: Stefan Ulbrich (TU Darmstadt)

Support: Graduate School of Computational Engineering, DFG

Contact: David Frenzel, Jens Lang

Project: Multiscale structure-functional modeling of musculoskeletal mineralized tissues

Musculoskeletal mineralized tissues (MMTs) are natural examples of materials that show unique and highly variable combinations of stiffness and strength. One of the striking features of MMTs is that the diversity of elastic functions is achieved by only one common building unit, that is the mineralized collagen fibril, but with variable structural arrangements at several levels of hierarchical organization. A profound understanding of the structure-function relations in MMTs requires both experimental assessment of heterogeneous elastic and structural parameters and theoretical modeling of the elastic deformation behavior. Multi-scale and multi-modal assessment of MMTs will be used to probe not only the microarchitecture, but also anisotropic linear elastic properties from the nanoscale to the macroscale. By combining experimental data obtained from MMTs at various length scales with numerical homogenization approaches in continuum mechanics, we hypothesize to gain new insight into self-assembly mechanisms, construction rules and physiological boundary conditions of MMTs.

Within this joint project, we focus on the development as well as efficient and reliable implementation of numerical homogenization techniques. Together with the groups in Berlin and Paris we devise new mathematical models in order to aid the understanding of MMTs. The experimental assessment of MMTs is performed in Berlin and with external cooperation partners.

Partner: Raimondo Penta (University of Glasgow, UK); Kay Raum (Charité-Universitätsmedizin Berlin); Quentin Grimal (Biomedical Imaging Lab, UPMC Paris, France)

Support: DFG grants GE1894/3 and Ra1380/7 within DFG SPP 1420

Contact: Alf Gerisch, Jens Lang

References

[1] A. Gerisch, R. Penta, and J. Lang, editors. *Multiscale Models in Mechano and Tumor Biology: Modeling, Homogenization, and Applications*, volume 122 of *Lecture Notes in Computational Science and Engineering*. Springer, Cham, 2018.

[2] R. Penta and A. Gerisch. The asymptotic homogenization elasticity tensor properties for composites with material discontinuities. *Continuum Mechanics and Thermodynamics*, 29:187–206, 2017.

[3] R. Penta and A. Gerisch. An introduction to asymptotic homogenization. In A. Gerisch, R. Penta, and J. Lang, editors, *Multiscale Models in Mechano and Tumor Biology: Modeling, Homogenization, and Applications*, pages 1–26. Springer, Cham, 2018.

Project: Cross-diffusion in models from mathematical biology

Cross-diffusion terms are nowadays widely used in reaction-diffusion equations encountered in models from mathematical biology and in various engineering applications. In this project we study the underlying model equations of such systems and investigate analytically their properties with an emphasis on pattern formation and positivity preservation. We also investigate and apply suitable numerical simulation techniques for applications from mathematical biology.

Partner: Anotida Madzvamuse (University of Sussex, UK); Raquel Barreira (Polytechnic Institute of Setubal, Portugal)

Contact: Alf Gerisch

References

[1] A. Madzvamuse, A. Gerisch, and R. Barreira. Cross-diffusion in reaction-diffusion models: analysis, numerics and applications. In P. Quintela, P. Barrali, D. Gómez, et al., editors, *Progress in Industrial Mathematics at ECMI 2016*, pages 385–392. Springer, Cham, 2017.

Project: Uncertainty quantification in hyperbolic conservation laws

We study random systems of hyperbolic conservations laws, where the initial data as well as the flux function might be random. The goal of this project is to provide a posteriori error estimates for intrusive (stochastic Galerkin) as well as non-intrusive (stochastic collocation) methods. A key aspect of this analysis is to try to distinguishing between errors caused by space-time discretization and errors caused by stochastic discretization. These error estimators are a crucial ingredient in the construction of space-time-stochastic adaptive schemes.

Partner: Fabian Meyer, Christian Rohde (Universität Stuttgart)

Contact: Jan Giesselmann

References

[1] F. Meyer, J. Giesselmann, and C. Rohde. A posteriori error analysis for random scalar conservation laws using the stochastic Galerkin method. arXiv:1709.04351, 2017.

[2] F. Meyer, J. Giesselmann, and C. Rohde. A posteriori error analysis and adaptive non-intrusive numerical schemes for systems of random conservation laws. arXiv:1902.05375, 2019.

Project: A posteriori analysis for post-processed solutions

Smoothness increasing accuracy conserving (SIAC) filters are an efficient post-processing tool for discontinuous Galerkin numerical solutions in a wide variety of problems (elliptic as well as hyperbolic). The SIAC methodology is based on mollifying the numerical solution in such a way that the superconvergence-properties inherent in Galerkin methods lead to a super-convergent post-processed solution. Classically, SIAC post-processors have been employed for the construction of error indicators, i.e. the difference between the numerical solution and its post-processed version was used as an approximation of the discretization error. However, since the post-processed solution is in many cases much more accurate than the original numerical solution it seems desirable to construct meshes which are optimal with respect to the error of the post-processed solution. Our goal is to enable the construction of such meshes by providing reliable and locally efficient error estimators for post-processed solutions for elliptic problems. It turns out that classical, residual-based techniques for deriving error estimators lead to inefficient estimators for post-processed solutions. This is due to the fact that the post-processed solutions do not satisfy Galerkin orthogonality. Thus, we propose a simple and cheap modification of the post-processing which re-establishes Galerkin-orthogonality and reduces the error of the post-processed solution.

Partner: Andreas Dedner (University of Warwick); Jennifer K. Ryan (University of East Anglia); Tristan Pryer (University of Reading)

Contact: Jan Giesselmann

Project: Robust a posteriori error estimates for compressible multiphase flows

We are interested in a posteriori error analysis of finite element schemes for a one-dimensional model problem for liquid-vapour flows in Lagrangian coordinates. This system describes the phase-boundary as a thin layer and it can be seen as a simplified version of the Euler-Korteweg model. In particular, we are interested in the link between a posteriori error estimates and stability properties of the continuous equations. For the equations at hand, there are at least two stability frameworks that are applicable: Firstly, the relative entropy and, secondly, estimates employing eigenvalues of the linearized operator. Error estimators based on the relative entropy have been derived previously but suffer from high sensitivity when the capillarity number decreases. Thus, we pursue an idea which is based on the similarity of the equations at hand and the Allen-Cahn equation. Indeed, the equations at hand can be viewed as an Hamiltonian system induced by the energy for which the Allen-Cahn equation is a gradient flow. For the Allen-Cahn equation robust estimates (with respect to capillarity) have been obtained as long as the linearized system has well behaved eigenvalues and we work on extending these results to the Hamiltonian case.

Partner: Rüdiger Müller (WIAS Berlin)

Contact: Jan Giesselmann

References

[1] S. Bartels, R. Müller, and C. Ortner. Robust a priori and a posteriori error analysis for the approximation of Allen-Cahn and Ginzburg-Landau equations past topological changes. *SIAM J. Numer. Anal.*, 49(1):110–134, 2011.

[2] J. Giesselmann and T. Pryer. Reduced relative entropy techniques for a posteriori analysis of multiphase problems in elastodynamics. *IMA J. Numer. Anal.*, 36(4):1685–1714, 2016.

Project: A posteriori analysis for hyperbolic conservation laws on networks

We are interested in gas flows on networks which are modeled as one-dimensional isothermal Euler equations. At the nodes of the network conservation of mass and continuity of enthalpy are required. The goal of this project is to provide a posteriori error estimates for Runge Kutta discontinuous Galerkin schemes by extending similar results for one-dimensional problems with periodic boundary conditions. Those results are based on Lipschitz-continuous reconstructions of the numerical solution and the relative entropy framework. The latter is a stability framework for systems of hyperbolic conservation laws which allows us to relate residuals and discretization errors. Thus, a main contribution of this work is to extend the relative entropy framework to hyperbolic balance laws on networks. It turns out the most crucial step in this endeavor is to control the relative entropy fluxes at the nodes, which can be done for certain entropy compatible coupling conditions [1].

Partner: Raul Borsche (TU Kaiserslautern)

Contact: Jan Giesselmann

References

[1] G. A. Reigstad. Numerical network models and entropy principles for isothermal junction flow. *Netw. Heterog. Media*, 9(1):65–95, 2014.

Project: Moment methods for kinetic equations

We are interested in numerical methods for the linearized Boltzmann equation. In particular, we study moment methods, i.e. a spectral approximation using Hermite polynomials in velocity space. The construction of entropy stable schemes for initial boundary value problems is not trivial but has been achieved recently. We study the convergence of these schemes, i.e. under suitable assumptions on the regularity of the exact solution, we have provided an explicit convergence rate for the Hermite approximation and have confirmed it by numerical experiments.

Partner: Neeraj Sarna, Manuel Torrilhon (RWTH Aachen)

Contact: Jan Giesselmann

References

[1] N. Sarna, J. Giesselmann, and M. Torrilhon. Convergence analysis of the Grad's Hermite approximation to the Boltzmann equation. arXiv:1809.08213, 2018.

Project: Spatial model adaptation of compressible chemically reacting flows based on a posteriori error estimates

A numerically challenging and notoriously computationally expensive application is the numerical simulation of multi-component chemically reacting flows. One reason for it being so challenging is the interaction between convection and reaction, which in many cases have different time scales. The governing equations of chemically reacting flows can be simplified by assuming chemical equilibrium and then it is possible to replace the full system with the equilibrium system on a part of the computational domain without introducing significant errors. The domain decomposition is carried out by employing a posteriori error estimates developed for hyperbolic systems of partial differential equations with stiff source terms. The error estimate, derived based on the relative entropy framework, provides a computable upper bound for the distance between the numerical solution and the exact solution. The error estimate accounts for both the modeling and the discretization error, careful control of the two allows for real-time model and mesh adaptation.

Support: DFG Gi 1131/1-1

Contact: Hrishikesh Joshi, Jan Giesselmann

References

[1] J. Giesselmann and T. Pryer. A posteriori analysis for dynamic model adaptation problems in convection dominated problems. *Math. Models Methods Appl. Sci.*, 27:2381–2432, 2017.

Project: Galerkin methods for simulation, calibration, and control of partial differential equations on networks

This project is part of the Transregional Collaborative Research Centre TRR 154 *Mathematical modelling, simulation and optimization of gas networks*, and deals with the construction and analysis of numerical methods for singularly perturbed hyperbolic problems with parabolic limit. The main goal is to devise efficient asymptotic preserving numerical schemes, which inherit basic physical principles as conservation of mass, balance of momentum, and stability of the entropy. To model the flow of a gas mixture in a network of pipes we consider the one-dimensional Euler equations with friction. Our methods are used to further calibrate the simulation models by utilizing additional measurements. Furthermore, we consider optimal control problems, where for example compressor stations are controled to reach a desired state in the network.

Partner: Björn Liljegren-Sailer, Nicole Marheineke (Universität Trier), Volker Mehrmann (TU Berlin); Nicolai Strogies (WIAS Berlin); Winnifried Wollner (AG Optimierung, TU Darmstadt)

Support: Project C04 within DFG TRR 154

Contact: Herbert Egger, Thomas Kugler

References

[1] H. Egger and T. Kugler. Damped wave systems on networks: Exponential stability and uniform approximations. *Numer. Math.*, 138:839–867, 2018.

[2] H. Egger, T. Kugler, and B. Liljegren-Sailer. Stability preserving approximations of a semilinear hyperbolic gas transport model. arXiv:1812.03726, 2018.

[3] H. Egger, T. Kugler, B. Liljegren-Sailer, N. Marheineke, and V. Mehrmann. On structure-preserving model reduction for damped wave propagation in transport networks. *SIAM Journal on Scientific Computing*, 40:A331–A365, 2018.

[4] H. Egger, T. Kugler, and V. Shashkov. An inexact Petrov-Galerkin approximation for gas transport in pipeline networks. arXiv:1811.05215, 2018.

[5] H. Egger, T. Kugler, and N. Strogies. Parameter identification in a semilinear hyperbolic system. *Inverse Problems*, 33:055022, 2017.

[6] H. Egger, T. Kugler, and W. Wollner. Numerical optimal control of instationary gas transport with control and state constraints. *TRR154 Report No. 214*, 2017.

Project: Space-time adaptive linearly implicit peer methods for parabolic problems

In this project a linearly implicit peer method is combined with a multilevel finite element method for the discretization of parabolic partial differential equations. Following the

Rothe method it is first discretized in time and then in space. A spatial error estimator based on the hierarchical basis approach is derived. It is shown to be a reliable and efficient estimator up to some small perturbations. The efficiency index of the estimator is shown to be close to the ideal value one for two one-dimensional test problems. Finally we compare the performance of the overall method, based on second, third, and fourth order peer methods with that of some Rosenbrock methods. We conclude that the presented peer methods offer an attractive alternative to Rosenbrock methods in this context.

Contact: Jens Lang, Alf Gerisch

References

[1] D. Schröder, A. Gerisch, and J. Lang. Space-time adaptive linearly implicit peer methods for parabolic problems. *J. Comp. Appl. Math.*, 316:330–344, 2017.

Project: Fully adaptive multilevel stochastic collocation method for randomized elliptic PDEs

We propose and analyse a new adaptive multilevel stochastic collocation method for randomized elliptic PDEs. A hierarchical sequence of adaptive mesh refinements for the spatial approximation is combined with adaptive anisotropic sparse Smolyak grids in the stochastic space in such a way as to minimize computational cost. We provide a rigorous analysis for the convergence and computational complexity of the adaptive multilevel algorithm.

Partner: Robert Scheichl (Universität Heidelberg)

Contact: Jens Lang

References

[1] J. Lang and R. Scheichl. Adaptive multilevel stochastic collocation method for randomized elliptic PDEs. Technical Report Technische Universität Darmstadt, Department of Mathematics, Preprint 2718, 2017.

Project: Simulation of reactive flows by projection onto time- and space-variable quasi-steady states

The simulation of a reactive flow leads to a partial differential equation, which usually contains a large number of unknown variables. Furthermore, the time scales of the different chemical reactions cover several orders of magnitude. In addition to the size the obtained partial differential equation is also very stiff and solving the partial differential equation is very time consuming. However, the fastest chemical reactions have small timescales and eventually reach their equilibrium in a period of time shorter than the timestep of the solver. In this case we can replace these chemical reactions by an algebraic equation. This approach leads to simulation of the chemical reaction system on a lower dimensional manifold describing the partial equilibrium of the fast reactions. Though, the state of the system can differ in time and space, the reaction rates depend on the state. For this reason the manifold changes in time and space. The goal of the project is to develop a model, which dynamically switches in space and time between the description of the chemical reactions via the kinetic model and the partial thermodynamic equilibrium.

Contact: Axel Lukassen, Martin Kiehl

References

[1] A. Lukassen and M. Kiehl. Reduction of round-off errors in chemical kinetics. *Combustion Theory and Modelling*, 21(2):183–204, 2017.

[2] A. A. Lukassen. *Simulation of chemical systems with fast chemistry*. PhD thesis, TU Darmstadt, 2018.

Project: Data assimilation for compressible flows

In this project, we investigate data assimilation (DA) techniques for compressible flows from a numerical analysis point of view. DA aims at bridging the gap between experimental approaches and numerical simulations for studying the behavior of an evolutionary system. In fact, DA techniques have long been used as the main tool for combining observational data and outputs of numerical models to provide a more realistic estimate of the evolving state of a dynamical system. In this project, we are going to provide solid mathematical ground for some DA techniques including 4D-Var when applied to compressible flow models and, in general, hyperbolic conservation laws (HCLs). However, given that solutions of HCLs are known to produce shock discontinuities in finite time, we face some difficulties in the numerical analysis of DA techniques for HCLs. In this project, we aim at alleviating these difficulties by applying some smooth reconstructions of numerical solutions which paves the path for mathematical analysis of DA techniques without adding artificial viscosity.

Contact: Jan Giesselmann, Hadi Minbashian

References

[1] J. Giesselmann, C. Makridakis, and T. Pryer. A posteriori analysis of discontinuous Galerkin schemes for systems of hyperbolic conservation laws. *SIAM J. Numer. Anal.*, 53(3):1280–1303, 2015.

Project: Efficient iterative methods for stochastic Galerkin finite element discretizations of Stokes flow with random data

When mathematical models are utilized to investigate physical phenomena, input data of the models are often not known precisely. In real-world applications, this is a result of measurement errors, production tolerances or a lack of knowledge in general. The field of uncertainty quantification (UQ) tackles this issue by quantifying the influence of data uncertainties on the model's solution. In this project, a particular approach is followed to solve forward UQ problems, namely the stochastic Galerkin method. Although its application can yield exponential convergence rates, large coupled systems of equations have to be solved in the process. In order to do this efficiently, sophisticated iterative methods and preconditioners are required. The goal of this project is to apply and extend existing methods specifically tailored to Stokes flow problems with random data.

Support: Graduate School Computational Engineering, DFG

Contact: Christopher Müller, Jens Lang, Sebastian Ullmann

References

[1] C. Müller. *Iterative Solvers for Stochastic Galerkin Discretizations of Stokes Flow with Random Data*. Dr. Hut Verlag, 2018.

[2] C. Müller, S. Ullmann, and J. Lang. A Bramble-Pasciak conjugate gradient method for discrete Stokes equations with random viscosity. arXiv:1801.01838, 2018.

[3] C. Müller, S. Ullmann, and J. Lang. A Bramble-Pasciak conjugate gradient method for discrete Stokes problems with lognormal random viscosity. In M. Schäfer, M. Behr, M. Mehl, and B. Wohlmuth, editors, *Recent Advances in Computational Engineering*, pages 63–87. Springer International Publishing, Cham, 2018.

Project: Mixed finite elements for acoustic and electromagnetic wave propagation

The study of wave propagation is an important topic in the field of engineering and it finds applications in various fields such as in antenna design, radar detection, noise cancellation, fiber optics, signal filtering, seismic prospection and many others. Therefore, the efficient and accurate simulation of wave phenomena is of big relevance from a practical point of view. Our goal is to design efficient mixed finite element approximations by means of mass lumping, which involves replacing the mass matrix by a block-diagonal approximation. This allows to efficiently apply explicit time stepping schemes. We look at different types of discretizations and provide thorough error analysis.

Support: Graduate School Computational Engineering, DFG

Contact: Herbert Egger, Bogdan Radu

References

[1] H. Egger and B. Radu. A mass-lumped mixed fem for acoustic wave propagation with inhomogeneous coefficients. *PAMM*, 18:1–2, 2018.

[2] H. Egger and B. Radu. A mass-lumped mixed finite element method for acoustic wave propagation. arXiv:1803.04238, 2018.

[3] H. Egger and B. Radu. A mass-lumped mixed finite element method for Maxwell's equations. arXiv:1810.06243, 2018.

[4] H. Egger and B. Radu. A second order multipoint flux mixed finite element method on hybrid meshes. arXiv:1812.03938, 2018.

[5] H. Egger and B. Radu. Super-convergence and post-processing for mixed finite element approximations of the wave equation. *Numer. Math.*, (2):427–447, 2018.

Project: Coupling of dynamical systems with convolution quadrature methods

Integrated circuits with smaller and smaller conducting structures lead to drastically faster processor generators in the last years. With the miniaturization there is more coupling of the signals between different conductors that is not anymore described by circuits. In this project we aim for coupled modelling of the dynamical behaviour of circuits and discretized 3D electromagnetic field equations through ports. We follow the convolution quadrature approach that leads to a model reduction based on precomputations for the electromagnetic field equations in frequency domains with a series of frequencies and to much reduced effort of the coupled dynamical simulation.

Support: Graduate School Computational Engineering, DFG

Contact: Herbert Egger, Kersten Schmidt, Vsevolod Shashkov

References

[1] H. Egger, V. Shashkov, and K. Schmidt. Multistep and Runge-Kutta convolution quadrature methods for coupled dynamical systems. arXiv:1811.09817, 2018.

Project: Interaction between boundary layers and domain singularities

In this project singularly perturbed partial differential equations including microperforated layers with emphasis on corner singularities shall be analyzed. Singularly perturbed partial differential equations are characterized by microscopic solution behaviour, especially boundary layers. Such a solution behaviour is caused by small (material) parameters in front of the leading order differential operator, like small viscosities, or equivalently large parameters in front of lower order terms as for highly conductive media in electromagnetism. Also, geometrically small features like for thin layers or sheets that may even possess a microstructure lead to boundary layers in the solution. Solution representations taking into account the interaction of boundary layers and domain singularities can be used to construct efficient numerical schemes.

Partner: Bérangère Delourme (University of Paris 13, France); Monique Dauge (University of Rennes 1, France); Ralf Hiptmair (ETH Zürich)

Contact: Adrien Semin, Kersten Schmidt

References

[1] A. Semin, B. Delourme, and K. Schmidt. On the homogenization of the Helmholtz problem with thin perforated walls of finite length. *ESAIM Math. Model. Numer. Anal.*, 52(1):29–67, 2018.

Project: Impedance conditions for visco-acoustic models

The acoustic damping in gas turbines and aero-engines relies to a great extent on acoustic liners that consist of a cavity and a perforated face sheet. The prediction of the impedance of the liners by direct numerical simulation is nowadays not feasible due to the hundreds to thousands of repetitions of tiny holes. We aim to obtain impedance conditions in viscous gases, especially for multiperforated acoustic absorbers, based on higher order asymptotic expansions and matched asymptotic expansion techniques.

Partner: Friedrich Bake (DLR Berlin); Anastasia Thöns-Zueva (TU Berlin)

Contact: Kersten Schmidt, Adrien Semin

References

[1] K. Schmidt, A. Semin, A. Thöns-Zueva, and F. Bake. On impedance conditions for circular multiperforated acoustic liners. *J. Math. Industry*, 8(1):15, 2018.

[2] A. Semin and K. Schmidt. On the homogenization of the acoustic wave propagation in perforated ducts of finite length for an inviscid and a viscous model. *Proc. R. Soc. Lond. A*, 474(2210), 2018.

Project: Model reduction techniques for biomechanical devices

Biomechanical devices like stents are used to recover the blood flow in arteria when they are blocked due to a disease. With optimized stent designs they remain comfortabley at position and guarantee a permanent blood flow for longer times. The modeling of the mechanical properties is challenging due to their structure as a network of struts and their interaction with the blood vessel as a contact problem. We aim for a model reduction based on homogenization of systems of differential equations on edges of a periodic graph.

Partner: Josip Tambača, Luka Grubišić, Matko Ljulj, Marko Hajba (University of Zagreb, Croatia)

Support: German Academic Exchange Service in the "Programm für projektbezogenen Personenaustausch mit Kroatien" (Project-ID 57334847), Graduate School Computational Engineering

Contact: Kersten Schmidt, Adrien Semin, Herbert Egger

Project: Shape optimization in acoustic-structure interaction

Acoustic-structure interaction is an emerging field in industry and mathematical modelling, with important applications in reducing the noise emitted by machines, vehicles, constructions, etc. In particular in the car industry, there is a huge interest to optimize and tailor the sound amplitudes within the car by changing the shape of parts of the elastic structure. We are interested in the minimization of the sound pressure by variation of the shape of the structure. For this we derive the shape derivative for the acoustic-structure interaction modelled by the Helmholtz equation for the acoustic part, the equations of linear elasticity and coupling conditions and consider a closed optimization process in 3D using a high-order finite element discretization on hexahedral meshes.

Partner: Antoine Laurain (University of São Paulo, Brazil); Philipp Kliewe (TU Berlin)

Contact: Kersten Schmidt

Project: Superconvergent IMEX Peer methods with variable step sizes

The spatial discretization of certain time-dependent PDEs (e.g. advection-reaction-diffusion systems) yields large systems of ODEs where the right-hand side admits a splitting into a stiff and non-stiff part. We construct time integrators that combine the favorable stability properties of implicit methods and the low computational costs of explicit schemes. In order to guarantee consistency and, thus, convergence, the implicit and explicit integrator must fit together. A natural way to construct these implicit-explicit (IMEX) Peer methods is to start with an appropriate implicit scheme and extrapolate it in a suitable manner. We follow the approach developed by Lang and Hundsdorfer in [1]. Peer methods have the advantage that all stage values have the same order and, hence, order reduction for stiff systems is avoided. Further, there remain enough free parameters such that additional properties can be guaranteed. This includes optimal zero-stability, A-stability of the implicit part and, in particular, superconvergence. In [2], we derive necessary and sufficient conditions on the coefficient matrices to construct new superconvergent IMEX schemes for $s = 2, 3, 4$ stages. When solving dynamical systems with sub-processes evolving on many different time scales, efficiency is greatly enhanced by automatic time step variation. Therefore, we investigate the theory, construction and application of IMEX Peer methods that are superconvergent even for variable step sizes. To construct schemes that keep their higher order for variable step sizes and exhibit favorable linear stability properties, we adapt our approach for constant step sizes and, eventually, derive additional necessary and sufficient conditions on the nodes and coefficient matrices. New superconvergent IMEX Peer methods which maintain the superconvergence property independently of step size changes are constructed for $s = 2, 3, 4$ stages.

Partner: Willem Hundsdorfer (CWI Amsterdam, The Netherlands); Rüdiger Weiner (Universität Halle-Wittenberg)

Contact: Moritz Schneider, Jens Lang

References

[1] J. Lang and W. Hundsdorfer. Extrapolation-based implicit-explicit Peer methods with optimised stability regions. *J. Comp. Phys.*, 337:203–215, 2017.

[2] M. Schneider, J. Lang, and W. Hundsdorfer. Extrapolation-based super-convergent implicit-explicit Peer methods with A-stable implicit part. *J. Comp. Phys.*, 367:121–133, 2018.

Project: Chemotaxis models on network structures

Chemotaxis describes the movement of cells and organisms caused by their reaction to chemical gradients. Since the first mathematical investigation of chemotactic phenomena by Keller and Segel, a variety of PDE models has been developed in order to reproduce the main features of population dynamics governed by chemotaxis. This project is concerned with some of these models in a network setting. Existence and uniqueness of global solutions has been considered for the minimal Keller-Segel model on a network. A finite element method that inherits the conservation of mass and positivity from the continuous model was developed and analyzed. Convergence of the method was obtained under general assumptions and convergence rates were deduced for smooth solutions.

Contact: Herbert Egger, Lucas Schöbel-Kröhn

References

[1] H. Egger and L. Schöbel-Kröhn. Chemotaxis on networks: Analysis and numerical approximation. arXiv:1805.00925, 2018.

Project: Numerical methods for a parabolic-elliptic interface problem

In this project, we want to find and analyze a suitable discretization method for a coupled system of partial differential equations consisting of the model problem for transport in porous media, which is a (possibly convection dominated) parabolic time-dependent diffusion-convection-reaction equation on a bounded domain and a diffusion process on the complement of the domain, modeled by the Laplace equation, which are coupled at the boundary. To approximate such problems the coupling of a method for the interior problem and the boundary element method (BEM) is of particular interest. Because of the possible convection domination, one would use such methods as an upwind stabilized Finite Volume Method (FVM) or a comparably stabilized Finite Element Method called Streamline Upwind Petrov Galerkin (SUPG). There are several methods to couple an interior method with BEM, depending on the formulation of the exterior problem and the transmission conditions between the interior and the exterior problem, one such method is the non-symmetric coupling, which has not been analyzed for the time-dependent case and thus is the main focus of this research project.

Support: Graduate School Computational Engineering, DFG

Contact: Robert Schorr, Christoph Erath

References

[1] H. Egger, C. Erath, and R. Schorr. On the non-symmetric coupling method for parabolic-elliptic interface problems. *SIAM J. Numer. Anal.*, 56(6):3510–3533, 2018.

[2] C. Erath and R. Schorr. Stable non-symmetric coupling of the finite volume and the boundary element method for convection-dominated parabolic-elliptic interface problems. *Preprint, arXiv:1805.05142*, 2018.

[3] C. Erath and R. Schorr. A simple boundary approximation for the non-symmetric coupling of finite element method and boundary element method for parabolic-elliptic interface problems. In *Numerical Mathematics and Advanced Applications ENUMATH 2017*, pages 993–1001. Springer International Publishing, 2019.

Project: Structure preserving simulation in nonlinear electromagnetics

The main aim of this project is to develop novel discretization schemes that preserve the inherent structure of underlying physical models for systems involving electromagnetics, i.e., conservation and/or dissipation of energy. Typical applications to be studied are electric machines, models of magnetohydrodynamics, and electronic devices leading to field-circuit coupled problems.

Partner: Herbert De Gersem, Sebastian Schöps (Institut für Theorie Elektromagnetischer Felder, TU Darmstadt)

Support: DFG GSC 233

Contact: Herbert Egger, Vsevolod Shashkov

References

[1] H. Egger, V. Shashkov, and K. Schmidt. Multistep and Runge-Kutta convolution quadrature methods for coupled dynamical systems. arXiv:1811.09817, 2018.

Project: Weighted reduced basis methods for parabolic partial differential equations with random input data

This project focuses on model order reduction for parabolic partial differential equations with parametrized random input data. The outcome of the model problem is the solution of the partial differential equation and a quantity of interest, which is determined by a functional that maps the solution to a real number. Due to the randomness of the input data, the expected value of the solution and the output is approximated by a Monte Carlo estimator. This work develops efficient reduced spaces by means of a weighted reduced basis method in order to decrease the expected solution errors compared to a non-weighted reduced basis method.

Support: Graduate School Computational Engineering, DFG

Contact: Christopher Spannring, Jens Lang, Sebastian Ullmann

References

[1] C. Spannring. *Weighted reduced basis methods for parabolic PDEs with random input data*. PhD thesis, TU Darmstadt, 2018.

[2] C. Spannring, S. Ullmann, and J. Lang. A weighted reduced basis method for parabolic PDEs with random data. In M. Schäfer, M. Behr, M. Mehl, and B. Wohlmuth, editors, *Recent Advances in Computational Engineering*, pages 145–161, Cham, 2018. Springer International Publishing.

Project: Simulation, optimization and uncertainty quantification for borehole thermal energy storage systems based on adaptive finite elements

Borehole thermal energy storage systems present an increasingly common solution for energy storage, especially in conjunction with renewable energies like solar power. In order to design such facilities and estimate their storage capabilities and efficiency, numerical simulations based on partial differential equations are inevitable. These simulations can be very challenging because of the great disparity in the magnitude of the simulated objects and the highly transient operation scenarios.
This project aims to build upon currently existing models [1] to efficiently simulate the behaviour of borehole thermal energy storage systems by means of adaptive finite elements. This is done with the adaptive PDE solver KARDOS. The model can be extended to include randomness, which allows for an uncertainty quantification. This is done with stochastic collocation based on deterministic PDE solutions to interpolate the stochastic solution and its properties over a domain of random variables. In future work, we also plan to optimize the layout and the performance of borehole thermal energy storage systems.

Partner: Ingo Sass, Daniel Schulte (Institut für Angewandte Geowissenschaften, TU Darmstadt)

Support: Darmstadt Graduate School of Excellence Energy Science and Engineering, GSC 1070

Contact: Philipp Steinbach, Jens Lang

References

[1] D. O. Schulte, W. Rühaak, B. Welsch, and I. Sass. Basimo - borehole heat exchanger array simulation and optimization tool. *Energy Procedia*, 97:210–217, 2016.

[2] P. Steinbach. Adaptive Finite-Elemente-Verfahren für Erdwärmesondenspeicher. Masterarbeit, Technische Universität Darmstadt, 2018.

Project: Adaptive moving finite element method for steady low-Mach-number compressible combustion

Recently, the renewable energies are increasingly recommended to be used in industry and their applications also exhibit a high rate of growth. Nevertheless, the corresponding contributions to the overall demand of energy are far from satisfactory. Hence, in a long-term future, the majority of energy will still be obtained by conventional processes through using coal, oil and gas as fuels and thus the premixed combustion remains important to industry with consideration of reducing the thermal formation of nitric oxides that constitutes a major portion of the pollutants and results in acid rain smog problems. While the computational fluid problem is still one of the most complicated tasks in the engineering field, the complexity of a reactive flow gets further increased not only because of the mixing process, like the mixing between fuel and oxidizer, but also the sophisticated mechanisms of chemical reactions. Herein, the time scales of the different elementary reactions always cover several orders of magnitude that makes computation very time comsuming. Moreover, nearly all the coefficients of the mass and heat transport processes are temperature and even pressure dependent. Hence, an adaptive discretization method is commonly recognized as an effective approach to solve such a complex system.

Contact: Zhen Sun, Jens Lang

References

[1] Z. Sun. *Adaptive Moving Finite Element Method for Steady Low-Mach-Number Compressible Combustion Problems*. PhD thesis, Technische Universität Darmstadt, 2018.

Project: Wall shear stress measurements using magnetic resonance imaging

The flow of blood in human vessels is of great interest in medicine. A very important physical quantity is the wall-shear stress (WSS) and its distribution along the wall, that can be computed from the geometry and the velocity therein. The goal of this project is to use both the magnetic resonance imaging (MRI) and a fluid dynamical model to provide accurate values of the WSS. In a first step the inverse problem of reconstructing the smooth flow domain and the velocity profile inside the flow domain from the MRI measurements is analyzed and solved. Now the focus is on the data assimilation problem to enhance the reconstructed velocity by utilizing knowledge of the governing fluid dynamics. From a mathematical point of view there arise a couple of problems like finding a proper model containing boundary conditions and minimizing the computational effort in the resulting optimization problem. The cardiology group of the Klinik für Radiologie (Universität Freiburg) will provide the MRI data, the Fachgebiet Strömungslehre und Aerodynamik (TU Darmstadt) will assess the accuracy of the developed algorithms by comparing the results with laser Doppler velocimetry (LDA) and CFD simulations for some selected test cases.

Partner: Andreas Bauer, Cameron Tropea (TU Darmstadt); Axel Krafft, Nina Shokina, Waltraud Buchenberg, Jürgen Hennig (Universität Freiburg)

Support: DFG Eg-331/1-1

Contact: Gabriel Teschner, Herbert Egger

References

[1] H. Egger and B. Hofmann. Tikhonov regularization in Hilbert scales under conditional stability assumptions. *Inverse Problems*, 34:115015, 2018.

[2] H. Egger, T. Seitz, and C. Tropea. Enhancement of flow measurements using fluid-dynamic constraints. *J. Comp. Phys.*, 344:558–574, 2017.

[3] H. Egger and G. Teschner. On the stable estimation of flow geometry and wall shear stress from magnetic resonance images. arXiv:1812.09848, 2018.

Project: Stochastic Galerkin reduced basis methods

We study stochastic Galerkin reduced basis methods for elliptic boundary value problems with parametrized random and deterministic inputs. For a given value of the deterministic parameter, a stochastic Galerkin finite element method can estimate the corresponding expected value and variance of a linear output at the cost of a single solution of a large block-structured linear algebraic system of equations. Reduced basis methods can lower the computational burden when statistical outputs are required for a high number of deterministic parameter queries. We aim at bounds for the error associated with the reduced-order estimates of the expected value and the variance.

Support: Graduate School Computational Engineering, DFG

Contact: Jens Lang

References

[1] S. Ullmann and J. Lang. Stochastic Galerkin reduced basis methods for parametrized linear elliptic PDEs. arXiv:1812.08519, 2018.

Project: Model reduction for incompressible flow

We study model order reduction based on proper orthogonal decomposition (POD) for unsteady incompressible Navier-Stokes problems, assuming that the snapshots are given by spatially adapted finite element solutions. We investigate two approaches: Firstly, a weak incompressibility constraint is imposed with respect to a pressure reference space. Secondly, the velocity reduced space is enriched with supremizers computed on a velocity reference space. In the presence of inhomogeneous Dirichlet conditions, suitable lifting functions must be provided.

Partner: Michael Hinze, Carmen Gräßle (Universität Hamburg)

Support: Graduate School Computational Engineering, DFG

Contact: Jens Lang

References

[1] C. Gräßle, M. Hinze, J. Lang, and S. Ullmann. POD model order reduction with space-adapted snapshots for incompressible flows. arXiv:1810.03892, 2018.

Project: EWAVE

EWAVE is part of the cooperation project ERWAS founded by the BMBF. The goal is to develop an innovative energy-management system which is currently tested at the Rheinisch-Westfälische Wasserwerkgesellschaft (RWW). A management system allows to compute optimal operation plans for the constructions of the water production, the water preparation and the water distribution. Additionally, the system can decide whether self-generated energy or energy purchased from energy supply companies is used. Mathematically, we develop numerical discretization methods which provide accuracy with higher order in time, are able to handle stiff source terms, and are compatible with adjoint based optimization.

Partner: Alexander Martin, Günter Leugering (Universität Erlangen-Nürnberg); Gerd Steinebach (Hochschule Bonn-Rhein-Sieg); Oliver Kolb (Universität Mannheim); Michael Plath (RWW Rheinisch-Westfälische Wasserwerkgesellschaft mbH); Olaf Kremsier (Grey-Logix Aqua); Andreas Pirsing (Siemens AG, Siemens Industry Automation); Roland Rosen (Siemens AG, Siemens Corporate Technology)

Contact: Lisa Wagner, Jens Lang

References

[1] L. Wagner. *Second-Order Implicit Methods for Conservation Laws with Applications in Water Supply Networks*. PhD thesis, Technische Universität Darmstadt, 2017.

Project: Residual-type a posteriori error estimator for a quasi-static Signorini contact problem

This project deals with the construction and the analysis of a residual-type a posteriori estimator for a quasi-static Signorini problem. In order to obtain an efficient, reliable and localized estimator, an error notion which measures the error in the displacements, the velocities and a suitable approximation of the contact forces is introduced. Further, the local properties of the solution are exploited such that the spatial estimator has no contributions related to the non-linearities in the interior of the actual time-dependent contact zone but gives rise to an appropriate refinement of the free boundary zone. The estimator splits in temporal and spatial contributions which can be used for the adaptation of the time step as well as the mesh size. To illustrate the performance of the estimator, the theoretical results are accompanied by numerical studies.

Contact: Mirjam Walloth

References

[1] M. Walloth. Residual-type a posteriori error estimator for a quasi-static Signorini contact problem. Preprint 2721, Fachbereich Mathematik, TU Darmstadt, 2018.

Project: Structure preserving adaptive enriched Galerkin methods for pressure-driven 3D fracture phase-field models (subproject of priority program 1748)

The project is concerned with the development of innovative enriched Galerkin methods for the reliable simulation of pressure-driven fracture problems. Within this project, convergent adaptive mesh-refinement schemes based on new efficient error estimators for the variational inequality associated with the fracture irreversibility will be developed.

Partner: Katrin Mang, Thomas Wick (Universität Hannover); Winnifried Wollner (AG Optimierung, TU Darmstadt)

Support: DFG Priority Program 1748

Contact: Mirjam Walloth

References

[1] M. Walloth. Residual-type A Posteriori Estimators for a Singularly Perturbed Reaction-Diffusion Variational Inequality – Reliability, Efficiency and Robustness. arXiv:1812.01957, 2018.

Project: Numerical methods for multi-phase flows with topological changes

The aim of this research project is the investigation of systems modeling compressible flows of one substance that is present as both liquid and vapor. Two phase flows are important in processes of practical interest such as combustion, cryogenics, and cloud formation, where the scales of interest are rather large. Understanding their modeling, which is usually based on averaged models, motivates us to develop tools for the simulation of small scale models. In this case, a posteriori analysis is crucial in determining how reliable a numerical scheme is and it allows for error control of the exact and the numerical solutions. While the former are considered to be weak-entropic solutions, the latter cannot be strong solutions since they are given in the context of a Discontinuous Galerkin (DG) framework. At the same time, exact solutions are not smooth in general. We introduce sufficiently regular intermediate functions called reconstructions that are considered as strong solutions of a perturbed system and then by employing a variant of the relative entropy technique we overcome the obstacle of the non-convexity of the energy. Thereby, we obtain an a posteriori estimator for the difference between the reconstruction and the numerical solution. This means, we explicitly bound the difference between the exact and the numerical solutions.

Contact: Dimitrios Zacharenakis, Jan Giesselmann

References

[1] J. Giesselmann and T. Pryer. Reduced relative entropy techniques for a posteriori analysis of multiphase problems in elastodynamics. *IMA J. Numer. Anal.*, 36:1685–1714, 2016.

[2] J. Giesselmann and D. Zacharenakis. A Posteriori Analysis for the Euler-Korteweg Model. In *Theory, Numerics and Applications of Hyperbolic Problems I*, pages 631–642. Springer International Publishing, 2018.

1.7 Optimization

The research group **Optimization** consists of the two directions **Discrete Optimization** and **Nonlinear Optimization**, which cooperate closely. Mathematical Optimization considers the development, analysis, and application of efficient numerical methods for minimizing (or maximizing) a function under constraints. While Discrete Optimization studies mainly linear or convex combinatorial problems involving integer variables, Nonlinear Optimization focuses on nonlinear problems with continuous variables. The research group covers both research topics in a comprehensive way and cooperates in particular in the challenging field of Mixed Integer Nonlinear Programming, which considers nonlinear optimization with mixed discrete-continuous variables.

Discrete Optimization has become an important component in modern applied mathematics. Many problems from business and industry can be modeled as discrete optimization problems. The development of solution methods for these problems is the main focus of the group Discrete Optimization. This includes the development of mathematical models of real-world problems, the theoretical analysis (using methods mainly from graph theory, polyhedral combinatorics, and integer programming), and the design and implementation of fast algorithms as well as their evaluation in practice.
Experiences of the group are, for instance, in the following applied areas: public mass transportation (line planning, disruption management), energy optimization (gas transport), or optimization in mechanical engineering (truss topology optimization), see the projects for details.

Nonlinear Optimization is nowadays an important technology in applied mathematics, science, and engineering. Nonlinear optimization problems appear in many applications, e.g., shape optimization in engineering, robust portfolio optimization in finance, parameter identification, optimal control, etc. Nonlinear Optimization has emerged as a key technology in modern scientific and industrial applications. Challenging are in particular optimization problems with partial differential equations as constraints (PDE-constraints), for example optimization problems for flows, transport problems, diffusion processes, wave propagation, or mechanical structures. An efficient solution of such problems requires highly developed optimization methods, which use modern adaptive multilevel techniques of scientific computing.
The research group Nonlinear Optimization considers the development, theory, implementation, and application of efficient algorithms for nonlinear optimization. Particular research topics are PDE-constrained optimization, large scale optimization, adaptive multilevel techniques, discretization error for PDE-constrained optimization, preconditioning, global optimization, and relaxation of discrete problems.

The research group Optimization is or was engaged among others in the Darmstadt Graduate School of Excellence GSC 233 *Computational Engineering: Beyond Traditional Sciences*, the Darmstadt Graduate School of Excellence GSC 1070 *Energy Science and Engineering*, the Collaborative Research Centre (SFB) 666 *Integral Sheet Metal Design with Higher Order Bifurcations – Development, Production, Evaluation*, the Collaborative Research Centre (SFB) 805 *Control of Uncertainty in Load-Carrying Structures in Mechanical Engineering*, the Collaborative Research Centre (SFB) 1194 *Interaction of Transport and Wetting Processes*, the Transregional Collaborative Research Centre (Transregio/SFB) 154 *Mathematical Modelling, Simulation and Optimization on the Example of Gas Networks*, the International Research Training Group (IRTG) 1529 *Mathematical Fluid Dynamics*, the German Research Foundation (DFG) Priority Programme (SPP) 1736 *Algorithms for Big Data*, the German Research Foundation (DFG) Priority Programme (SPP) 1748 *Reliable Simulation Techniques in Solid Mechanics. Development of Non-standard Discretization Methods, Mechanical and Mathematical Analysis*, the German Research Foundation (DFG) Priority Programme (SPP) 1798 *Compressed Sensing in Information Processing* and the German Research Foundation (DFG) Priority Programme (SPP) 1962 *Non-smooth and Complementarity-based Distributed Parameter Systems: Simulation and Hierarchical Optimization*.

Members of the research group

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Secretaries

Constanze Drechsel, Monika Kammer, Ursula Röder

Project: Numerical approximation of optimal control problems for hyperbolic conservation laws (Subproject A02 of Transregio/SFB 154, phase 2)

A lot of continuum models for physical problems, such as traffic modeling and fluid mechanics, are described by hyperbolic conservation laws. Some of these networks include switching processes like traffic flow models and water/gas network models. This motivates an analytic study and numerical approximation of optimal control problems of nonlinear hyperbolic conservation laws on networks under modal switching, where switchings are considered in the source terms as well as at boundary nodes and junctions. The main difficulty in the analysis of conservation laws arises from the fact that even in the case of a single scalar conservation law and smooth data the entropy solution usually develops shocks, which causes the solution operator to not be differentiable in the usual sense. However, encouraging progress has been achieved recently for the optimal control of conservation laws by using a generalized notion of differentiability (so called shift-differentiability). It was shown by Pfaff and Ulbrich that under weak assumptions tracking-type objective functionals are differentiable with respect to the initial and boundary control and that the reduced gradient can be represented by the reversible solution of a suitable adjoint equation. The goal of this project is a precise study of this adjoint equation and its solution and a detailed numerical analysis of optimal control problems for switched networks of conservation laws.

Partner: Transregio/SFB 154: "Mathematical Modelling, Simulation and Optimization on the Example of Gas Networks"; speaker Prof. Dr. Alexander Martin (Department of Mathematics, Universität Erlangen-Nürnberg)

Support: DFG

Contact: P. Schäfer Aguilar, S. Ulbrich

Project: Structure preserving adaptive enriched Galerkin methods for pressure-driven 3D fracture phase-field models (Project in SPP 1748)

This project is focused on numerically stable treatment of incompressible and quasi-incompressible materials within a quasi-static fracture growth problem. Within this problem, we will address the issue of transferring solutions from one time-step to the next without introducing spurious pressure errors. Moreover, at a given time-step the discretization of the incompressible material by standard mixed methods will introduce an error of the displacement depending on the pressure; a situation that is highly problematic in hydraulic equilibria where the pressure error can be large despite the fact that the displacement is easy to calculate. Therefore, we will investigate pressure robust discretization techniques for incompressible quasi-static damage evolutions. Finally, it will be investigated whether and how this can be extended towards the quasi-incompressible case.

Partner: Katrin Mang, Thomas Wick (Universität Hannover), Mirjam Walloth (TU Darmstadt), DFG Priority Programme (SPP) 1748: "Reliable Simulation Techniques in Solid Mechanics. Development of Non-standard Discretization Methods, Mechanical and Mathematical Analysis "; speaker Prof. Dr. Jörg Schröder (Universität Duisburg-Essen)

Support: DFG

Contact: S. Reddy Basava, W. Wollner

References

[1] K. Mang, T. Wick, and W. Wollner. A phase-field model for fractures in incompressible solids. Preprint, arXiv:1901.05378, 2019.

Project: Control of fracture propagation by choice of materials

Control of damage and fracture in elastic materials is of interest in mechanical systems. In this context, desired fracture paths may be of interest to ease detection of damaged materials. Mathematically, damage and fracture evolutions can be modeled by a constrained energy minimization. Thus the control of such processes gives rise to a mathematical program with complementarity constraints (MPCC) in function spaces. Further complications in the mathematical analysis arise from the potential non-uniqueness of minimizers of the damage/fracture energy and the related nonlinear coupling between the damage phase-field and the displacement variables. Particular emphasis of this project will be the consideration of control via coefficients, e.g., by selection of suitable material distributions for controlling the damage/fracture evolution.

Contact: C. Becker, W. Wollner

Project: Multi-leader-follower games in function space (Project P21 in SPP 1962)

This project aims to design efficient and problem tailored numerical solution methods for certain classes of multi-leader-follower games (MLFGs) in function space accompanied by the theoretical analysis of these problems. While in a classical Nash equilibrium problem (NEP) we have several players that simultaneously make a decision which influences their own outcome and that of the others, in a MLFG the group of players is split into the so-called leaders deciding first and followers reacting to this. This hierarchical game has various applications in finite dimensions, e.g. in telecommunications, traffic networks and electricity markets as well as in infinite dimensions, e.g. the pursuit problem, autonomous vehicles and an elastoplastic multi-obstacle problem. It can be seen as an extension of the single-leader-multi-follower (Stackelberg) game or mathematical program with equilibrium constraints (MPEC).
By reducing the MLFG to a single-level problem, the equilibrium problem with equilibrium constraints (EPEC), we start with the theoretical investigation (existence and uniqueness of leader-follower equilibria and their approximation by surrogate problems, e.g. EPECs). These outcomes are not only of interest by themselves, but serve us as starting point for the design of numerical solution methods.
Additionally applications are considered to build a test library for our algorithms.

Partner: Sonja Steffensen, Anna Thünen (RWTH Aachen), DFG Priority Programme (SPP) 1962: “Non-smooth and Complementarity-based Distributed Parameter Systems: Simulation and Hierarchical Optimization”; speaker Prof. Dr. Michael Hintermüller (HU Berlin / WIAS Berlin)

Support: DFG

Contact: J. Becker, A. Schwartz

Project: Multilevel optimization based on reduced order models with application to fluid-structure interaction

In this project we derive and implement a multilevel optimization algorithm based on reduced order models with application to fluid-structure interaction (FSI) problems. The interaction of fluid flows with elastic deformation of structures is a problem occurring in many problems in engineering applications.
We build our work on a finite element discretisation of the fluid flow modelled with the 2D Navier-Stokes equations for incompressible fluids and a hyperelastic material.
The model reduction is done with help of the Proper Orthogonal Decomposition (POD) technique and the inf-sup stability is ensured by the enrichment of the POD spaces with supremizers. We further derive error control criteria and a convergence analysis under suitable assumptions.

The project builds on the work of Sarah Essert within GSC CE, who derives and implements adjoint-based derivative computations for fluid-structure interaction problems.

Partner: Darmstadt Graduate School of Excellence Computational Engineering (GSC 233); speaker Prof. Dr. Michael Schäfer (Department of Mechanical Engineering, TU Darmstadt)

Support: DFG

Contact: J. Biehl, S. Ulbrich

Project: Tight competitive ratios for online Dial-a-Ride

Online optimization deals with settings where algorithmic decisions have to be made over time without knowledge of the future. A prominent problem of this type arises when controlling a transportation system, where requests to transport objects arrive over time and the system needs to decide online how to adapt its trajectory over time, e.g., the problem of controlling an elevator, a conveyor system, an autonomous vehicle fleet, etc. In terms of competitive analysis, the central question in this context is how much we lose in solution quality in the worst-case, compared to an optimum offline solution that knows all requests ahead of time, i.e., we ask for solutions with good competitive ratio.
From an abstract point of view, the goal of this project is to tightly analyze variants of online DIAL-A-RIDE and provide best-possible online algorithms. At first, the focus will be on providing an online algorithm that secures a scheduling of an elevator against the worst-case in the best-possible way. We already conducted a complete analysis of the Smartstart algorithm [1] and improved the best known upper bound of the competitive ratio in the open setting (i.e. the server does not need to return to the origin after serving the final request) of online DIAL-A-RIDE on the line to 2.94 [2]. After tightening the competitive ratios of the classical online DIAL-A-RIDE, an extension of the results to more involved variants is planned. The goal is to provide a complete analysis of modifications of online DIAL-A-RIDE that model special features of a personal elevator, which have not been considered in the initial model. Additionally, other objective functions besides the makespan are planned to be investigated. For example, for companies it is not important to have a guarantee that every person is at its working place at some point of time, but more important, that every person is at its working place as soon as possible. Thus, it makes more sense to take the average waiting time or the maximum waiting time as objective function.

Partner: Darmstadt Graduate School of Excellence Computational Engineering (GSC 233); speaker Prof. Dr. Michael Schäfer (Department of Mechanical Engineering, TU Darmstadt)

Support: DFG

Contact: A. Birx, Y. Disser

References

[1] N. Ascheuer, S. Krumke, and J. Rambau. Online Dial-a-Ride problems: Minimizing the completion time. In *Proceedings of the 17th Annual Symposium on Theoretical Aspects of Computer Science (STACS)*, pages 639–650, 2000.

[2] A. Birx and Y. Disser. Tight analysis of the smartstart algorithm for online dial-a-ride on the line. Preprint, arXiv:1901.04272, 2019.

Project: A continuous reformulation of cardinality constrained optimization problems

Cardinality constraints are used to model the fact that the solution of an optimization problem is expected or desired to be sparse. They impose an upper bound on the cardinality of the support of feasible points. In this project we consider a nonlinear objective function which is to be minimized subject to the cardinality constraint as well as further nonlinear constraints. A classical application of cardinality constrained optimization problems is portfolio optimization in which the cardinality constraint limits the number of active positions in a portfolio. Other applications are compressed sensing or the subset selection problem in regression.
A recent approach is to reformulate the cardinality constraint with complementarity constraints using continuous auxiliary variables [3]. This opens up the possibility to use methods from nonlinear optimization. The reformulation possesses a strong similarity to a mathematical program with complementarity constraints (MPCC) and, like an MPCC, does not fulfill standard constraint qualifications. Using the strong link between the aforementioned reformulation of cardinality constrained optimization problems and MPCCs, we developed second-order optimality conditions [2] and a solution algorithm [1] for the reformulated problem.

Partner: Darmstadt Graduate School of Excellence Computational Engineering (GSC 233); speaker Prof. Dr. Michael Schäfer (Department of Mechanical Engineering, TU Darmstadt)

Support: DFG

Contact: M. Bucher, A. Schwartz

References

[1] M. Branda, M. Bucher, M. Červinka, and A. Schwartz. Convergence of a scholtes-type regularization method for cardinality-constrained optimization problems with an application in sparse robust portfolio optimization. *Computational Optimization and Applications*, pages 1–28, 2018.

[2] M. Bucher and A. Schwartz. Second-order optimality conditions and improved convergence results for regularization methods for cardinality-constrained optimization problems. *Journal of Optimization Theory and Applications*, 178(2):383–410, 2018.

[3] O. P. Burdakov, C. Kanzow, and A. Schwartz. Mathematical programs with cardinality constraints: Reformulation by complementarity-type conditions and a regularization method. *SIAM Journal on Optimization*, 26(1):397–425, 2016.

Project: Simulation-based optimization and optimal design of experiments for wetting processes (Subproject B04 of Collaborative Research Centre (SFB) 1194)

This project is part of the Collaborative Research Centre (SFB) 1194: “Interaction of Transport and Wetting Processes” and considers the development of adjoint-based multilevel optimization methods for optimization and parameter identification problems arising in wetting processes. Moreover, optimization-based approaches for the optimal design of experiments will be developed, such that the resulting experiments allow the estimation of non-measurable parameters with minimal error variance. The results of this project should be particularly valuable for the future selection of generic experimental setups and will make available quantities which are difficult to measure experimentally. Moreover, the geometry of surfaces as well as material properties of fluids or surfaces will be optimized to design wetting processes with desirable properties.

Partner: Collaborative Research Centre (SFB) 1194: "Interaction of Transport and Wetting Processes"; speaker Prof. Dr.-Ing. Peter Stephan (Department of Mechanical Engineering, TU Darmstadt)

Support: DFG

Contact: E. Diehl, A. Matei, S. Ulbrich

Project: Adaptive multigrid methods for fluid-structure interaction optimization

Strong fluid structure coupling is part of many technical systems. The aim of this project is to develop an efficient adaptive multilevel algorithm to solve an optimization problem governed by Fluid-Structure Interaction (FSI).
This algorithm should combine modern techniques of PDE-constrained optimization, adaptivity and Fluid-Structure Interaction simulation. Since for elliptic as well as for parabolic partial differential equations an adjoint based Trust-Region SQP method has shown good results, we want to adapt this method. Thus we aim for an adjoint based algorithm that is able to refine the given grids (both the spatial and the temporal) adaptively during the optimization process.
The Fluid-Structure Interaction problem we consider as the constraint for the optimization problem, is in the weak form of the FSI problem considered in an Arbitrary-Lagrangian-Eulerian (ALE) framework. The coupling of the two different parts of the partial differential equation is done via strong coupling.
Suitably the adjoint equation is considered in an ALE framework and in a strongly coupled way.

Partner: Michael Schäfer (TU Darmstadt), Darmstadt Graduate School of Excellence Computational Engineering (GSC 233); speaker Prof. Dr. Michael Schäfer (Department of Mechanical Engineering, TU Darmstadt)

Support: DFG

Contact: S. Essert, S. Ulbrich

Project: Mathematical models and methods for optimal combinations of passive and active components (Subproject A4 of Collaborative Research Centre (SFB) 805)

This project is part of the Collaborative Research Centre (SFB) 805: "Control of Uncertainty in Load-Carrying Structures in Mechanical Engineering". The project deals with the optimal design of mechanical trusses under uncertainty. Trusses are important in many applications (undercarriages of airplanes, bicycles, electrical towers, etc.) and are often overdimensioned to withstand given forces under several uncertainties in loadings, material and production processes. Active parts can react to these uncertain effects and reduce the dimension of trusses. The Collaborative Research Centre 805 introduces new technologies to handle uncertainty in load-carrying systems. The aim of this project is to find optimal combinations of active and passive parts in a mechanical truss under uncertain loadings. Mathematically, this leads to mixed-integer nonlinear semidefinite problems. For this kind of problem, there exists no solver that exploits the structure of the problem efficiently. Besides the development of an appropriate solver, another focus lies in a mathematical handling of the upcoming uncertainties. Ellipsoidal and polyhedral sets are used to integrate uncertainty in different loading scenarios. The focus of the third funding period lies in the detection of model uncertainty and in the design of resilient trusses. Since mathematical models can only describe reality up to a certain degree, it is important to investigate the uncertainty caused by inadequacy of mathematical models. Within subproject A4, this is done by combining techniques from parameter estimation and optimal design of experiments to optimally place sensors to ensure that model uncertainty can be detected. Resilient trusses should be able to sustain certain forces even after the failure of a subset of bars. This leads to mixed-integer semidefinite programs with large numbers of semidefinite constraints, which should be generated dynamically to still allow for the solution of practically-relevant instances. All of this includes interdisciplinary communication to mechanical engineers to achieve realistic models.

Partner: Collaborative Research Centre (SFB) 805: "Control of Uncertainty in Load-Carrying Structures in Mechanical Engineering"; speaker Prof. Dr.-Ing. Peter Pelz (Department of Mechanical Engineering, TU Darmstadt)

Support: DFG

Contact: T. Gally, A. Kuttich, M. E. Pfetsch, S. Ulbrich

References

[1] L. C. Altherr, N. Brötz, I. Dietrich, T. Gally, F. Geßner, H. Kloberdanz, P. Leise, P. F. Pelz, P. Schlemmer, and A. Schmitt. Resilience in mechanical engineering – a concept for controlling uncertainty during design, production and usage phase of load-carrying structures. In P. F. Pelz and P. Groche, editors, *Uncertainty in Mechanical Engineering III*, volume 885 of *Applied Mechanics and Materials*, pages 187–198, 2018.

[2] T. Gally, C. M. Gehb, P. Kolvenbach, A. Kuttich, M. E. Pfetsch, and S. Ulbrich. Robust truss topology design with beam elements via mixed integer nonlinear semidefinite programming. In P. F. Pelz and P. Groche, editors, *Uncertainty in Mechanical Engineering II*, volume 807 of *Applied Mechanics and Materials*, pages 229–238, 2015.

[3] T. Gally, A. Kuttich, M. E. Pfetsch, M. Schaeffner, and S. Ulbrich. Optimal placement of active bars for buckling control in truss structures under bar failures. In P. F. Pelz and P. Groche, editors, *Uncertainty in Mechanical Engineering III*, volume 885 of *Applied Mechanics and Materials*, pages 119–130, 2018.

[4] T. Gally, M. E. Pfetsch, and S. Ulbrich. A framework for solving mixed-integer semidefinite programs. *Optimization Methods and Software*, 33(3):594–632, 2018.

[5] B. Götz, A. Kuttich, and S. Ulbrich. Robust optimization of shunted piezoelectric transducers for vibration attenuation considering different values of electromechanical coupling. In *Model Validation and Uncertainty Quantification*, volume 3, pages 51–59, 2017.

Project: Global methods for stationary and instationary gastransport (Subproject A01 of Transregio/SFB 154)

This project is part of the Transregio/SFB 154: "Mathematical Modelling, Simulation and Optimization on the Example of Gas Networks". Adaptive methods for the global solution of nonlinear mixed-integer optimization problems subject to ODE or PDE constraints are developed. In the first funding period, we designed a new approach for the global solution for a class of ODE constrained optimization problems using the example of stationary gas networks. In this approach we combine spatial and variable branching with appropriate discretizations of the differential equations to construct relaxations of the original problem. Therefore, we derived sufficient conditions under which numerical methods yield

lower and upper bounds on the ODE solutions. Moreover, we derived conditions that ensure convexity or concavity of the obtained under- and overestimators for specific numerical methods. A key property of this approach is that the solutions of the ODEs only need to be known at a finite number of points due to the underlying network structure. This property enables us to adaptively refine discretizations without introducing new variables in the optimization problem. Furthermore, we proved that using these relaxations in a spatial branch-and-bound process yields an algorithm which terminates finitely under some natural assumptions [1].
In the second funding period this approach will be extended to PDE constrained optimization problems, now using the example of instationary gas networks. Therefore, new relaxations for the PDEs have to be developed. Again, these relaxations will be based on appropriate discretizations such that the accuracy can be increased without introducing additional variables into the optimization problem.
Moreover, we will extend our approach to topology planing, i.e., planing the extension of an already existing supply network such as gas or water networks. For this purpose we use stationary models and investigate perspective cuts for ODE constraints. These cuts include binary decisions representing whether or not to extend the network in a certain way, e.g., to build pipes.

Partner: Transregio/SFB 154: "Mathematical Modelling, Simulation and Optimization using the Example of Gas Networks"; speaker Prof. Dr. Alexander Martin (Department of Mathematics, Universität Erlangen-Nürnberg)

Support: DFG

Contact: O. Habeck, M. E. Pfetsch, S. Ulbrich

References

[1] O. Habeck, M. E. Pfetsch, and S. Ulbrich. Global optimization of ODE constrained network problems on the example of stationary gas transport. Preprint, SFB-TRR 154, 2017.

Project: Polyhedral symmetry handling techniques

Symmetries in (mixed) binary programs may have a negative impact on the performance of branch-and-bound solvers since symmetric solutions reappear multiple times during the solving process.
The aim of this project is two-fold. On the one hand, we develop polyhedral models which allow to solve symmetric (mixed) binary programs. We focus on the facial structure of the derived polytopes to obtain strong cutting planes which can be used within branch-and-cut procedures to speed up the solution process of such binary programs. Furthermore, we investigate complete linear descriptions of polytopes that arise if we also consider further properties of given binary programs besides symmetry information to derive strong cutting planes for applications [1, 2].
As a second goal, established methods like orbital fixing, see [3], are generalized to arbitrary mixed-integer non-linear programs and mechanisms are developed that allow to simultaneously use different symmetry handling approaches for the same problem to strengthen the effect of the different methods.

Contact: C. Hojny, M. E. Pfetsch

References

[1] C. Hojny. Packing, partitioning, and covering symresacks. Preprint, Optimization Online, 2017.

[2] C. Hojny and M. E. Pfetsch. Polytopes associated with symmetry handling. *Mathematical Programming*, 2018.

[3] M. E. Pfetsch and T. Rehn. A computational comparison of symmetry handling methods for mixed integer programs. Preprint, Optimization Online, 2015.

Project: The complexity of Zadeh's pivot rule

Zadeh's Least-Entered pivot rule [3] is a memorizing pivot rule applicable to a wide range of algorithms. The most prominent example is the Simplex Algorithm since, for over thirty years, it was not clear if Zadeh's pivot rule might be the first polynomial time pivot rule for the Simplex Algorithm. In general, the worst-case running time of algorithms using Zadeh's pivot rule is not exhaustively and satisfyingly researched yet, though it attracted more attention through the last years.

Following the work of Friedmann [2], the goal of this project is to further investigate the worst-case running time of algorithms using Zadeh's pivot rule. We already corrected the work of Friedmann in [1] as a first step towards further understanding the design of general worst-case examples. The main goal of the project is to provide an improved exponential lower bound for several algorithms using Zadeh's pivot rule. This class includes the discrete Strategy Improvement Algorithm for solving parity games and the Simplex Algorithm. This result and the insights on the general structure of worst-case examples for Zadeh's pivot rule might then be used to prove exponential lower bounds for even more algorithms using Zadeh's pivot rule and other pivot rules.

Partner: Darmstadt Graduate School of Excellence Computational Engineering (GSC 233); speaker Prof. Dr. Michael Schäfer (Department of Mechanical Engineering, TU Darmstadt)

Support: DFG

Contact: Y. Disser, A. V. Hopp

References

[1] Y. Disser and A. V. Hopp. On Friedmann's subexponential lower bound for Zadeh's pivot rule. Technical report, TU Darmstadt, 2018. Available at `http://tuprints.ulb.tu-darmstadt.de/id/eprint/7557`.

[2] O. Friedmann. A subexponential lower bound for Zadeh's pivoting rule for solving linear programs and games. In *Proceedings of the 15th International Conference on Integer Programming and Combinatorial Optimization (IPCO)*, pages 192–206, 2011.

[3] N. Zadeh. What is the worst case behavior of the simplex algorithm? Technical Report 27, Department of Operations Research, Stanford, 1980.

Project: Mathematical models and algorithms for an automated product development of branched sheet metal products (Subproject A2 of Collaborative Research Centre (SFB) 666)

This project was part of the Collaborative Research Centre (SFB) 666: "Integral sheet metal design with higher order bifurcations – development, production, evaluation" and addresses the shape optimization of sheet metal products. There are different types of considered sheet metal products: Multi-chambered profiles, mechanical connectors and hydroformed branched sheet metal structures.

For profiles, the goal was to find the optimal design of the profiles' cross sections as well as optimal decomposition into smaller parts that are easier to produce. For this purpose, a combination of topology and geometry optimization as well as graph partitioning techniques were applied. To solve the decomposition problem more efficiently, the information of the defined polyhedron has been used in the integer program solvers [3].

For the optimization of mechanical connectors, multibody models including contact constraints were used. The variety of shapes are increased by following the approach of isogeometric analysis. To solve the resulting PDE constrained problems optimization techniques for nonsmooth and nonconvex problems were applied.

As hydroformed parts can show arbitrary curvature, the geometry of those parts is parameterized by cubic B-spline surfaces. The product behavior is described by the three dimensional linear elasticity equations. To optimize the geometry of the branched and hydroformed sheet metal products, PDE constrained optimization techniques were used. The arising nonconvex geometry optimization problem was solved with an algorithm using exact constraints and a globalization strategy based on adaptive cubic regularization. For decreasing the computational effort multilevel-techniques are applied.

Partner: Collaborative Research Centre (SFB) 666: "Integral sheet metal design with higher order bifurcations – development, production, evaluation"; speaker Prof. Dr.-Ing. Dipl.-Wirtsch.-Ing. Peter Groche (Department of Mechanical Engineering, TU Darmstadt)

Support: DFG

Contact: B. M. Horn, H. Lüthen, M. E. Pfetsch, S. Ulbrich

References

[1] U. Günther, W. Hess, B. M. Horn, and H. Lüthen. A holistic topology and shape optimization approach with an application to steel profiles. *Structural and Multidisciplinary Optimization*, 57(3):1267–1281, 2017.

[2] B. M. Horn, H. Lüthen, M. E. Pfetsch, and S. Ulbrich. Geometry and topology optimization of sheet metal profiles by using a branch-and-bound framework. *Materials Science & Engineering Technology*, 48:27–40, 2017.

[3] H. Lüthen. *Partitioning into isomorphic or connected subgraphs*. PhD thesis, TU Darmstadt, 2018.

[4] H. Lüthen, S. Gramlich, B. M. Horn, I. Mattmann, M. E. Pfetsch, M. Roos, S. Ulbrich, C. Wagner, and A. Walter. Finding the best: Mathematical optimization based on product and process requirements. In P. Groche, E. Bruder, and S. Gramlich, editors, *Manufacturing Integrated Design: Sheet Metal Product and Process Innovation*, pages 147–200. Springer International Publishing, 2017.

Project: Optimization of energy systems for settlements involving renewable energy systems

In this project, we investigate the energy network design of multiple energy carrier systems, concentrating on electricity, natural gas and district heating and their coupling through energy conversion plants. In addition to conventional energy sources we consider geothermal-, solar- and wind-energy sources. The settlements are equipped with

a borehole heat exchanger, wind turbines and photovoltaic systems. Our goal is to obtain a cost-minimal strategy satisfying the consumers' energy demand in a settlement by determining the dimensioning of transmission lines and storages as well as routing the particular energy carriers through the energy distribution system.
In order to achieve this aim, further steps will be the mathematical analysis of the given mixed-integer nonlinear problem (MINLP) with partial differential equations (PDEs) and the derivation of optimality conditions under given assumptions for our network problem. To master the remaining complexity of the network, we will apply the branch-and-bound method including global relaxation methods. For solving the PDE constraints and nonlinear equations of the transmission processes, we will use discretization methods and convexify the investigated equations. This must be balanced, however, with the discretization errors. To show the applicability, the developed approaches will be implemented and tested in detail.

Partner: Darmstadt Graduate School of Excellence Energy Science and Engineering (GSC 1070); speakers Prof. Dr. Wolfram Jaegermann and Prof. Dr. Johannes Janicka (TU Darmstadt)

Support: DFG

Contact: K. Janzen, S. Ulbrich

Project: Mathematical programming in robust design (Subproject A3 of Collaborative Research Centre (SFB) 805)

The objective of the subproject is the optimal design of load-carrying systems under uncertainty based on complex finite-element component models. This is achieved by the development and application of novel mathematical methods for the robust optimization of geometry, topology and for actuator placement. For an efficient numerical treatment, first- and second-order approximations with respect to the uncertain parameters will be used. Based on finite-element models, optimal excitations and sensor positions will be determined such that model uncertainty during production and usage can be identified reliably.

Partner: Collaborative Research Centre (SFB) 805: "Control of Uncertainty in Load-Carrying Structures in Mechanical Engineering"; speaker Prof. Dr.-Ing. Peter Pelz (Department of Mechanical Engineering, TU Darmstadt)

Support: DFG

Contact: P. Kolvenbach, A. Matei, S. Ulbrich

References

[1] P. Kolvenbach, O. Lass, and S. Ulbrich. An approach for robust PDE-constrained optimization with application to shape optimization of electrical engines and of dynamic elastic structures under uncertainty. *Optimization and Engineering*, 19(3):697–731, 2018.

[2] P. Kolvenbach, S. Ulbrich, M. Krech, and P. Groche. Robust design of a smart structure under manufacturing uncertainty via nonsmooth PDE-constrained optimization. In *Uncertainty in Mechanical Engineering III*, volume 885 of *Applied Mechanics and Materials*, pages 131–144. Trans Tech Publications, 2018.

Project: Robust optimization (Subproject AP4 of SIMUROM)

This subproject is part of SIMUROM, a project that focuses on the modeling, simulation and optimization of electromechanical energy converters that can work as motors or generators. As a subproject the focus is on the optimal design of such energy converters under uncertainty. Due to manufacturing, there are uncertainties in material and production precision. During the design process it is important to consider these uncertainties in order to obtain reliable and efficient machines. A robust optimization problem is formulated that incorporates the uncertainties into the initial optimization problem utilizing the worst-case approach. In order to obtain numerically feasible problems, different approximation methods are investigated. For this, the robust counterpart is approximated by different degrees of Taylor expansions [1, 3, 2]. To solve the resulting nonlinear PDE constrained optimization problems, efficient algorithms are needed. To achieve this, different model order reduction techniques [4], adaptive multilevel methods [5] and possible extensions are investigated.

Partner: Sebastian Schöps (TU Darmstadt), Andreas Bartel (Bergische Universität Wuppertal), Michael Hinze (Universität Hamburg), Oliver Rain (Robert Bosch GmbH), Markus Brunk (Robert Bosch GmbH), Enno Lange (CST – Computer Simulation Technology AG)

Support: Federal Ministry of Education and Research (BMBF)

Contact: O. Lass, S. Ulbrich

References

[1] M. Diel, H. G. Bock, and E. Kostina. An approximation technique for robust nonlinear optimization. *Mathematical Programming*, 107(1-2):213–230, 2006.

[2] O. Lass and S. Ulbrich. Model order reduction techniques with a posteriori error control for nonlinear robust optimization governed by partial differential equations. *SIAM Journal on Scientific Computing*, 2016. To appear.

[3] A. Sichau and S. Ulbrich. A second order approximation technique for robust shape optimization. *Applied Mechanics and Materials*, 104(13):13–22, 2011.

[4] T. Tonn, K. Urban, and S. Volkwein. Comparison of the reduced-basis and POD a posteriori error estimators for an elliptic linear-quadratic optimal control problem. *Applied Mechanics and Materials*, 17(4):355–369, 2011.

[5] S. Ulbrich and J. C. Ziems. Adaptive multilevel inexact SQP methods for PDE-constrained optimization. *SIAM Journal on Optimization*, 23(2):1257–1283, 2011.

Project: Exploiting structure in compressed sensing using side constraints – From analysis to system design (EXPRESS II)

In the first phase of the EXPRESS project, we investigated sparse signal recovery in the context of multidimensional frequency and direction-of-arrival estimation under various structural side constraints. We devised new algorithms, optimization strategies, and theoretical results that exploit specific structures in the sensor array and the signal waveform to enhance sparse reconstruction. Building on the results obtained in the first phase, the key objective in EXPRESS II is to design, configure, and dimension hybrid analog/digital data acquisition systems for sparse signal recovery under structure. In accordance with EXPRESS I, we consider exploiting prior knowledge of particular structure in the array geometry (e.g., uniform-linear arrays, shift-invariant arrays, etc.), the source signals (e.g., signal constellations, constant modulus, etc.), and the temporal signature of the signals (e.g., block-, row-, or rank-sparsity) in the hybrid system. In our design, we address the fundamental questions of how to synthesize the analog mixing network (dimension of the mixing networks, filter weights, etc.), and how to choose and parameterize nonlinear network components, e.g., for thresholding or quantization to sense the signal most efficiently in terms of hardware cost and storage bandwidth, given the prior knowledge that the signal exhibits sparsity in some domain. This requires theoretical results regarding the sparse signal recoverability exploiting the available structure as well as formulating and solving the corresponding optimization criteria. Considering the concept of virtual array design, we enforce favorable structures for sparse reconstruction. Moreover, with respect to sparse signals with structure, we explore the potential to improve recoverability using methods from mixed-integer nonlinear programming. Finally, we address row-, block- and rank-sparse recovery from nonlinear mixtures exploiting temporal structure and high-dimensional data.

Partner: DFG Priority Programme (SPP) 1798: "Compressed Sensing in Information Processing"; speakers Prof. Dr. Rudolf Mathar (Institute of Theoretical Information Technology, RWTH Aachen) and Prof. Dr. Gitta Kutyniok (Department of Mathematics, TU Berlin)

Support: DFG

Contact: F. Matter, M. E. Pfetsch

References

[1] T. Fischer. *Branch-and-Cut for complementarity and cardinality constrained linear programs*. Dr. Hut Verlag, 2017.

[2] T. Fischer, G. Hegde, F. Matter, M. Pesavento, M. E. Pfetsch, and A. M. Tillmann. Joint antenna selection and phase-only beamforming using mixed-integer nonlinear programming. In *WSA 2018; 22nd International ITG Workshop on Smart Antennas*, pages 1–7, 2018.

[3] C. Steffens, M. Pesavento, and M. E. Pfetsch. A compact formulation for the $\ell_{2,1}$ mixed-norm minimization problem. *Transactions on Signal Processing*, 66(6):1483–1497, 2018.

Project: Analysis and optimal control of quasilinear parabolic evolution equations in divergence form on rough domains

Nearly all irreversible processes in the natural sciences are modeled by parabolic evolution equations. In this project, we consider optimal control problems subject to quasilinear equations of such type in divergence form in an abstract setting.

Quasilinear equations exhibit some features which make their analysis quite difficult, the maybe most outstanding one being possibly varying domains for the elliptic differential operators, including existence of possible blow-up for the solutions. We choose an approach via maximal parabolic regularity, which is very flexible and suitable for the abstract framework, relying on results on maximal elliptic regularity. The general setting regarding the underlying spatial domain is a generally nonsmooth one, beyond the Lipschitz class. It is the aim to also be able to treat rather general nonlinearities in the equation, allowing to include also solution mappings for subordinated equations. In this way, also systems of equations can be handled at once; these were the original motivation for this project.

In the optimal control problem built around the quasilinear equation, we additionally impose both state and control constraints on the system. The lack of a priori estimates for the solutions of the quasilinear evolution equations turns out to be especially difficult when establishing existence of globally optimal controls. Furthermore, one has to deal with the

possibility of blow-up of solutions which seems incompatible with the general optimization procedure.
The developed theory is simultaneously tried and applied on a real-world example, the thermistor problem, for this class of optimal control problems.

Contact: H. Meinlschmidt, S. Ulbrich

References

[1] H. Meinlschmidt. *Analysis and optimal control of quasilinear parabolic evolution equations in divergence form on rough domains*. sierke Verlag, Göttingen, 2017. PhD thesis, TU Darmstadt.

[2] H. Meinlschmidt, C. Meyer, and J. Rehberg. Optimal control of the thermistor problem in three spatial dimensions, part 1: Existence of optimal solutions. *SIAM Journal on Control and Optimization*, 55(5):2876–2904, 2017.

[3] H. Meinlschmidt, C. Meyer, and J. Rehberg. Optimal control of the thermistor problem in three spatial dimensions, part 2: Optimality conditions. *SIAM Journal on Control and Optimization*, 55(4):2368–2392, 2017.

Project: Solution of nonconvex/nonsmooth Nash games: Optimality conditions and algorithms

Non-cooperative game theory is a strong tool for deriving solutions in a decentralized system where every player chooses his strategy selfishly. As shown by John Nash in 1950, convexity is a crucial assumption for the existence of equilibrium points for such games. In this project we investigate solution concepts for nonconvex or nonsmooth Nash games, where the nonconvexity may occur in the objective functions and/or constraints of the players. Nonconvex constraints may also be induced by a hierarchical structure of the game, where some players (leaders) have a temporal advantage over the other players (followers). This results - depending on the number of leaders - in a mathematical program with equilibrium constraints (MPEC) or equilibrium problem with equilibrium constraints (EPEC). Applications of this project are for example computation offloading in mobile networks.
In particular we are investigating Quasi-Nash-Equilibria (QNE). QNEs are solutions of the concatenated Karush-Kuhn-Tucker conditions for each player written as a constrained variational inequality (VI), where the convex constraints of the optimization problems are kept as constraints for the VI. This formulation introduces a weaker stationarity concept than Nash equilibria. The goal of this project is to derive some new existence theorems for QNEs and to evaluate the quality of such weaker stationarity concepts for problems where the existence of a Nash equilibrium cannot be guaranteed.
In the application of computation offloading several selfish mobile users try to offload some computation task to a server [1]. This could be a service provided by a university or company to enable the offloading of computationally heavy tasks. In the application case the task is uniformly splittable which leads to a vanishing constraint in the admissible set of each mobile user. Although the vanishing constraint is highly nonconvex the existence and uniqueness of a generalized Nash equilibrium can be shown, additionally the generalized Nash equilibrium can be derived as the solution of a single optimization problem.

Partner: Darmstadt Graduate School of Excellence Computational Engineering (GSC 233); speaker Prof. Dr. Michael Schäfer (Department of Mechanical Engineering, TU Darmstadt)

Support: DFG

Contact: D. Nowak, A. Schwartz

References

[1] D. Nowak, T. Mahn, H. Al-Shatri, A. Schwartz, and A. Klein. A generalized Nash game for mobile edge computation offloading. In *6th IEEE International Conference on Mobile Cloud Computing, Services, and Engineering (MobileCloud)*, pages 95–102, March 2018.

Project: Strategic booking decisions in the Entry-Exit-System

We are investigating a multi-leader-multi-follower Nash game, which models competition between several firms on the gas market. The competition is modeled in the so called Entry-Exit-System, in which we consider a star shaped graph with a single customer on the middle node and the considered firms (suppliers) on the outer nodes. Gas suppliers first have to book a certain capacity of gas for a longer time period (month/year) and after that can nominate varying amounts of gas in each of several subsequent shorter time periods (hours/days). The booking decisions of the firms are an upper bound for the nomination decisions. Thus each firm needs to anticipate the result of the nomination phase, which leads to a hierarchical structure. The lower level is a constrained Cournot-Nash game, which admits a unique equilibrium, but the upper level is – given this equilibrium – a nonconvex Nash equilibrium problem.

Partner: Transregio/SFB 154: “Mathematical Modelling, Simulation and Optimization on the Example of Gas Networks”; speaker Prof. Dr. Alexander Martin (Department of Mathematics, Universität Erlangen-Nürnberg)

Support: DFG

Contact: D. Nowak, A. Schwartz

Project: `polymake`

The mathematical software system `polymake` provides a wide range of functions for convex polytopes, simplicial complexes, polyhedral cones and fans, lattice polytopes, toric geometry and tropical geometry. While the system exists for more than 20 years it was continuously developed and expanded. The focus of the development in the last years was on interaction with other software systems that complement methods and computations offered by `polymake`, among them `GAP` and `Singular`, and their application to extend the capabilities of `polymake`. `polymake` offers an interface similar to many computer algebra systems. However, on the technical level polymake differs from most mathematical software systems: rule based computations, a flexible object hierarchy and an extendible dual Perl/C++ interface are the most important characteristics. Recent development also allows access to `polymake` via Jupyter notebooks and via a common Julia based interactive shell with `GAP` and `Singular`.
`polymake` is an open source software project. The current version 3.2 can be downloaded freely from www.polymake.org.

Partner: Michael Joswig (TU Berlin); Ewgenij Gawrilow (TomTom N.V.), The `polymake` team

Contact: A. Paffenholz

References

[1] B. Assarf, E. Gawrilow, K. Herr, M. Joswig, B. Lorenz, A. Paffenholz, and T. Rehn. Computing convex hulls and counting integer points with `polymake`. *Mathematical Programming Computation*, 9(1):1–38, 2017.

Project: Optimization and control (Subproject AP C of PASIROM)

This project is a subproject of PASIROM, which builds upon the achievements of SIMUROM, its predecessing project. As in SIMUROM, the modeling, simulation and optimization of electromechanical energy converters is investigated. In the subproject we particularly focus on the robust optimization of an electrical machine, which can be modeled by a coupled system of partial differential algebraic equations. In our robust optimization approach we treat uncertainties due to imperfect manufacturing and therefore geometric imprecision. We use the worst case approach and approximate the robust counterpart by Taylor expansions of different degrees to get a numerically convenient problem. To reduce computational effort we will apply a model order reduction technique in the form of proper orthogonal decomposition.

Partner: Sebastian Schöps (TU Darmstadt); Stephanie Friedhoff (Universität Wuppertal); Michael Hinze (Universität Hamburg); Stefan Kurz, Oliver Rain (Robert Bosch GmbH); Enno Lange, Stefan Reitzinger (CST - Computer Simulation Technology AG)

Support: Federal Ministry of Education and Research (BMBF)

Contact: B. Polenz, S. Ulbrich

References

[1] O. Lass and S. Ulbrich. Model order reduction techniques with a posteriori error control for nonlinear robust optimization governed by partial differential equations. *SIAM Journal on Scientific Computing*, 39(5):S112–S139, 2017.

Project: Optimization methods for mathematical programs with equilibrium constraints in function spaces based on adaptive error control and reduced order or low rank tensor approximations (Project P23 in SPP 1962)

This project investigates optimization methods for mathematical programs with equilibrium constraints (MPECs) in function space that adaptively control the accuracy of the underlying discretization and of inexact subproblem solves in such a way that convergence is ensured. This enables the use of adaptive discretizations, reduced order models, and low rank tensor methods, thus making the solution of MPECs with high dimensional equilibrium constraints tractable and efficient. Two prototype classes of MPECs in function space are considered in the project: One with a family of parametric variational inequalities as constraints and the other constrained by a parabolic variational inequality. Based on a rigorous analytical foundation in function space, the project will develop and analyze inexact bundle methods combined with an implicit programming approach. In addition, inexact all-at-once methods will be considered. In both cases, the evaluation of cost function, constraints, and derivatives is carried out on discretizations which are adaptively refined during optimization and can further be approximated by reduced order models or low rank tensor methods. We will develop implementable control mechanisms for the inexactness, which are tailored to the needs of the optimization methods and can be based on a posteriori error estimators. The algorithms will be implemented and tested for the considered prototype classes of MPECs.

Partner: Michael Ulbrich (TU München), Lukas Hertlein (TU München), DFG Priority Programme (SPP) 1962: “Non-smooth and Complementarity-based Distributed Parameter Systems: Simulation and Hierarchical Optimization”; speaker Prof. Dr. Michael Hintermüller (HU Berlin / WIAS Berlin)

Support: DFG

Contact: A.-T. Rauls, S. Ulbrich

References

[1] L. Hertlein and M. Ulbrich. An Inexact Bundle Algorithm for Nonconvex Nondifferentiable Functions in Hilbert Space. Preprint, SPP 1962, 2018.

[2] A.-T. Rauls and S. Ulbrich. Subgradient Computation for the Solution Operator of the Obstacle Problem. Preprint, SPP 1962, 2018.

[3] A.-T. Rauls and G. Wachsmuth. Generalized Derivatives for the Solution Operator of the Obstacle Problem. *Set-Valued and Variational Analysis*, 2019.

Project: Resilient design (Subproject A9 of Collaborative Research Centre (SFB) 805)

In this subproject, optimization methods for the optimal design of technical systems under uncertainty are developed. The goal is to find an optimal combination of different components constituting a resilient system structure, i.e., a structure which can tolerate failing components. To asses and optimize resilience we use the concept of k-reliability. If a system is k-reliable, k components can fail and it still fulfills a previously defined minimum function. If one takes this property into account, the corresponding mathematical optimization model has multiple stages, since an emergency function must be guaranteed for each combination of a previously specified maximum number k of failed components. To understand this complex structure, we have analyzed a model to design a cost-optimal but k-reliable water supply system for a high-rise building and presented a solution approach [1]. The algorithm repeatedly solves a relaxation of the problem and checks solution candidates for the existence of unbearable pump failures. Suitable inequalities for these worst-case scenarios are then dynamically added to the relaxation in order to cut off non-resilient solution candidates. Using this solving scheme, we are able to find the cost-optimal connection of pipes, placement and operation of pumps to supply buildings with up to seven pressure zones and such that the total system withstands up to three arbitrary pump failures.

Partner: Collaborative Research Centre (SFB) 805: “Control of Uncertainty in Load-Carrying Structures in Mechanical Engineering”; speaker Prof. Dr.-Ing. Peter Pelz (Department of Mechanical Engineering, TU Darmstadt); Lena C. Altherr, Philipp Leise (Department of Mechanical Engineering, TU Darmstadt)

Support: DFG

Contact: A. Schmitt, M. E. Pfetsch

References

[1] L. C. Altherr, P. Leise, M. E. Pfetsch, and A. Schmitt. Algorithmic design and resilience assessment of energy efficient high-rise water supply systems. In P. F. Pelz and P. Groche, editors, *Un-*

certainty in Mechanical Engineering III, volume 885 of *Applied Mechanics and Materials*, pages 211–223. Trans Tech Publications, 2018.

Project: Adaptive multilevel methods for the optimal control of hyperbolic equations in gas networks (Subproject A02 of Transregio/SFB 154, phase 1)

This project is part of the Transregio/SFB 154: "Mathematical Modelling, Simulation and Optimization on the Example of Gas Networks". We want to analyze the optimal control of hyperbolic PDE systems with state constraints on the example of gas networks. Through the time-dependent control of compressors and valves, the pressure and velocity distribution of the transported gas in the network has to be optimized under constraints, e.g. such that the pressure lies within a specified tolerance range. The constraints of the resulting optimal control problem (P) consist of coupled systems of one-dimensional isothermal Euler equations describing the gas flow, node conditions and state constraints. We plan to use Moreau-Yosida regularizations to approximate (P) in order to derive optimality conditions. The main goal of this project is to provide an optimization theory, which will form the basis of adaptive multilevel methods.

Partner: Transregio/SFB 154: "Mathematical Modelling, Simulation and Optimization on the Example of Gas Networks"; speaker Prof. Dr. Alexander Martin (Department of Mathematics, Universität Erlangen-Nürnberg)

Support: DFG

Contact: J. M. Schmitt, S. Ulbrich

References

[1] S. Pfaff and S. Ulbrich. Optimal boundary control of nonlinear hyperbolic conservation laws with switched boundary data. *SIAM Journal on Control and Optimization*, 53(3):1250–1277, 2015.

[2] S. Pfaff and S. Ulbrich. Optimal control of scalar conservation laws by on/off-switching. *Optimization Methods and Software*, 32(4):904–939, 2017.

[3] J. M. Schmitt and S. Ulbrich. Optimal boundary control of hyperbolic balance laws with state constraints. Preprint, TRR 154, 2017. `https://opus4.kobv.de/opus4-trr154/frontdoor/index/index/docId/219`.

Project: Optimal control of Navier-Stokes with combustion

Based on the work of the SFB 568 subproject D5 we continue to develop efficient methods for the optimization of combustion chambers containing turbulent fluid flow and combustion processes, which are modeled by partial differential equations.
The employed optimization methods rely on adjoints and derivative information, calculated by automatic differentiation [1]. The implementation uses the parallel multi-grid flow solver "Fastest", which incorporates recent simplified combustion models such as the flamelet-generated-manifold (FGM) method.

Partner: Darmstadt Graduate School of Excellence Energy Science and Engineering (GSC 1070); speakers Prof. Dr. Wolfram Jaegermann and Prof. Dr. Johannes Janicka (TU Darmstadt)

Support: DFG

Contact: C. Sehrt, S. Ulbrich

References

[1] R. Roth and S. Ulbrich. A discrete adjoint approach for the optimization of unsteady turbulent flows. *Flow, Turbulence and Combustion*, 90(4), 2013.

Project: Simulation-based optimization methods for the hydroforming of branched structures (Subproject A6 of Collaborative Research Centre (SFB) 666)

This project is part of the Collaborative Research Centre (SFB) 666: "Integral sheet metal design with higher order bifurcations – development, production, evaluation" and is concerned with the optimal control of the sheet metal hydro-forming. The sheet metal hydroforming process is a complex forming process, which involves contact, friction, and plasticity to manufacture complexly curved sheet metals with bifurcated cross-section. Mathematically, this leads to a quasi-variational inequality. We want to find optimal controls for typical control variables, e.g., the time dependent blank holder force and the fluid pressure, by the use of simulation-based optimization methods. Our goal is to obtain a desired final configuration, taking into consideration relevant parameters for the production. On the one hand, we use derivative free optimization methods to solve the optimal control problem, where the commercial FEM-software ABAQUS is invoked for the simulations and, on the other hand, instantaneous optimization methods are under investigation. In this context model reduction techniques, e.g., Proper Orthogonal Decomposition, will be employed to achieve a suboptimal solution for the optimal control problem. In addition to the optimization of the controllable parameters of the hydro-forming process, we optimize the height profile of stringer sheets to avoid production defects like stringer buckling.

Partner: Collaborative Research Centre (SFB) 666: "Integral sheet metal design with higher order bifurcations – development, production, evaluation"; speaker Prof. Dr.-Ing. Dipl.-Wirtsch.-Ing. Peter Groche (Department of Mechanical Engineering, TU Darmstadt)

Support: DFG

Contact: S. Ulbrich, A. Walter

References

[1] H. Lüthen, S. Gramlich, B. M. Horn, I. Mattmann, M. E. Pfetsch, M. Roos, S. Ulbrich, C. Wagner, and A. Walter. Finding the best: Mathematical optimization based on product and process requirements. In P. Groche, E. Bruder, and S. Gramlich, editors, *Manufacturing Integrated Design: Sheet Metal Product and Process Innovation*, pages 147–200. Springer International Publishing, 2017.

Project: Optimizing fracture propagation using a phase-field approach (Project P17 in SPP 1962)

We consider the numerical approximation and solution of control problems governed by a quasi-static brittle fracture propagation model. As a central modeling component, a phase-field formulation for the fracture formation and propagation is considered.

The fracture propagation problem itself can be formulated as a minimization problem with inequality constraints, imposed by multiple relevant side conditions, such as irreversibility of the fracture-growth or non-selfpenetration of the material across the fracture surface. These lead to variational inequalities as first order necessary conditions. Consequently,

optimization problems for the control of the fracture process give rise to a mathematical program with complementarity constraints (MPCC) in function spaces.
Within this project, we intend to analyze the resulting MPCC with respect to its necessary and sufficient optimality conditions by means of a regularization of the lower-level problem and passage to the limit with respect to the regularization parameter. Moreover, we will consider SQP-type algorithms for the solution of this MPCC in function space and investigate its properties. Additionally, we will consider the discretization by finite elements and show the convergence of the discrete approximations to the continuous limit.
The simultaneous consideration of the inexactness due to discretization and regularization error will allow us to construct and analyze an efficient inexact SQP-type solver for the MPCC under consideration.

Partner: Ira Neitzel (Universität Bonn), Thomas Wick (Universität Hannover), Christoph Ortner (University of Warwick), DFG Priority Programme (SPP) 1962: "Non-smooth and Complementarity-based Distributed Parameter Systems: Simulation and Hierarchical Optimization"; speaker Prof. Dr. Michael Hintermüller (HU Berlin / WIAS Berlin)

Support: DFG

Contact: M. Mohammadi, W. Wollner

References

[1] R. Haller-Dintelmann, H. Meinlschmidt, and W. Wollner. Higher regularity for solutions to elliptic systems in divergence form subject to mixed boundary conditions. *Annali di Matematica Pura ed Applicata*, 2018. online-first.

[2] M. Mohammadi and W. Wollner. A priori error estimates for a linearized fracture control problem. Technical Report SPP1962-90, SPP 1962, 2018.

[3] I. Neitzel, T. Wick, and W. Wollner. An optimal control problem governed by a regularized phase-field fracture propagation model. *SIAM Journal on Control and Optimization*, 55(4):2271–2288, 2017.

[4] I. Neitzel, T. Wick, and W. Wollner. An Optimal Control Problem Governed by a Regularized Phase-field Fracture Propagation Model. Part II: The Regularization Limit. Technical Report SPP1962-91, SPP 1962, 2018.

Project: Discretization error in mixed integer optimization (Subproject A08 of Transregio/SFB 154)

The project is concerned with a posteriori error estimation in the context of mixed integer-continuous optimization. It aims at robustification of discrete decisions with respect to unavoidable discretization errors. In contrast to robustification against uncertainties that are only realized ex-post, the discretization errors can, in principle, be made arbitrarily small by increasing the computational effort. In continuous optimization, the error in the decision can thus be made arbitrarily small by spending additional computational time. If discrete decisions are involved this is no longer true, since discrete decisions inherently depend discontinuously upon the data of the problem. Consequently, the central question of this project is to derive conditions under which it can be ensured that a discrete decision would have been taken identically even if no discretization error had occurred, i.e., the decision is robust with respect to the chosen discretization accuracy.
In the context of gas networks, this problem can be demonstrated already with a single pipe with connected compressor. If, for disabled compressor, the pressure in the pipe is

close to the minimal allowed pressure, a small discretization error may lead to a wrong decision whether to activate the compressor or not. The methods to be developed within this project therefore will allow to characterize these situations, and thereby provide information whether the decision may still depend upon the discretization accuracy, or if further changes in the discretization will not have any influence on the decisions made.

Partner: Pia Domschke (TU Darmstadt), Transregio/SFB 154: "Mathematical Modelling, Simulation and Optimization on the Example of Gas Networks"; speaker Prof. Dr. Alexander Martin (Department of Mathematics, Universität Erlangen-Nürnberg)

Support: DFG

Contact: S. Beckers, W. Wollner

References

[1] S. Beckers, J. Behrens, and W. Wollner. Duality based error estimation in the presence of discontinuities. Preprint, SFB-TRR 154, 2017.

[2] H. Egger, T. Kugler, and W. Wollner. Numerical optimal control of instationary gas transport with control and state constraints. Preprint, SFB-TRR 154, 2017.

[3] M. Schmidt, M. Sirvent, and W. Wollner. A Decomposition Method for MINLPs with Lipschitz Continuous Nonlinearities. *Mathematical Programming*, 2018. online-first.

[4] M. Schmidt, M. Sirvent, and W. Wollner. The Cost of Not Knowing Enough: Mixed-Integer Optimization with Implicit Lipschitz Nonlinearities. Preprint, TU Darmstadt, 2018.

Project: Finite Element error in discretization of state-constrained parabolic optimization problems

The aim of the project is the numerical analysis of optimal control problems governed by parabolic PDEs and subject to constraints on the state variable and its first derivative. The control is acting distributed in time only while the state constraints are considered pointwise in time and global in space; this setting generates an optimization problem of semi-infinite type.

A time-space discretization of the problem is considered, leading naturally to the study of the convergence of the discretized solution toward the continuous one as time and space mesh size tend to zero. This is based, at any level of discretization, on a priori error estimates for the solution of the parabolic differential equations which are obtained within this project.

One of the main challenges for state-constrained problems consists in the presence of a Lagrange multiplier appearing as a Borel measure in the system of first-order optimality conditions. In particular, such a measure enters the optimality system as data in the adjoint equation afflicting the regularity of the adjoint variable itself. This issue must be considered when deriving convergence rates as we cannot rely on adjoint information.

This situation is magnified for non-convex problems where the presence of local solutions and the need for second-order optimality conditions require a different strategy compared to the convex case, making the analysis more involved. Indeed, the convergence of the discretized solution towards the continuous one is based on a so-called quadratic growth-condition, which arises from the second order optimality conditions. When using this quadratic growth-condition a phenomenon called two-norm discrepancy comes into play: the objective functional is differentiable in a norm stronger than the one where the coercivity holds. For the problem at hand it is possible to remove this discrepancy, avoiding in this way the derivation of convergence rates for the control variable in the stronger norm. For both convex and non-convex case our findings are verified numerically and we expect the convergence rates of the optimal control problems to coincide with the rates of the corresponding error in the differential equation.

Partner: Ira Neitzel (Universität Bonn)

Contact: F. Ludovici, W. Wollner

References

[1] F. Ludovici. *Numerical analysis of parabolic optimal control problems with restrictions on the state and its first derivative*. PhD thesis, TU Darmstadt, 2017.

[2] F. Ludovici, I. Neitzel, and W. Wollner. A priori error estimates for state constrained semilinear parabolic optimal control problems. *Journal of Optimization Theory and Applications*, 178(2):317–348, 2018.

1.8 Stochastics

Research in the stochastics group is split into a probability theory part (Aurzada, Betz) and a part on mathematical statistics (Kohler).

In the mathematical statistics part, we work on curve estimation. The particular focus here is on nonparametric regression and nonparametric density estimation. The major research topics studied by the probability group are statistical mechanics, interacting particle systems, stochastic processes, and queueing theory with applications to engineering problems. The particular problems considered are from the following areas: spacial random permutations, probabilistic methods in quantum theory, the theory of Bose-Einstein condensation, exit problems for stochastic processes, and the analysis of steady-state properties of Markov chains.

The members of the research group stochastics are involved in joint projects with colleagues working in probability and statistics as well as colleagues in sciences where probability and statistics are applied to, such as econometrics, engineering, telecommunication, physics, and psychology. Furthermore, we carry out research projects in applied stochastics with industrial partners.

Members of the research group

Professors and Permament Staff

Frank Aurzada, Volker Betz, Michael Kohler, Cornelia Wichelhaus

Postdocs

Benjamin Lees, Christian Mönch, Helge Schäfer, Lorenzo Taggi

PhD Students

Alina Braun, Micha M. Buck, Johannes Ehlert, Sebastian Kersting, Martin Kilian, Marvin Kettner, Sophie Langer, Jan-Erik Lübbers, Dominic T. Schickentanz, Sebastian Zaigler

Secretaries

Alexandra Frohn, Ute Hasenzahl

Project: Persistence probabilities of fractional processes

Persistence probabilities concern the question whether a stochastic process remains above (or below) a fixed boundary for a long time. This is a classical question in probability that was studied extensively for random walks and Lévy processes. It has various connections to other fields, most notably to statistical physics and insurance. In physics, the rate of decay of the persistence probability is perceived as a measure for the return of a complicated physical system to an equilibrium state. In insurance, one asks for the probability of (non)ruin of an asset, which is clearly the probability that a stochastic process remains above a fixed boundary. In this project, we study persistence probabilities of fractional processes. The prototype is fractional Brownian motion, but we mainly look at discrete-time analogs such as sums of correlated random variables. This project is supported by DFG grant AU370/5.

Partner: Alexis Devulder (University of Versailles), Nadine Guillotin-Plantard (University of Lyon), Françoise Pène (University of Western Brittany, Brest)

Contact: Frank Aurzada

References

[1] F. Aurzada and M. Buck. Persistence probabilities of two-sided (integrated) sums of correlated stationary Gaussian sequences. *J. Stat. Phys.*, 170(4):784–799, 2018.

[2] F. Aurzada, A. Devulder, N. Guillotin-Plantard, and F. Pène. Random walks and branching processes in correlated Gaussian environment. *J. Stat. Phys.*, 166(1):1–23, 2017.

[3] F. Aurzada, N. Guillotin-Plantard, and F. Pène. Persistence probabilities for stationary increment processes. *Stochastic Process. Appl.*, 128(5):1750–1771, 2018.

[4] F. Aurzada and C. Mönch. Persistence probabilities and a decorrelation inequality for the Rosenblatt process and Hermite processes. 2017+. Theory of Probability and Its Applications, to appear, arXiv:1607.04045.

Project: Persistence probabilities and large deviations

Persistence probabilities concern the question whether a stochastic process remains above/below a fixed boundary for a long time. It is a particular instance of non-exit probabilities. In this project, we study these quantities with the help of large deviation theory and functional analytic tools. The first step – which can be pursued via large deviation techniques or via direct arguments – is to relate the mentioned probabilistic quantities to eigenvalue problems for a related operator. This step is highly non-trivial for both paths. In a second step, one analyses the resulting eigenvalue equation. Here we studied three sets of questions: 1) We solved the eigenvalue equation explicitly in a number of very particular cases. 2) We proved properties of the eigenvalues as a function of the underlying process. 3) We developed a perturbation argument that allows to obtain a series representation of the eigenvalue in the parameter of the underlying stochastic process. This project is supported by DFG grant AU370/4.

Partner: Amir Dembo (Stanford University), Fuchang Gao (University of Idaho), Ohad Feldheim (Hebrew University, Jerusalem), Naomi Feldheim (Weizmann Institute), Sumit Mukherjee (Columbia University), Thomas Simon (University of Lille), Ofer Zeitouni (Weizmann Institute)

Contact: Frank Aurzada

References

[1] F. Aurzada and M. Kettner. Persistence exponents via perturbation theory: AR(1)-processes. 2018+. Preprint, arXiv:1810.09861.

[2] F. Aurzada, S. Mukherjee, and O. Zeitouni. Persistence exponents in Markov chains. 2017+. Preprint, arXiv:1703.06447.

Project: Mathematical analysis of models from communications engineering

The purpose of this project is the analysis of certain protocols and algorithms in the area of communications engineering using probabilistic methods, in particular methods coming from queueing theory. In communications engineering applications, many algorithms are applied that involve randomness: most often, the traffic offered to the system is not predictable and thus can be modelled as random. A major goal is to understand the limitations of the algorithm depending on the parameters: the question here is for the throughput of the system, i.e. how much traffic can, on average, be served by the algorithm. This is where queueing-theoretic methods and other probabilistic tools come into play. Further questions involve the performance of the system in case it is stable: usually, even if the current traffic is less than the theoretical threshold, the performance of the algorithm can be quite poor. We obtained mathematical results for certain queueing models that are of importance in concrete communication protocols. This project is supported by the Graduate School "Computational Engineering".

Partner: A. Zoubir (Fachbereich ETIT, TU Darmstadt)

Contact: Frank Aurzada

References

[1] F. Aurzada and S. Schwinn. Improving the performance of polling models using forced idle times. *Probab. Engrg. Inform. Sci.*, 32(4):580–602, 2018.

[2] F. Aurzada and S. Schwinn. Scaling limits for a random boxes model. 2018+. Preprint, arXiv:1806.11029.

Project: Small deviation probabilities for stochastic processes

Small deviation theory concerns the probability that a stochastic process remains in a small ball of its target space. This question has a large range of applications in particular in functional analysis and statistics but also in coding theory, approximation theory, and other areas. Our contributions concern the computation of small deviation rates for discrete analogues of fractional Brownian motion, i.e. sums of correlated (Gaussian) random variables. Further, small deviation rates enter when studying the exit of multivariate processes from certain domains; where in particular we studied parabola-shaped domains. This project is supported by the DFG grant GO420/6.

Partner: Mikhail Lifshits (St. Petersburg State University)

Contact: Frank Aurzada

References

[1] F. Aurzada and M. Lifshits. The first exit time of fractional Brownian motion from a parabolic domain. 2018+. Preprint, arXiv:1808.09731.

[2] F. Aurzada and M. A. Lifshits. Small deviations of sums of correlated Gaussian sequences. *Theory Probab. Appl.*, 61(4):540–568, 2017.

Project: Complexity of random geometric structures

The aim of this project is to understand the amount of information of various kinds of random geometric structures. By "amount of information", the classical complexity measures such as quantization error and entropy coding error are studied, as well as other quantities. The geometric structures are germ-grain models, where the grains may have different distributions. The answer depends in a non-trivial way on the dimension of the space, the geometry of the balls, and the grain distribution. This project is supported by the DFG grant GO420/6.

Partner: Mikhail Lifshits (St. Petersburg State University)

Contact: Frank Aurzada

References

[1] F. Aurzada and M. Lifshits. How complex is a random picture? 2018+. Journal of Complexity, to appear, arXiv:1806.06597.

Project: Spatial random permutations and Bose-Einstein condensation

The theoretical understanding of the quantum phenomenon of Bose-Einstein condensation is one of the great unsolved problems of theoretical physics. It is well known that the quantum mechanical problem can be translated into a probabilistic one by using the Feynman-Kac formula. The result is a system of interacting spatial permutations, and the question to be answered is about a phase transition in the typical length of cycles, with the order parameter being the typical distance of two spatial points that will be mapped into each other by the permutation. Even though an understanding of the full probabilistic model is currently out of reach, there are various simplifications that should exhibit typical properties of the full model and are interesting in their own right. Moreover, these simpler models touch on many other current topics of statistical mechanics, such as motion by mean curvature, percolation or Schramm-Löwner evolution. The work in the research group is focused on understanding various of these aspects in simple cases, using both analytical and numerical methods.

Partner: D. Ueltschi (University of Warwick); L. Taggi (WIAS Berlin); P. Mörters (Universität Köln); S. Dereich (Universität Münster)

Support: DFG

Contact: V. Betz

References

[1] V. Betz, S. Dereich, and P. Mörters. The shape of the emerging condensate in effective models of condensation. *Annales Henri Poincare*, pages 1869–1889, 2018.

[2] V. Betz and H. Schäfer. The number of cycles in random permutations without long cycles is asymptotically Gaussian. *ALEA*, 14:427–444, 2017.

[3] V. Betz, H. Schäfer, and L. Taggi. Interacting self-avoiding polygons. *preprint*, 2018.

[4] V. Betz, H. Schäfer, and D. Zeindler. Random permutations without macroscopic cycles. *preprint*, 2018.

[5] V. Betz and L. Taggi. Scaling limit of a self-avoiding walk interacting with spatial random permutations. *preprint*, 2018.

[6] V. Betz and D. Ueltschi. Spatial random permutations and Poisson-Dirichlet law of cycle lengths. *Electronic Journal of Probability*, 16:41, 2011.

[7] V. Betz and D. Ueltschi. Spatial random permutations with small cycle weights. *Probab. Th. Rel. Fields*, 149:191–222, 2011.

[8] V. Betz, D. Ueltschi, and Y. Velenik. Random permutations with cycle weights. *Ann. Appl. Probab.*, 21:312–331, 2011.

Project: Superadiabatic transitions in molecules

An important problem in quantum chemistry are the so-called non-adiabatic transitions. These enable molecules to change their electronic eigenstates without emitting a photon, and are thus important in chemical processes such as the reception of light in the retina. These transitions are very challenging to predict numerically due to their seemingly highly oscillatory behaviour. In the 2000s, an approach has been developed by Volker Betz that allows to change the frame of reference in a way that eliminates those oscillations. Thus, it is possible to predict non-adiabatic transitions with higher accuracy than previously possible. The ongoing work in this area focusses on extending the range of utility of this approach, especially to higher dimensions.

Partner: B. Goddard (University of Edinburgh), U. Manthe (Universität Bielefeld)

Contact: V. Betz

References

[1] V. Betz and B. Goddard. Accurate prediciton of non-adiabatic transitions through avoided crossings. *Phys Rev Letters*, 103:213001, 2009.

[2] V. Betz, B. Goddard, and T. Hurst. Non-adiabatic transitions in multiple dimensions. *preprint*, 2018.

Project: Metastable Markov chains

Metastability is the property of stochastic systems to remain in a seemingly stationary state for a long time, but then to switch quickly to another state. Such a behavior usually involves multiple time scales, and it is of interest to understand the relevant effective behavior on these time scales. In a project with Stéphane Le Roux and Martin Ziegler, we investigate finite Markov chains with a small parameter that governs the metastable time scale, and derive a rather complete description of the various time scales. The practical relevance of this research lies in applications to evolutionary game theory, and importance ranking for entries of large linked databases.

Partner: S. Le Roux (Université Libre de Bruxelles); M. Ziegler (KAIST, Daejeon, Korea)

Contact: V. Betz

References

[1] V. Betz and S. Le Roux. Multi-scale metastable dynamics and the asymptotic stationary distribution of perturbed Markov chains. *Stoch. Proc. Appl.*, 126:3499–3526, 2016.

[2] V. Betz and S. Le Roux. Stable States of Perturbed Markov Chains. *Proceedings of the 41st International Symposium on Mathematical Foundations of Computer Science*, pages 18:1–18:14, 2016.

Project: Loop models and quantum systems

Quantum many body systems can be described by so-called loop models. These are percolation type models that, however, have much stronger correlations than usual and are thus very hard to analyse. On certain graphs (like trees) there has been some progress. In our group, we investigate different types of loop models using probabilistic techniques.

Partner: D. Ueltschi (Warwick)

Contact: V. Betz, B. Goddard, J. Ehlert

References

[1] V. Betz, J. Ehlert, and B. Lees. Explicit phase conditions for random loop models on trees using an exploration scheme. *preprint*, 2018.

[2] V. Betz, J. Ehlert, and B. Lees. Phase transition for loop representations of quantum spin systems on trees. *Journal of Mathematical Physics*, 59:113302, 2018.

Project: Estimation of the random behaviour of fatigue parameters

This project is motivated by experimental fatigue tests from the Collaborative Research Center 666 at the TU Darmstadt. The Collaborative Research Center 666 at the TU Darmstadt studies integral sheet metal design with higher order bifurcations. Here the main idea is to obtain several advantages concerning the material properties by producing structures out of one part by linear flow and bend splitting. The main goal in this project is to study whether this modified, splitted material shows better fatigue behavior under cyclic loading than the base material. Therefore for each material m data is obtained by a series of experiments, in which for a strain amplitude $\epsilon_i^{(m)}$ the number of cycles $N_i^{(m)}$ until the failure is determined. This data will be used to compare the estimated 5%-quantiles of the number of cycles until failure of the modified and the base material of ZStE500 for different amplitudes ϵ. In other words we are interested in estimating the number of cycles such that no failure occurs with a probability of 95%.
Since the above mentioned experiments are very time consuming, we only have available 4 to 35 data points per material, which is not enough for a nonparametric estimation. In order to define nevertheless reasonable estimates, the very few measured data points are augmented by data from similar materials. This artificial data is constructed using a database which contains for 228 materials experimental data for these materials together with so-called static material parameters like yield limit for 0.2% residual elongation, temperature, modulus of elasticity and sensitivity of static stress strain curve, which describe the materials. We use these static material parameters to decide how similar each of the 228 additional materials is to the material which we want to study, and use data from the similar materials together with the data from the material under study in order to construct quantile estimates.
We derive a general theory which enables us to analyze the consistency and the rate of convergence of the estimate, analyze the finite sample size behaviour of the estimates by using simulated data, and use the estimate to study the fatigue behaviour under cyclic loading of linear flow and bend splitted steel ZStE500.

Partner: SFB 666 (TU Darmstadt)

Contact: M. Kohler

References

[1] M. Hansmann and M. Kohler. Estimation of quantiles from data with additional measurement errors. *Statistica Sinica*, 27:1661–1673, 2017.

Project: Efficient estimation of uncertainty of technical systems

In any design of a complex technical system by engineers, uncertainty has to be taken into account. This uncertainty occurs, e.g., because of the use of an imperfect mathematical model of the technical system during the design process, or because of a lack of knowledge about future use. A good quantification of the uncertainty of the technical system is essential in order to avoid oversizing and to conserve resources. The starting point of uncertainty quantification is often a stochastic model of the technical system. Of course, in practice a model will never be able to represent the technical system perfectly. So it is clear that the mathematical model is imperfect, and the question is what the consequences of this are in view of uncertainty quantification.

In this project, new methods for efficient estimation of densities and quantiles on the basis of imperfect simulation models are studied, their rate of convergence is analyzed theoretically, and their finite sample size behaviour is analyzed using simulated data. Here also real data of the technical system is used to improve the estimates.

Partner: SFB 805 (TU Darmstadt)

Contact: S. Kersting, M. Kohler

References

[1] B. Götz, S. Kersting, and M. Kohler. Estimation of an improved surrogate model in uncertainty quantification by neural networks. Preprint, TU Darmstadt, 2018.

[2] M. Kohler and A. Krzyżak. Estimation of a density from an imperfect simulation model. Preprint, TU Darmstadt, 2017.

[3] M. Kohler and A. Krzyżak. Improving a surrogate model in uncertainty quantification by real data. Preprint, TU Darmstadt, 2018.

[4] M. Kohler, A. Krzyżak, S. Mallapur, and R. Platz. Uncertainty quantification in case of imperfect models: A non-bayesian approach. *Scandinavian Journal of Statistics*, 45:729–752, 2018.

Project: Deep learning as a remedy for the curse of dimensionality in nonparametric regression

Assuming that a smoothness condition and a suitable restriction on the structure of the regression function hold, it is shown that least squares estimates based on multilayer feedforward neural networks are able to circumvent the curse of dimensionality in nonparametric regression. The proof is based on new approximation results concerning multilayer feedforward neural networks with bounded weights and a bounded number of hidden neurons. The estimates are compared with various other approaches using simulated data.

Partner: Stiftung der Deutschen Wirtschaft

Contact: M. Kohler

References

[1] B. Bauer and M. Kohler. On deep learning as a remedy for the curse of dimensionality in nonparametric regression. Preprint, TU Darmstadt, 2017.

Project: Estimating quantiles in imperfect simulation models using conditional density estimation

In this project we consider the problem of estimating quantiles related to the outcome of experiments with a technical system given the distribution of the input together with an (imperfect) simulation model of the technical system and (few) data points from the technical system. The distribution of the outcome of the technical system is estimated in a regression model, where the distribution of the residuals is estimated on the basis of a conditional density estimate. It is shown how Monte Carlo can be used to estimate quantiles of the outcome of the technical system on the basis of the above estimates, and the rate of convergence of the quantile estimate is analyzed. Under suitable assumptions it is shown that this rate of convergence is faster than the rate of convergence of standard estimates which ignore either the (imperfect) simulation model or the data from the technical system, hence it is crucial to combine both kinds of information. The results are illustrated by applying the estimates to simulated and real data.

Partner: A. Krzyżak (Concordia University, Montreal)

Contact: M. Kohler

References

[1] M. Kohler and A. Krzyżak. Estimating quantiles in imperfect simulation models using conditional density estimation. Preprint, TU Darmstadt, 2017.

Project: Strong universal consistency of local averaging regression estimates

A general result concerning the strong universal consistency of local averaging regression estimates is presented, which is used to extend previously known results on the strong universal consistency of kernel and partitioning regression estimates. The proof is based on ideas from Etemadi's proof of the strong law of large numbers, which shows that these ideas are also useful in the context of strong laws of large numbers for conditional expectations in L_2.

Partner: H. Walk (Universität Stuttgart)

Contact: M. Kohler

References

[1] M. K. Matthias Hansmann and H. Walk. On the strong universal consistency of local averaging regression estimates. Preprint, TU Darmstadt, 2017.

Project: Deep versus deeper learning in nonparametric regression

Recent results in nonparametric regression show that deep learning, i.e., neural networks estimates with many hidden layers, are able to circumvent the so–called curse of dimensionality in case that suitable restrictions on the structure of the regression function hold. One key feature of the neural networks used in these results is that they are not fully connected. In this project it is shown that one can get similar results also for fully connected multilayer feedforward neural networks, provided the number of neurons per hidden layer is fixed and the number of hidden layers tends to infinity for sample size tending to infinity.

Contact: M. Kohler, S. Langer.

References

[1] S. Langer and M. Kohler. Deep versus deeper learning in nonparametric regression. Preprint, TU Darmstadt, 2018.

Project: Functional Central Limit Theorems for discrete-time GI / G /∞ Queueing Systems

In this project we consider nonparametric analysis of discrete-time queueing networks consisting of GI/G/∞ nodes. We investigate the nonparametric estimation of the service time distribution at the nodes. We aim to extend existing approaches substantially by providing functional central limit theorems for the resultant estimators. For this, we discuss the consequences of considering various metrics in the function space of absolutely summable sequences, and we establish a simple procedure for ensuring tightness of a given sequence in a very general setting.

Partner: Sebastian Schweer (1&1 Telecommunication SE)

Contact: C. Wichelhaus

References

[1] D. Edelmann and C. Wichelhaus. Nonparametric inference for queueing networks of Geom^X/G/∞-queues in discrete time. *Advances in Applied Probability*, 46:790–811, 2014.

[2] S. Schweer and C. Wichelhaus. Nonparametric estimation of the service time distribution in the discrete-time GI/G/∞-queue with partial information. *Stochastic Processes and their Applications*, 125:233–253, 2015.

[3] S. Schweer and C. Wichelhaus. Nonparametric estimation of the service time distribution in discrete-time queueing networks. *Preprint*, 2017.

Project: Bayesian Nonparametric Inference for Queueing Systems

In this project, we study nonparametric statistical inference for continuous-time queueing models from a Bayesian point of view. The inference is based on observations of the interarrival and service times. Beside other characteristics of the system, particular interest is in the waiting time distribution which is not accessible in closed form. We use an indirect statistical approach by exploiting the Pollaczek-Khinchine transform formula for the Laplace transform of the waiting time distribution. We construct appropriate estimators and study their frequentist validation in terms of posterior consistency and posterior normality.

Support: German Research Association (DFG).

Partner: Moritz von Rohrscheidt (Universität Heidelberg)

Contact: Cornelia Wichelhaus

References

[1] M. von Rohrscheidt and C. Wichelhaus. Bayesian Nonparametric Inference for M/G/1 Queueing Systems. *Preprint*.

Project: Inference for Lévy-driven queues by Poisson sampling

In this project we consider estimation problems for the large class of networks of single server queues driven by spectrally-positive Lévy input processes. Using the idea of Poisson probing of the system, the available observation consists of the workload processes at the nodes sampled at Poisson times. The aim is to estimate the characteristic exponent functions of the Lévy input processes. In our approach we have to take into account the dependence between subsequent observations. We distinguish the cases of subordinator inputs and the cases of general spectrally-positive inputs.

Partner: Liron Ravner (University of Amsterdam)

Contact: Cornelia Wichelhaus

References

[1] O. B. Liron Ravner and M. Mandjes. Estimating the input of a Lévy-driven queue by Poisson sampling of the workload process. *Preprint*, 2018.

[2] L. Ravner and C. Wichelhaus. Inference for Lévy-driven queues by Poisson sampling. *in preparation*, 2019.

2 Collaborative Research Projects and Cooperations

The department is involved in a number of interdisciplinary research projects including excellence projects, collaborative research centres and priority programs. This section gives a brief overview of these activities.

2.1 Collaborative Research Centre SFB 666

The Collaborative Research Centre SFB 666 "Integral Sheet Metal Design with Higher Order Bifurcations" (07/2005 to 06/2017), considered the enormous prospective potential of the new linear flow splitting technique for sheet metal and developed methodical tools to integrate this technique into the product development processes. The research center was interdisciplinary, involving mechanical and civil engineers, mathematicians and material scientists.

The investigated technologies of the SFB, linear flow splitting and linear bend splitting, make it possible to produce branched sheet metal products in integral style. Hereby the disadvantages of conventional procedures to create branched sheet metal structures, e.g., gluing or welding, can be avoided. The SFB was structured into the four main units of development, production, evaluation and synthesis. In each of these units, new methodologies, techniques and proceedings arise. They cope with the occurring new requirements of this product category. This interdisciplinary research environment has lead to novel product development methodologies by combining engineering expertise with mathematical modeling and optimization methods.

The Department of Mathematics participated in the SFB 666 within three sub-projects (Kohler, Pfetsch, Ulbrich). The mathematical research concentrated on development and on evaluation. In the product development process, the aim was to provide an optimal design of the desired product as well as an optimal process control of selected forming methods. This was done by means of discrete optimization and PDE-constrained nonlinear optimization. In the evaluation process, statistical methodologies were used to provide estimates for relations between properties of the considered sheet metal part and its structural durability. Thus, a smaller number of costly and time consuming experiments have to be carried out.

2.2 Collaborative Research Centre SFB 805

The Collaborative Research Centre SFB 805 "Control of Uncertainty in Load-Carrying Structures in Mechanical Engineering" was established in January 2009. The third funding period started in January 2017 and runs through 2020. The main objective is the development of methods and techniques to control uncertainties in the development, production and usage of load-carrying structures to significantly enhance their safety, reliability and economic efficiency. While uncertainty cannot be avoided or eliminated, its influence during the product lifecycle – from material properties to production and usage – can be controlled and hence minimized. Especially in the area of light-weight construction, the trade-off between low weight and low production cost on one hand and adequate load-bearing capacity on the other hand makes the influence of uncertainties critical. Hence, the control of uncertainty is of significant importance and is therefore a focus of the research to be conducted by the SFB 805.

The control of uncertainty through the entire process chain of development, production and usage necessitates a close interdisciplinary cooperation of engineers, mathematicians and legal experts. The mathematical research assesses the influence and effects of uncertainty and its interdependencies. It then derives optimal solution strategies for processes with minimal uncertainty and optimal design concepts for load-carrying systems from this. The Department of Mathematics is involved in four projects of SFB 805 (Kohler, Pfetsch, Ulbrich). To deal with uncertainty, the tool of robust optimization is applied, where complex products are optimized while controlling inherent uncertainty already in the product development phase. Uncertainty may occur because of uncertain loadings, uncertain material properties or unknown user behavior. A further source of uncertainty are models that do not adequately describe reality. To detect such model uncertainty, mathematical methods like optimal design of experiments and parameter identification are applied. Furthermore, the SFB 805 examines the use of active elements to react on uncertainty in a load-carrying system. The question of optimal placement of active elements in the structure is a challenging nonlinear mixed-integer optimization problem. Another focus lies in the optimal design of resilient technical systems, which are able to tolerate component failures. Additionally, an attempt is made to control stochastic uncertainty at the planning stage of a product. Therefore knowledge of the effects of unavoidably occurring (random) fluctuations in the production or usage are required. Based on suitable models of the underlying process, methods of nonparametric regression were and will be developed to do this in an efficient way.

2.3 Collaborative Research Centre SFB 1194

The Collaborative Research Centre SFB 1194 "Interaction between Transport and Wetting Processes", established in July 2016, involves researchers from the TU Darmstadt and the Max Planck Institute for Polymer Research Mainz. Their common goal is the fundamental analysis of the interaction between transport and wetting processes. The SFB focuses particularly on the interactions between wetting and transport processes when, parallel to momentum transport, also heat and mass transport occur, complex fluids are involved or complex surfaces are examined. Although the physical phenomena take place only in a range of nanometres or micrometres, they often determine the efficiency of the overall process and the resulting product quality. Therefore, fundamental processes and phenom-

ena are examined over a wide range of length scales (nano-micro-macro) and the transfer of basic research to applications is an integral part of the research program.
The SFB comprises 18 projects in the current first funding period, grouped into three research areas: A – Generic Experiments, B – Modeling and Simulation and C – New and Improved Applications. The Department of Mathematics is involved in three projects of SFB 1194 (Bothe, Ulbrich), which are allocated to research area B.
Research area B includes developments of mathematical models and numerical simulation techniques that describe the interaction of wetting processes with momentum, heat and mass transport, using physics based approaches. These models and simulations are closely linked and validated with the generic experiments performed in research area A. Once validated, these models and simulations are not subjected to the same parameter constraints as the generic experiments, e.g. with respect to resolution or parameter space; hence they contribute essential information to the overall understanding of the phenomena. Based on sensitivity as well as adjoint-based derivative computations, parameter identification, derivative-based optimization, and optimal experimental design are performed. This leads to suggestions for improved designs and process control for specific applications, such as in printing or heat transfer devices. Throughout the future funding periods of the SFB the complexity of the fluids and surfaces being examined will increase.

2.4 Collaborative Research Centre Transregio TRR 146

Multiscale modeling is a central topic in theoretical condensed matter physics and materials science. One prominent class of materials, whose properties can rarely be understood on one length scale and one time scale alone, is soft matter. The properties of soft materials are determined by an intricate interplay of energy and entropy, and minute changes of molecular interactions may lead to massive changes of macroscopic system properties.
In a joint effort of physicists, chemists, applied mathematicians, and computer scientists, the Collaborative Research Center TRR 146 investigates some of the most pressing problems in multiscale modeling, viz.

- Dynamics: In the past, multiscale coarse-graining approaches have to a large extent focused on static equilibrium properties. However, a thorough understanding of the coarse-grained dynamical system properties is necessary if one wants to apply multiscale concepts to the study of transport and nonequilibrium processes.
- Coarse-graining and mixed resolution: In many applications, selected small (e.g., functional) regions of a material must be treated in great detail, whereas the large bulk can be modeled at a coarse-grained level. Simulation schemes are desirable, where fine-grained and coarse-grained regions can dynamically be assigned to the current state of the system. In this context, we will also have to re-analyze fundamental aspects of coarse-graining from a mathematical point of view.
- Bridging the particle-continuum gap: So far, only few successful attempts have been made to combine particle models of soft matter with continuum models in a nontrivial fashion. Multiscale schemes for particle models have mostly been developed in the soft matter community, whereas schemes for treating continuum models with variable resolution are developed in the applied mathematics community. In the CRC-TR, we will bring these two communities together to advance the field as a whole.

Problems addressed in the TRR 146 require a massive interdisciplinary effort at the level of fundamental science and algorithmic development. The TRR 146 brings together scientists with complementary expertise in a wide range of modeling methods. Also one professor of the Department of Mathematics (Egger) is in the group of principal investigators.

2.5 Collaborative Research Centre Transregio TRR 154

The Collaborative Research Centre Transregio TRR 154 "Mathematical Modelling, Simulation and Optimization Using the Example of Gas Networks" was established in 2014 and is after successful evaluation in its second funding period. The energy transition ("Energiewende") in Germany and its success are currently in the focus of public interest. This transition is of central significance to society, politics, and science, since Germany, like many other industrial nations, finds itself in a situation of dramatically increased dependence on a reliable, secure, and affordable energy supply. At the same time, the request for clean, environment- and climate-friendly energy generation is as large as never before. In order to achieve that and, in parallel, to master the nuclear power phase-out, natural gas as an energy source will play a pivotal role in the coming decades. Within this time span, a sufficient amount of natural gas will be available; it will be readily accessible, tradable, and storable. Nevertheless, the focus on an efficient natural gas supply implies a multiplicity of problems concerning gas transport and network technology as well as the consideration of market-regulatory conditions, and also the coupling with other energy sources. As an example, we mention that gas carriers must provide evidence that, within given technical capacities, all contracts which come into existence on the market are physically and technically satisfiable.

The aim of the TRR 154 is to offer answers to these challenges by using methods of mathematical modelling, simulation, and optimization and, in turn, to provide solutions of increased quality. Novel mathematical findings are required in different areas such as mathematical modelling, numerical analysis, simulation and integer, continuous, and stochastic optimization as well as equilibrium problems in order to achieve this aim. As examples, we mention the modelling and analysis of complex networks of hyperbolic balance equations including switches and the development of a mixed-integer optimization theory together with its algorithmic realisation for such networks including the handling of data uncertainty. Furthermore, efficient hierarchical numerical approximation techniques for the resulting algebraically coupled PDEs need to be developed and a sophisticated error control, taking the interaction with the mixed-integer optimization algorithms into account, is required.

The Department of Mathematics at TU Darmstadt is involved with Dr. Domschke and Professors Egger, Lang, Pfetsch, Schwartz, Ulbrich, and Wollner in the collaborative research centre Transregio TRR 154. Furthermore, groups at Universität Erlangen-Nürnberg (speaker), HU Berlin, TU Berlin, Universität Duisburg-Essen, and WIAS – Leibniz-Institut im Forschungsverbund Berlin e.V. are part of TRR 154.

The homepage of TRR 154 is `trr154.fau.de`.

2.6 Graduate School of Computational Engineering

Computational Engineering (CE) denotes computer based modeling, analysis, simulation, and optimization. It is a cost-effective, efficient and complementary approach to study engineering applications and to engineer new technical solutions when experimental investigations are too complex, risky, or costly. CE enables the creation of scalable models to support research, development, design, construction, evaluation, production, and operation of engineering applications which address key issues in future technology developments for the economy and society in areas such as energy, health, safety, and mobility. However, such engineering applications are becoming increasingly complex. Consequently, the theory and methodologies required to investigate corresponding systems become challenging.

With the Graduate School of Computational Engineering, TU Darmstadt was able to further strengthen its role in CE. The school enables highly talented PhD students to develop their scientific skills in a focused way, and to cooperate under optimal conditions in a highly stimulating interdisciplinary environment based on the interaction of Computer Science, Mathematics, and Engineering Sciences. Partnerships with well established research organizations as well as cooperation with industry increase the impact of the Graduate School. Building on the well established interdepartmental expertise at TU Darmstadt, the Graduate School focusses on the following key research areas: modeling and simulation of coupled multi-physics problems, simulation based optimization, and hierarchical multi-scale modeling and simulation. The research efforts in the above fields are accompanied by corresponding developments of methods of visualization, simulated reality, high-performance computing, verification and validation, as well as software engineering and lifecycle research. The PhD students work together within research foci comprising one or more of the above topics. The joint research on specially defined use cases will further strengthen the interdisciplinary skills and cooperation.

Eight professors of the Department of Mathematics are Principal Investigators within the Graduate School Computational Engineering (Aurzada, Bothe, Egger, Giesselmann, Lang, Pfetsch, Ulbrich, Wollner) with expertise in Probability Theory and Stochastic Analysis, Mathematical Modeling and Analysis, Numerical Analysis and Scientific Computing, Numerics of Partial Differential Equations, Discrete Optimization, and Nonlinear Optimization and Optimal Control. Five more members of the department are Research Group Leaders (Disser, Erath, Marschall, Schwartz, Ullmann) with scientific focus on Online Optimization, Numerical Analysis, Two-Phase and Interfacial Flows, Discrete-Nonlinear Optimization, and Uncertainty Quantification. Together they supervise more than 12 interdisciplinary PhD projects within the Graduate School in close cooperation with a co-supervisor from Engineering or Computer Science. The field of Computational Electromagnetics is represented by one research assistant (Dölz), who is also a member of the Darmstadt Mathematical School.

2.7 Graduate School of Energy Science and Engineering

The mission of the Darmstadt Graduate School of Energy Science and Engineering is to educate tomorrow's leading Energy Engineers in a multidisciplinary field of expertise needed to identify and master the most demanding scientific, engineering, economic and social challenges in an interdisciplinary approach. The main challenge is viewed to be a continuous transition from the carbon-based, non-renewable primary energy sources of today to renewable and environmentally friendly energy resources of tomorrow.

The optimal strategy to meet this challenge is, on the one hand, to improve conventional energy technologies and render them progressively more efficient to meet the ever more

stringent demands on pollutant emissions and, on the other hand, to simultaneously develop innovative, advanced renewable energy technologies which must be brought to a competitive technological readiness level and provide safe, reliable and cost-effective solutions.
Two professors of the Department of Mathematics are Principal Investigators within the Graduate School Energy Science and Engineering (Lang, Ulbrich) with expertise in Numerical Analysis, Nonlinear Optimization and Optimal Control.

2.8 International Research Training Group IRTG 1529

The International Research Training Group "Mathematical Fluid Dynamics"(IRTG 1529) is funded by the German Research Foundation (DFG) and the Japan Society for the Promotion of Science (JSPS). It is associated with TU Darmstadt and with two universities located in Tokyo, Waseda University and University of Tokyo.
The research of the program focuses on analytical, numerical and stochastic aspects as well as on modeling, optimization and aerodynamics of fluid dynamics. It distinguishes itself through joint teaching and supervision. The core program consists of interdisciplinary lectures and seminars and includes research and study periods in Tokyo. Presently, there are 12 PhD students and 2 Postdocs on the Darmstadt side and a similar amount on the Japanese side.
The principal investigators in Darmstadt are Volker Betz, Dieter Bothe, Herbert Egger, Reinhard Farwig, Matthias Hieber, Ulrich Kohlenbach, Maria Lukáčová, Cameron Tropea and Stefan Ulbrich. The participating colleagues in Tokyo are Tadahisa Funaki, Yoshikazu Giga, Yosuke Hasegawa, Akitoshi Kawamura, Hideo Kozono, Hirofumi Notsu, Yoshihiro Shibata, Masahiro Yamamoto, Masao Yamazaki and Keita Yokoyama.
IRTG 1529 is organizing seminars, short courses, workshops and conferences on a regular basis in Darmstadt and Tokyo. The list of speakers in 2017 and 2018 includes leading experts of the field, e.g., P. Constantin, R. Danchin, G.P. Galdi, Y. Giga, F. Flandoli, H. Koch, H. Kozono, T. Ogawa, F. Otto, F. Lin, J. Prüss, G. Seregin, G. Simonett, R. Takada, E. Titi and Z. Xin.
Highlights of the program were several conferences or bigger workshops in 2017 and 2018, e.g., the "International Workshops on Mathematical Fluid Dynamics" at Waseda University, Tokyo, in March 2017 and January 2018 and in Darmstadt in May 2018.

2.9 Priority Programme SPP 1740

DFG Priority Program 1740: The Influence of Local Transport Processes on Chemical Reactions in Bubble Flows.
In bubble column reactors a gas phase is dispersed into a liquid so as to provide large interfacial area for mass transfer of gaseous species. In the liquid bulk, chemical conversion takes place. The local interplay of two-phase hydrodynamics, mass transfer and chemical reactions governs the reactor performance, i.e. product yield and selectivity.
The priority program is concerned with new experimental and numerical methods to elucidate the interaction between hydrodynamics and reaction in bubbly flows with focus on the influence of product selectivity. The central objective of the priority program is to design relevant reaction systems and, on this basis, study reactive bubbly systems in detail. Thus, close interaction between engineering, chemistry and mathematics is of particular

importance. Special attention is devoted to local hydrodynamics with turbulence, mass transfer/mass transport, and competitive reaction mechanisms.

The SPP 1740 is coordinated by Michael Schlüter (TU Hamburg-Harburg). The second funding period started in 2017 and runs until 2019. The Department of Mathematics participates in the SPP 1740 with two projects (Bothe, Marschall).

2.10 Priority Programme SPP 1962

Many of the most challenging problems in the applied sciences involve non-differentiable structures as well as partial differential operators, thus leading to non-smooth distributed parameter systems. Those systems are investigated by the DFG Priority Programme 1962 "Non-smooth and Complementarity-based Distributed Parameter Systems: Simulation and Hierarchical Optimization". The non-smoothness considered in this DFG-Priority Programme typically arises (i) directly in the problem formulation, (ii) through inequality constraints, nonlinear complementarity or switching systems, or (iii) as a result of competition and hierarchy.

In fact, very challenging applications for (i) come from frictional contact problems, or non-smooth constitutive laws associated with physical processes such as Bean's critical state model for the magnetization of superconductors, which leads to a quasi-variational inequality (QVI) problem; for (ii) are related to non-penetration conditions in contact problems, variational inequality problems, or inequality constraints in optimization problems which, upon proper re-formulation lead to complementarity problems and further, by means of non-linear complementarity problem (NCP) functions, to non-smooth systems similar to (i); and for (iii) come from multi-objective control systems or leader-follower principles, as they can be found in optimal system design in robotics and biomechanics. Modeling "competition" often leads to generalized Nash equilibrium problems (GNEPs) or partial differential games. Moreover, modeling "hierarchy" results in mathematical programs with equilibrium constraints (MPECs), a class of optimization problems with degenerate, non-smooth constraints. All of these problems are highly nonlinear, lead to QVIs, and represent rather novel mathematical structures in applications based on partial differential operators. In these and related applications, the transition from smoothing or simulation-based approaches to genuinely non-smooth techniques or to multi-objective respectively hierarchical optimization is crucial.

The SPP1962 is coordinated by Michael Hintermüller (HU Berlin/WIAS Berlin). It started in 2016 and runs until 2019, comprising 23 scientific projects in the current first funding period.

The Department of Mathematics participates in the SPP1962 with three projects (Schwartz, Ulbrich, Wollner).

2.11 Research Unit Symmetry, Geometry, and Arithmetic

The DFG Research Unit 1920 "Symmetry, Geometry and Arithmetic" examines current issues in modern arithmetic. An important and key theme is the investigation of absolute Galois groups and their generalizations. These elegantly code arithmetic information which can be extracted through the study of these groups and their representations. The researchers, who are based in Heidelberg and Darmstadt, are hoping that by dovetailing motivic homotopy theory, deformation theory, Iwasawa theory, the theory of automorphic

forms and L-functions, they will be able to draw interesting conclusions from new insight into one of these areas which they can apply to the others, in a contemporary vision and modern understanding of basic mathematical research.
As a principal investigator Jan Bruinier is part of this research unit with a project centered around special cycles on the moduli space of abelian surfaces and their connections with L-functions. The spokesperson is Alexander Schmidt from the Universität Heidelberg.

2.12 LOEWE Research Unit USAG: Uniformized Structures in Arithmetic and Geometry

The LOEWE research unit Uniformized Structures in Arithmetic and Geometry (USAG) aims at joining the broad expertise of TU Darmstadt and GU Frankfurt in the fields of number theory and arithmetic/algebraic geometry. The spokesperson is Jan H. Bruinier.
The concept of uniformization, which goes back to famous works by Riemann and Klein from the 19th century, makes it possible to replace a complicated geometric space with a much simpler one without changing the local structure. The complexity is then described with inner symmetries of the simpler space. This basic idea has proven to be very effective. The aim of the LOEWE research unit is to gain new insights into current arithmetic and geometric classification problems by combining different techniques of uniformization.
Our research program focuses on the following three research areas: A Special Subvarieties, B Automorphic Forms, and C Variation of Geometry.
In research area A we explore Orthogonal Shimura Varieties and the Kudla Conjecture, in research area B we investigate Borcherds-Products as well as Vertex Algebras, and in research area C we study the Uniformization of Spherical Varieties, the Anabelian Section Conjecture, as well as Tropical Moduli Spaces. The research areas A, B, and C are mutually interconnected and techniques of uniformization are crucial in our research approaches.

2.13 Scientific and Industrial Cooperations

In the following we list all scientific and industrial projects by names of the researcher of our department in alphabetic order, by names of partners in universities and industry, and the title of the project.

Frank Aurzada

- Prof. Dr. Amir Dembo (Stanford University): Research on Gaussian processes.
- Dr. Alexis Devulder (University of Versailles): Research on persistence probabilities.
- Prof. Dr. Ohad Feldheim (Hebrew University, Jerusalem): Research on Gaussian processes.
- Dr. Naomi Feldheim (Weizmann Institute): Research on Gaussian processes.
- Prof. Dr. Fuchang Gao (University of Idaho): Research on Gaussian processes.
- Dr. Nadine Guillotin-Plantard (Claude Bernard University Lyon 1): Research on persistence probabilities.
- Prof. Dr. Mikhail Lifshits (St. Petersburg State University): Research on Gaussian processes and stochastic geometry.

- Prof. Dr. Sumit Mukherjee (Columbia University): Research on Gaussian processes.
- Prof. Dr. Françoise Pène (University of Western Brittany, Brest): Research on persistence probabilities.
- Prof. Dr. Thomas Simon (University of Lille): Research on Gaussian processes.
- Prof. Dr. Ofer Zeitouni (Weizmann Institute): Research on Gaussian processes.

Volker Betz

- Dr. Daniel Ueltschi (University of Warwick): Spatial random permutations and Bose-Einstein condensation.
- Prof. George Hagedorn (Virginia Tech): Nonadiabatic Transition through Born-Oppenheimer surfaces.
- Prof. Erwin Bolthausen (University of Zürich): Enhanced binding via path integrals.
- Prof. Peter Moerters (Universität zu Köln): Universal shape of condensing waves.
- Prof. Steffen Dereich (Universität Münster): Universal shape of condensing waves.
- Dr. Stephane Le Roux (University of Paris, Cachan): Metastability in Markov Chains.
- Dr. Benjamin Goddard (University of Edinburgh): Nonadiabatic Transition through Born-Oppenheimer surfaces.
- Dr. Dirk Zeindler (University of Lancaster): Cycle counts in random permutations.

Dieter Bothe

- Freudenberg New Technologies SE & Co. KG: Simulation of viscoelastic flows with OpenFOAM.
- Prof. Dr. Wolfgang Dreyer (WIAS Berlin): Continuum thermodynamics of viscoelastic fluids.
- Prof. Dr. Michael Schlüter (Institut für Mehrphasenströmung, TU Hamburg-Harburg): Numerical and experimental analysis of reactive mass transfer at bubbles.
- Prof. Dr. Michel Pierre (ENS Cachan, Antenne de Bretagne): Modeling and analysis of reaction-diffusion systems.
- Prof. Dr. Jan Prüss (Universität Halle-Wittenberg): Analysis of two-phase fluid systems with mass transfer.
- Prof. Dr. Günter Brenn (TU Graz): Numerical and experimental analysis of bubbles rising in viscoelastic liquids.
- Prof. Dr. Josef Malek, Dr. Ondrej Soucek (Charles University Prague): Mathematical modeling of heterogeneous catalysis.
- Prof. Dr. Jürgen Saal (Universität Düsseldorf): Analysis of reaction-diffusion-sorption systems.

- Dr. Matthias Köhne (Universität Düsseldorf): Analysis of reaction-diffusion-sorption systems, analysis of dynamic contact lines.
- Dr. Kathrin Schulte (Universität Stuttgart): Direct Numerical Simulation of binary droplet collisions.
- Dr. Masahiro Kunimoto (Waseda University): Modeling of liquid-liquid interfacial reaction mechanism of boric acid esterification.

Regina Bruder

- Ministry of Education Hesse and Lower Saxony: Development of concepts for further teacher training, project MAKOS (Hesse; projects), LEMAMOP, TANS and ELMA (Lower Saxony).
- Studienseminar Darmstadt, Dr. Alexander Best and Frank Dill and Studienseminar Kassel, Karl-Friedrich Gründer: Project MAKOS – Development of Mathematical Competencies on Upper Secondary Level.
- Prof. Dr. Wolfram Koepf (Universät Kassel) and Prof. Dr. Rolf Biehler (Universät Paderborn) and Prof. Dr. Reinhard Hochmuth (Universät Hannover): Project VEMINT, Development of bridge courses in mathematics.
- Dr. Eva Sattlberger and Dr. Jan Steinfeld (Ministry of Education Vienna, Austria), Prof. Dr. Tina Hascher (Universät Bern, Switzerland, Dr. Torsten Linnemann (Universät Basel, Switzerland), Prof. Dr. Stefan Siller (Universät Würzburg): O-M-A: project for modelling competencies for the examination MATURA in Austria.
- Prof. Dr. Vincent Geiger, ACU Brisbane, Australia: DAAD-project about the development of challenging learning tasks in digital learning environments.
- DZLM (Deutsches Zentrum für Lehrerbildung Mathematik): Online teachertraining courses for teachers in service.
- Prof. Dr. Olaf Koeller (IPN Kiel) and expert group: Scientific company of mathematics lessons in Hamburg.

Jan H. Bruinier

- Prof. Dr. B. Howard (Boston College) and Prof. Dr. T. Yang (University of Wisconsin at Madison): Arithmetic intersection theory on Shimura varieties.
- Prof. Dr. J. Funke (University of Durham) and Prof. Dr. O. Imamoglu (ETH Zürich): Regularized theta liftings and periods of modular functions.
- Prof. Dr. E. Freitag (Universität Heidelberg): Automorphic products.
- Prof. Dr. S. Kudla (University of Toronto): Green currents and Whittaker functions.
- Prof. Dr. T. Yang (University of Wisconsin): Arithmetic Siegel-Weil formulas.
- Prof. Dr. M. Möller (Universität Frankfurt): Cones of effective divisors.

Aday Celik

- Prof. Dr. M. Kyed (Hochschule Flensburg): Resonance in hyperbolic-parabolic coupled systems.
- Dr. M. Braukhoff (TU Wien): Elliptic systems in divergence form.

Karoline Disser

- J. Rehberg (WIAS Berlin): Elliptic and parabolic problems in rough settings.
- A.F.M. ter Elst (University of Auckland): Elliptic and parabolic problems in rough settings.
- T. Takahashi (University of Nancy): Fluid-structure interaction.
- A. Mielke (WIAS und HU Berlin): Kolmogorov equations.
- M. Thomas (WIAS Berlin): Bulk-interface interaction.
- H. Meinlschmidt (RICAM Linz): Parabolic PDEs and optimal control.

Yann Disser

- Prof. Dr. Aaron Bernstein (Rutgers University): Incremental Maximization.
- Dr. Jérémie Chalopin (Aix-Marseille University): Graph Exploration and Delivery.
- Prof. Dr. Andreas Feldmann (Charles University): Highway Dimension.
- Dr. Oliver Friedmann (LMU München): Simplex Algorithm.
- Dr. Martin Groß (RWTH Aachen): Incremental Maximization.
- Prof. Dr. Max Klimm (HU Berlin): Graph Exploration, Secretary Leasing.
- Prof. Dr. Adrian Kosowski (Paris Diderot University): Collaborative Exploration.
- Prof. Dr. Stefan Kratsch (HU Berlin): Robust Search.
- Prof. Dr. Jannik Matuschke (KU Leuven): Robust Flows.
- Prof. Dr. Nicole Megow (Universität Bremen): Scheduling.
- Prof. Dr. Matúš Mihalák (Maastricht University): Graph Exploration and Delivery.
- Dr. Kevin Schewior (ENS Paris): Online Dial-a-Ride.
- Dr. Miriam Schlöter (ETH Zürich): Online Dial-a-Ride.
- Prof. Dr. Martin Skutella (TU Berlin): Simplex Algorithm, Network Flows.
- Prof. Dr. Angelika Steger (ETH Zürich): Collaborative Exploration.
- Prof. Dr. Leen Stougie (CWI Amsterdam): Online Dial-a-Ride.
- Dr. Przemysław Uznański (ETH Zürich): Collaborative Exploration.

- Dr. Anna Zych-Pawlewicz (University of Warsaw): Interval Coloring.

Jürgen Dölz

- Prof. Dr. Helmut Harbrecht (Universität Basel): Software cooperation on boundary element methods.
- Prof. Dr. Michael Multerer (USI Lugano, Switzerland): Software cooperation on boundary element methods.
- Group of Prof. Dr. Sebastian Schöps (Institut für Theorie Elektromagnetsicher Felder, TU Darmstadt): Software cooperation on boundary element methods.

Pia Domschke

- Prof. Dr. Mark A. J. Chaplain (University of St. Andrews, UK), Dr. Dumitru Trucu (University of Dundee, UK), Dr. Alf Gerisch (TU Darmstadt): Mathematical Modelling of Cancer Invasion.
- Jun.-Prof. Dr. Oliver Kolb (Universität Mannheim): Simulation and optimization of gas and water supply networks.

Herbert Egger

- Prof. Dr. Simon Arridge, Dr. Samuel Powell (UCL London, UK), Prof. Dr. Matthias Schlottbom (University of Twente, The Netherlands): Numerical methods for radiative transfer.
- Prof. Dr. Jan-Frederik Pietschmann (TU Chemnitz), Prof. Dr. Matthias Schlottbom (University of Twente, The Netherlands): Parameter estimation for nonlinear inverse problems.
- Prof. Dr. Bernd Hofmann (TU Chemnitz): Conditional stability and regularization of inverse problems.
- Prof. Dr. Volker Mehrmann (TU Berlin): Structure preserving approximation of Hamiltonian systems.
- Prof. Dr. Andreas Hildebrandt (Universität Mainz), Prof. Dr. Günther Of (TU Graz): Numerical approximation of non-local diffusion processes.
- Prof. Dr. Martin Schmidt (Universität Trier): Global optimal control of linear dynamical systems.

Thomas Eiter

- Prof. Dr. M. Kyed (Hochschule Flensburg): Time-periodic Navier–Stokes equations.
- Prof. Dr. Y. Shibata (Waseda University, Tokyo): Steady and time-periodic motion of liquid drops.
- Prof. Dr. G. P. Galdi (University of Pittsburgh): Asymptotic structure and bifurcation phenomena for fluid flow around an obstacle.

Christoph Erath

- Prof. Dr. Dirk Praetorius (TU Wien): Optimal convergence of adaptive mesh refinement schemes.
- Prof. Dr. Olaf Steinbach (TU Graz): Coupling FEM-BEM.

Tristan Gally

- Daniel Rehfeldt (TU Berlin), Dr. Yuji Shinano (Zuse Institut Berlin): Parallelization of Combinatorial Optimization Problem Solvers.

Alf Gerisch

- Prof. Dr. Mark A. J. Chaplain (University of St. Andrews, UK), Dr. Dumitru Trucu (University of Dundee, UK), Dr. Pia Domschke (TU Darmstadt), Prof. Dr. Kevin J. Painter (Heriot-Watt University, Edinburgh, UK), Prof. Dr. Thomas Hillen (University of Alberta, Canada), Dr. Andreas Buttenschön (UBC Vancouver, Canada): Mathematical Modelling of Cancer Invasion.
- Prof. Dr. Kai Raum (Charité Universitätsmedizin Berlin), Prof. Dr. Quentin Grimal (Biomedical Imaging Lab, UPMC Paris, France), Dr. Raimondo Penta (University of Glasgow, UK): Multiscale structure-functional modelling of musculoskeletal mineralized tissues.
- Prof. Dr. Jens Lang (TU Darmstadt), Prof. Dr. Rüdiger Weiner, Dr. Helmut Podhaisky (Universität Halle-Wittenberg): Peer methods and their application in the Finite Element system KARDOS.
- Prof. Dr. Anotida Madzvamuse (University of Sussex, UK), Dr. Raquel Barreira (Polytechnic Institute of Setubal, Portugal): Cross-diffusion in models from mathematical biology.

Jan Giesselmann

- Group of Prof. Dr. Christian Rohde (Universität Stuttgart): Uncertainty quantification in hyperbolic conservation laws.
- Prof. Dr. Andreas Dedner (University of Warwick, UK), Prof. Dr. Jennifer Ryan (University of East Anglia, UK), Prof. Dr. Tristan Pryer (University of Reading, UK): Reconstruction techniques for energy-based a posteriori error estimates.
- Dr. Rüdiger Müller (WIAS Berlin): Robust a posteriori error estimates for compressible multiphase flows.
- Dr. Raul Borsche (TU Kaiserslautern): A posteriori analysis for hyperbolic conservation laws on networks.
- Group of Prof. Dr. Manuel Torrilhon (RWTH Aachen): Moment methods for kinetic equations.

Karsten Große-Brauckmann

- Prof. Dr. John Sullivan (TU Berlin): Networks and lattices.
- Prof. Dr. Robert Kusner (University of Massachusetts at Amherst): Constant mean curvature surfaces.
- Prof. Dr. Steffen Fröhlich (Universität Mainz): Minimal surfaces.

Robert Haller-Dintelmann

- Felix Ali Mehmeti and Virginie Régnier (University of Valenciennes, France): The Klein-Gordon equations on a star-shaped network.
- Russell Brown (University of Kentucky, Lexington, KY, USA) and Patrick Tolksdorf (University of Paris-Est): The Jones extension operator for mixed boundary conditions.

Christopher Hojny

- Dr. Imke Joormann (TU Braunschweig), Prof. Dr. Martin Schmidt (Universität Erlangen-Nürnberg): Connected Graph Partitioning.
- Dr. Matthias Walter (RWTH Aachen): Linearizations of Polynomials over Binary Variables.

Amru Hussein

- Prof. Dr. Y. Giga (University of Tokyo): Cooperation on the analysis of the primitive equations.
- Dr. A. P. Choudhury (Universität Linz): Cooperation on the analysis of the nematic liquid crystals.
- Prof. Dr. D. Mugnolo (Fernuniversität Hagen): Cooperation on the analysis on graphs and networks.

Ulrich Kohlenbach

- PD Dr. M. Bačák (MPIM Leipzig): On proximal mappings with Young functions in uniformly convex Banach spaces.
- Dr. M. Fujiwara (Waseda U): Interrelation between weak fragments of double negation shift and related principles.
- Prof. Dr. G. Lopéz-Acedo and Dr. A. Nicolae (University of Sevilla): Moduli of regularity and rates of convergence for Fejer monotone sequences.
- Prof. Dr. G. Lopéz-Acedo and Dr. A. Nicolae (University of Sevilla): A quantitative analysis of the 'Lion-Man' game.

Michael Kohler

- Prof. Dr. Adam Krzyżak (Concordia University, Montreal): Estimating quantiles in imperfect simulation models using conditional density estimation.
- Prof. Dr. Harro Walk (Universität Stuttgart): Strong universal consistency of local averaging regression estimates.
- SFB 666 (TU Darmstadt): Estimation of the random behaviour of fatigue parameters.
- SFB 805 (TU Darmstadt): Efficient estimation of uncertainty of technical systems.

Burkhard Kümmerer

- Prof. Dr. G. Alber (Fachbereich Physik, TU Darmstadt): Quantum Markov Processes.
- Prof. Dr. J. Fröhlich (ETH Zürich): Quantum Measurement.
- Prof. Dr. R. Gohm (Aberystwyth): Quantum System Theory, Quantum Markov Processes.
- Prof. Dr. H. Maassen (Nijmegen): Quantum Probability.

Jens Lang

- Prof. Dr. Willem Hundsdorfer (CWI Amsterdam, The Netherlands): IMEX Peer methods.
- Prof. Dr. Weizhang Huang (University of Kansas, USA), Lennard Kamenski (WIAS Berlin): Anisotropic mesh methods.
- Prof. Dr. Rüdiger Weiner (Universität Halle-Wittenberg): IMEX Peer methods.
- Prof. Dr. Michael Hinze, Carmen Gräßle (Universität Hamburg): Model reduction for incompressible flow.
- Prof. Dr. Robert Scheichl (Universität Heidelberg): Uncertainty quantification.
- Prof. Dr. Volker Mehrmann (TU Berlin): Model hierarchy for gas networks.
- Prof. Dr. Malte Braack (Universität Kiel): Adaptive moving FEM for compressible combustion.
- Dr. Rainald Ehrig (ZIB): Kardos programming.

Yingkun Li

- Dr. Shaul Zemel (Hebrew University, Jerusalem): Research on modular forms.
- Prof. Dr. Jens Funke (Durham University, UK): Research on modular forms.
- Prof. Dr. Özlem Imamoḡlu (ETH, Zurich): Research on modular forms.
- Prof. Dr. Hiro-aki Narita (Waseda University, Tokyo): Research on modular forms.

– Prof. Dr. Ameya Pitale (University of Oklahoma, USA): Research on modular forms.

Jolanta Marzec

– Dr. T. Bouganis (Durham University): Properties of the standard L-function attached to Siegel-Jacobi modular forms.

Hannes Meinlschmidt

– Apl. Prof. Dr. Dirk Horstmann (Universität Köln), Dr. Joachim Rehberg (WIAS Berlin): Well-Posedness of the Full Keller-Segel Model.

– Prof. Dr. Robert Haller-Dintelmann (TU Darmstadt), Prof. Dr. Winnifried Wollner (TU Darmstadt): Higher Regularity for Solutions to Elliptic Systems in Divergence Form subject to Mixed Boundary Conditions.

– Dr. Karoline Disser (TU Darmstadt), Dr. Joachim Rehberg (WIAS Berlin): Maximal Regularity for Nonsmooth Parabolic Systems.

Marc Pfetsch

– Prof. Dr. Max Klimm (HU Berlin): Algorithms for Gas Transport Optimization.

– Prof. Dr. Martin Haardt (TU Ilmenau): Compressed Sensing in Signal processing.

– Prof. Dr. Alexander Martin (Universität Erlangen-Nürnberg): Gas Transport Optimization.

– Prof. Dr. Sebastian Pokutta (Georgia Tech., Atlanta, USA): Methods for Integer Programs.

– Prof. Dr. Marius Pesavento (TU Darmstadt): Mixed-Integer Programs in Signal Processing.

– Prof. Dr. Giovanni Rinaldi (IASI Rome): Separation of Oracle-Based Cutting Planes.

– Prof. Dr. Martin Skutella (TU Berlin): Algorithms for Gas Transport Optimization.

Anna-Maria von Pippich

– Prof. Dr. K. Bringmann (Universität Köln): Higher Green's functions.

– Dr. S. Herrero (University Gothenburg): Mock modular forms.

– Prof. Dr. Ö. Imamoglu (ETH Zürich): Hyperbolic Jensen formula.

– Prof. Dr. J. Kramer (HU Berlin): Bounds on Arakelov invariants.

– Dr. G. Freixas i Montplet (CNRS Paris): Arithmetic Riemann–Roch theorems.

– Prof. Dr. Ä. Toth (ETH Zürich): Hyperbolic Jensen formula.

Anne-Therese Rauls

- Prof. Dr. Gerd Wachsmuth (TU Chemnitz): Generalized Derivatives for the Solution Operator of the Obstacle Problem.

Steffen Roch

- Prof. Dr. Bernd Silbermann (TU Chemnitz): Operator theory and numerical analysis.
- Prof. Dr. Vladimir S. Rabinovich (IPN Mexico/City): Limit operators and their applications to the spectral theory of PDE.

Martin Saal

- Prof. Dr. F. Flandoli (Scuola Normale Superiore di Pisa): Stochastic aspects of geophysical PDEs.

Nils Scheithauer

- Prof. Dr. R. Borcherds (University of California, Berkeley): Automorphic forms and vertex algebras.
- Prof. Dr. J. van Ekeren, (Fluminense Federal University, Rio de Janeiro): Vertex algebras and Lie algebras.
- Prof. Dr. E. Freitag (Universität Heidelberg): Automorphic forms.
- Prof. Dr. V. Gritsenko (University of Lille 1 and National Research University HSE, Moscow): Automorphic forms.
- Prof. Dr. G. Höhn (Kansas State University, Manhattan): Vertex algebras and Lie algebras.
- Prof. Dr. M. Möller (Universität Frankfurt): Automorphic forms.
- Prof. Dr. S. Möller (Rutgers University, Piscataway): Automorphic forms and vertex algebras.
- Prof. Dr. R. Salvati Manni (La Sapienza, Rome): Automorphic forms.

Kersten Schmidt

- Group of Prof. Dr. Reinhold Schneider (TU Berlin): High-order finite element modelling in Quantum Physics.
- Group of Prof. Dr. Volker Mehrmann (TU Berlin): Parametric and nonlinear eigenvalue problems.
- Groups of Prof. Dr. Luka Grubišić and Prof. Dr. Josip Tambača (University of Zagreb, Croatia): Nonlinear eigenvalue problems and model reduction techniques for biomechanical devices.

- Prof. Dr. Patrick Joly (INRIA Paris-Saclay, France), Prof. Dr. Monique Dauge (University of Rennes 1, France), Dr. Bérangère Delourme (University of Paris 13, France), Dr. Sébastien Tordeux (INRIA Bordeaux South-West, France): Impedance boundary conditions for PDEs with boundary layers.
- Prof. Dr. Ralf Hiptmair (ETH Zürich): Modelling in electromagnetics and boundary element methods.
- Prof. Dr. Antoine Laurain (University of São Paulo, Brazil): Shape optimization.

Alexandra Schwartz

- RNDr. Martin Branda Ph.D. (Czech Academy of Sciences): Portfolio Optimization using Modern Risk Measures.
- RNDr. Michal Červinka Ph.D. (Czech Academy of Sciences): Portfolio Optimization using Modern Risk Measures.
- Prof. Dr. Christian Kanzow (JMU Würzburg): Sparse Optimization.
- Dr. Sonja Steffensen (RWTH Aachen): Multi-Leader-Follower Games in Function Space.
- Prof. Dr. Martin Schmidt (Universität Trier): Optimal Booking Decisions in Gas Trade.
- Dr. Lars Schewe (Universität Erlangen-Nürnberg): Optimal Booking Decisions in Gas Trade.
- Prof. Dr. Gregor Zöttl (Universität Erlangen-Nürnberg): Optimal Booking Decisions in Gas Trade.
- Prof. Dr. Veronika Grimm (Universität Erlangen-Nürnberg): Optimal Booking Decisions in Gas Trade.
- Group of Prof. Dr. Anja Klein (TU Darmstadt): Computation Offloading.
- Prof. Dr. Anne Lange: A Game Theoretic Model for Vanilla Harvesting.

Andrei Sipoş

- Laurenţiu Leuştean (University of Bucharest): Proximal point algorithm.
- Adriana Nicolae (Babeş-Bolyai University, Cluj): Proximal point algorithm.

Christian Stinner

- Prof. Dr. Tomasz Cieślak (Polish Academy of Sciences, Warsaw): Blow-up in Keller-Segel models.
- Dr. Philippe Laurençot (Directeur de Recherches CNRS, University Paul Sabatier of Toulouse): Extinction in diffusive Hamilton-Jacobi equations.
- Prof. Dr. Mária Lukácová (Universität Mainz): Multiscale models for tumor cell migration.

– Dr. Nikolaos Sfakianakis (Universität Heidelberg): Multiscale models for tumor cell migration.

– Prof. Dr. Christina Surulescu (TU Kaiserslautern): Multiscale models for tumor cell migration.

– Prof. Dr. Michael Winkler (Universität Paderborn): Chemotaxis models.

Stefan Ulbrich

– Prof. Dr. Herbert de Gersem (TU Darmstadt): Optimization under Uncertainty.

– Prof. Dr. Serge Gratton (INP ENSEEIHT Toulouse): Subspace Decomposition Methods for Optimization.

– Prof. Dr. Peter Groche (TU Darmstadt): Identification of Model Uncertainty.

– Prof. Dr. Martin Gugat (Universität Erlangen-Nürnberg): Optimal Control of Hyperbolic Conservation Laws.

– Prof. Dr. Matthias Heinkenschloss (Rice University): PDE-Constrained Optimization.

– Prof. Dr. Michael Hintermüller (WIAS Berlin): Optimal Control of Hyperbolic Conservation Laws.

– Prof. Dr. Michael Hinze (Universität Hamburg): Model Order Reduction in Optimization.

– Prof. Dr. Alexander Martin (Universität Erlangen-Nürnberg): Gas Transport Optimization.

– Prof. Dr. Sebastian Schöps (TU Darmstadt): Optimization under Uncertainty.

– Prof. Dr. Michael Ulbrich (TU München): PDE- and VI-Constrained Optimization.

– Prof. Dr. Stefan Volkwein (Universität Konstanz): Model Order Reduction in Optimization.

Sebastian Ullmann

– Prof. Dr. Michael Hinze, Carmen Gräßle (Universität Hamburg): Model reduction for incompressible flow.

Mirjam Walloth

– Prof. Dr. Thomas Wick (Universität Hannover), Prof. Dr. Winnifried Wollner (AG Optimierung, TU Darmstadt), Katrin Mang (Universität Hannover): Adaptive numerical simulation of quasi-static fracture phase-field models.

– Prof. Dr. Andreas Veeser (University of Milano, Italy): A posteriori error estimators for contact problems.

– Prof. Dr. Rolf Krause (USI Lugano, Switzerland): Adaptive finite element discretization methods for the numerical simulation of static and dynamic contact problems.

Torsten Wedhorn

- Paul Ziegler (University of Oxford): Research cooperation.
- Jean-Stefan Koskivirta (University of Tokyo): Research cooperation.

Cornelia Wichelhaus

- Dr. Sebastian Schweer (1&1 Telecommunication SE): Functional limit theorems for queueing systems.
- Dr. Moritz von Rohrscheidt (Universität Heidelberg): Bayesian nonparametric inference for queues.
- Dr. Liron Ravner (University of Amsterdam): Inference for Lévy-driven queues by Poisson sampling.

Winnifried Wollner

- Prof. Dr. Jörn Behrens (Universität Hamburg): Goal-Oriented Adaptivity for Hyperbolic PDEs.
- Prof. Dr. Roland Herzog (TU Chemnitz): A Conjugate Direction Method for Linear Systems in Banach Spaces.
- Prof. Dr. Christian Kreuzer (TU Dortmund): Finite Element Approximation of PDE Constrained Optimization Problems.
- Prof. Dr. Ulrich Langer (Universität Linz): Numerical Methods for Phase-Field Fracture.
- Dr. Alexander Linke (WIAS Berlin): Pressure-Robust Stokes Elements.
- Dr. Hannes Meinlschmidt (RICAM Linz): Regularity of Elliptic Systems.
- Dr. Christian Merdon (WIAS Berlin): Pressure-Robust Stokes Elements.
- Prof. Dr. Ira Neitzel (Universität Bonn): Optimizing Fracture Propagation Using a Phase-Field Approach.
- Prof. Dr. Thomas Richter (Universität Magdeburg): Numerical Methods for Time Periodic Problems.
- Prof. Dr. Martin Schmidt (Universität Erlangen-Nürnberg): Global Mixed-Integer Nonlinear Optimization.
- Prof. Dr. Andreas Veeser (University of Milan): Finite Element Approximation of PDE Constrained Optimization Problems.
- Prof. Dr. Thomas Wick (Universität Hannover): Optimizing Fracture Propagation Using a Phase-Field Approach.

3 Teaching

Teaching of mathematics in our department can be divided into three categories: teaching in mathematical degree programmes, specific teaching activities for future mathematics teachers (in secondary education), and teaching mathematics to students in the sciences and engineering subjects (often described as ‘service teaching’). Each of these teaching activities has its own characteristics in terms of mathematical content and style as well as in terms of specific regulations of corresponding degree schemes.

3.1 Degree Programmes in Mathematics

There are currently three mathematics programmes: the Diplom programme in mathematics (being discontinued), the Bachelor programme in mathematics (since 2007) and the Master programme in mathematics (since 2005). With the winter term 2018/19 the English-taught Master’s degree programme in mathematics has started. The following table shows the enrolement numbers over the last 8 years:

Students in Mathematics programmes
(Source: Data Warehouse (DW), 22.02.2019)

Programme	2011	2012	2013	2014	2015	2016	2017	2018
Diplom	151	88	58	35	13	4	3	1
Bachelor	674	629	646	581	535	518	480	435
Master	141	189	224	276	309	292	274	251
Teacher (secondary)	417	398	380	351	335	289	270	227
Teacher (vocational)	47	42	41	23	18	18	15	12

There are some special circumstances besides aspects of demographic change to explain some of the fluctuations of these numbers. Among these are the nearly two-fold increase in students finishing school in Bavaria (2011) and Baden-Württemberg (2012) caused by the transition from 13 to 12 school years, the last conscription calls in Germany in 2011, and the introduction of an aptitude test (“Eignungsfeststellungsverfahren”) for our Bachelor and Teacher programmes from the academic year 2011/12. The aptitude test has been reworked effictive for enrolment in winter semester 2016/17 to simplify the admission criteria. In 2012, it was also decided to discontinue enrolment of students beginning in the summer semester, and as of the summer of 2013 we do not offer enrolment for students beginning our Bachelor programme in a summer semester.

New enrolments
(Source: Data Warehouse (DW), 22.02.2019)

Programme	2011	2012	2013	2014	2015	2016	2017	2018
Bachelor	275	173	177	150	122	126	120	134
Master (incl. Engl. Master)	58	68	73	94	96	89	86	79
Teacher (secondary)	72	56	54	40	48	45	39	47
Teacher (vocational)	15	13	8	2	5	7	5	4

Looking at the number of students who turned up for their courses, it seems that the introduction of the aptitude test has a stronger effect on our Teaching programme than on our Bachelor programmes. We suspect that in both tracks it largely discourages some of the more weakly motivated students from applying, and especially those who might not have the intention to pursue university studies seriously.

With the start of the Master programme in mathematics, accredited and started in the year 2005, and with the Bachelor programme in mathematics, accredited and started in the year 2007, the department completed the implementation of the Bologna Accord. The new programme structure replaces the Diplom programme and incorporates the previous Bachelor programme "Mathematics with Computer Science". With the academic year 2011/12, the study regulations for the Bachelor and Master programmes were modified, and the corresponding accreditations were successfully renewed until September 30, 2017, and became effective on October 1, 2018. Due to the interdependencies between our Bachelor programme and our Teaching programme, also the study regulations for the latter had to be revised (with effect from the academic year 2017/18).

The main aspects in the design of the current programme structure could be described as both modern and conservative at the same time. A more detailed look at both programmes resolves this apparent contradiction. They combine proven and tested components of the Diplom programme with new aspects such as modularization and a credit point system. The new programme retains the idea that mathematics should be studied together with a minor, which is typically a subject in which mathematics is applied. The standard choice of a minor can be one of computer science, economics, physics, chemistry or, since 2018, mechanics. Further subjects are available upon application. If students choose the option "Mathematics with Economics" (available both for Bachelor and Master), their minor is a combination of economics and computer science.

The Bachelor programme has a duration of 6 semesters and finishes with a Bachelor thesis on a mathematical topic. A unique feature of our Bachelor programme are the optional bilingual courses. Both options "Mathematics" (with arbitrary minor) and "Mathematics with Economics" can be studied as a bilingual programme since 2009.
According to a survey during the orientation week in the winter semester 2017/18, about 33 % among the 118 Bachelor students interviewed expressed the intension of obtaining the bilingual certificate.

Graduates of the Bachelor programme have the option of taking up a job or continuing their studies in a Master programme. This can be the Master programme at our department, at a different university or even a Master programme in a different area based on their education in mathematics.

Our Master programme has a duration of 4 semesters. It is centred on two in-depth specializations or focus areas within mathematics or, alternatively, one focus area in mathematics and one in a cognate subject in which mathematics is applied (such as computer science, economics, physics, chemistry or, since 2018, mechanics). The mathematical specializations (Vertiefungsrichtungen) are offered by the research groups in the department. Beside the two focus areas (at 18 CP each), there is room for additional courses in mathematics, minors and general studies. The topic of the Master thesis is selected in one of the two focus areas; in the case of a combination with an extra-mathematical focus area, the topic of the Master thesis may be chosen from that other subject but has to be related to mathematics.

With the academic year 2018/19 we launched an English-taught Master's degree programme in Mathematics. Its structure is close to the German-taught Master. Deviating from the mandatory minor, the students can choose between taking a minor or a third mathematical specialization.

Graduates of the Bachelor programme (incl. MCS)
(Source: Data Warehouse (DW), 22.02.2019)

Programme	2012	2013	2014	2015	2016	2017
Total	80	87	122	90	73	83
Female students	24	29	38	30	24	26
Graduation within 3 years	33	48	51	31	20	25
Graduation within 4 years	71	71	107	68	48	61

Graduates of the Master programme
(Source: Data Warehouse (DW), 22.02.2019)

Programme	2012	2013	2014	2015	2016	2017
Total	27	46	49	68	89	83
Female students	5	19	18	24	25	35
Graduation within 2 years	18	23	19	22	32	11
Graduation within 3 years	22	40	40	55	72	57

Graduates in Education for Secondary Schools
(Source: Data Warehouse (DW), 22.02.2019)

Programme	2012	2013	2014	2015	2016	2017
Total	6	10	18	18	18	13
Female students	4	5	8	9	6	8
Graduation within 9 semesters	0	0	2	3	1	1
Graduation within 11 semesters	2	2	5	7	7	4

Graduates in Education for Vocational Colleges
(Source: Data Warehouse (DW), 22.02.2019)

Programme	2010	2011	2012	2013	2014	2015
Total	7	10	11	6	7	7
Female students	0	4	5	2	3	3
Graduation within 4 semesters	3	6	7	0	1	0
Graduation within 6 semesters	6	10	10	5	4	3

International exchange

Many students choose to study at a university abroad for one or two terms, typically in their third year.
The department provides general information (online and through an annual information event) as well as individual advice for students who plan a period of time abroad and also maintains contacts with various popular destinations abroad. Students who return after their time abroad are encouraged to share their experiences through short summaries with informal advice on the departmental web pages.
Close cooperation between the students and the department facilitates the transfer of their credits from abroad into their study programme in Darmstadt. This helps to avoid negative effects on the overall duration of studies.

Academic year	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18
Erasmus outgoers	11	18	15	11	8	27	13	12
Further outgoers	8	13	9	7	7	12	7	7
Incomers	2	5	8	3	2	5	4	4

3.2 Teaching for Other Departments

Students in almost all study programmes of this university have to take at least one course in mathematics. The department teaches students in the engineering sciences (mechanical, electrical, civil engineering, material sciences), in computer science, the natural sciences (chemistry, physics, biology, geology), economics, the liberal arts, social sciences and in architecture.

Service teaching comprises courses of a variety of different formats. There are large lecture courses providing a solid foundation in mathematics covering subjects such as basic analysis (calculus), differential equations, numerical methods and stochastics. For instance, there is a four semester cycle for students of Electrical Engineering, with 4 hours of lectures and 2 hours of exercise groups per week. There are also smaller courses, concentrating on special areas in mathematics used in particular disciplines, as, for instance, our one-semester statistics courses for students in Biology or the social sciences. In an innovative format (Team Teaching), the course “Mathematik für Chemiker” is taught jointly by a mathematician and a chemist.

Service courses, no. participants, winter semester 2018/19 (Source: TUCaN, 22.02.2019)	
Darstellende Geometrie	236
Höhere Mathematik I	135
Mathematik I für Bauwesen	816
Mathematik I für Elektrotechnik	822
Mathematik I für Informatik	1194
Mathematik I für Maschinenbau	940
Mathematik III für Bauwesen	535
Mathematik III für Elektrotechnik	538
Mathematik III für Maschinenbau	632
Mathematik für Chemiker	178
Mathematik und Statistik für Biologie	212
Statistik I für Human- und Sozialwissenschaft	181
Statistik I für Wirtschaftsingenieurwesen	742

It is one of the principles of this university that the department of mathematics is responsible for the teaching of mathematics across all subjects that require mathematics in their education. The importance of this aspect of our teaching activities is also borne out in the university’s KIVA initiative, which among other aspects emphasises the critical role of mathematics education in the early phases of university studies in the sciences and engineering disciplines. Among our efforts to strengthen the basis for this mathematical education, the department has set up optional extra learning platforms under the name of “Treffpunkte Mathematik”, which serve to give extra support to students in the large mainstream mathematics lecture courses. We also have established the ”Lernzentrum Mathematik”, a working space especially for students taking maths courses where more than seven hours a day research assistants (during the term) or advanced students (during the vacations) are available for assistance. One of the guiding ideas in these activities is the attempt to provide auxiliary training and to improve the motivation of students from those other subjects through problems that relate mathematics better with themes from the own subjects. Participation and student evaluations for these extras show this approach to be a success.

3.3 Characteristics in Teaching

As in previous years, the efforts of the department of mathematics were rewarded in the “CHE-Hochschul Ranking Mathematik” (Bachelor as well as Master). According to the results published in 2018, the department of mathematics again holds one of the top positions among all universities in Germany, with excellent grades especially for “overall study situation” (1.6), “teaching programme” (1.9), “study entry phase” (1.9), “libraries” (1.5) and “IT infrastructure” (1.6). The “study entry phase” achieved the maximum point score. This success also reflects the emphasis on teaching methods at the department of mathematics. Our aim in teaching is to encourage and motivate students to actively pursue the understanding of the taught material. The learning of mathematics is an intellectual activity equally supported by classroom teaching, by individual work and study, and by team work, both with and without direct supervision.

Lectures present mathematical content and methods through personal presentation; the systematic development and exposition of the material in the lectures is intended to stimulate the students’ mathematical intuition. Lectures are complemented by exercise groups, and by additional tutorials during the first year. The time ratio between classroom lectures and exercises is 2:1.

In exercise classes, students work on problems and topics from the lecture with the support of a tutor and they are encouraged to present and discuss solutions to homework problems. Students are also expected to work on weekly sets of homework problems and to submit their solutions to their tutors for marking in order to obtain feedback. The department has implemented a format for tutorials in the first year, which are provided as an additional learning platform besides exercise groups. Here teaching assistants hold classroom sessions devoted to the review of current material from the lecture classes, current and past problems from the exercises, further examples, basic problems and illustrations, or to filling gaps in students’ basic understanding. Regarded as an optional extra rather than as a mandatory part of the course, these tutorials are offered on a weekly alternating basis for the two main first-year courses (Analysis and Linear Algebra). Overall, all these activities are meant to support learning and to give students ample opportunity to improve and to test their knowledge and understanding.
Exercise groups and homework activities also form an integral part of most of the more advanced lecture courses, including those at Master level. In the course of the re-accreditation in 2011/12, the department decided to strengthen the Master programme with its rich spectrum of focus areas to choose from, by giving firmer guarantees as to the concrete choices of specialization areas that would be available to any cohort of Master students in the upcoming three years. The department also committed itself to devote any

extra teaching capacity that was freed through the termination of freshers' enrolment in the summer semester to a corresponding strengthening of the Master programme. Among other changes this has enabled us to allow for a larger number of teaching assistants to be employed in exercises for Master level courses. These measures are meant to make our Master programme even more competitive through its quality of teaching, greater reliability and impressive variety across a considerable breadth of research areas – both to retain our own Bachelor students and to attract new Master students from elsewhere. These strengthenings of the Master programme proved to be succesful by the accreditation in 2017/18 and have been continued accordingly.

Moreover, the department supports students in their learning experience by the following measures:

- the organisation of exercises and tutorials typically lies in the hands of experienced teaching assistants
- newly recruited tutors and student demonstrators undergo a dedicated training programme (which serves as an example of good practice in the context of the KIVA project, where similar ideas are being tested in other departments' teaching)
- exercise groups are limited to a size of 20 students in the first year and 25 students from the second year onwards
- we provide an open learning environment with small learning groups
- all teaching staff offer weekly consultation hours for individual help and support
- the department provides altogether 12 student rooms (open access and reserved) with about 160 places for students to meet in learning groups, to work on their thesis or to prepare for their final exams
- the Mathematics Learning Center (Lernzentrum Mathematik) is staffed during opening hours by an assistant, available to answer questions; in addition, textbooks and up-to-date material for the current courses are provided
- there are 32 places for reading and studying in the departmental library (towards the end of 2012, this departmental library was incorporated into the new central university library)
- the department has three open access computer labs (with a total of 43 Linux machines) and two reserved computer labs (with a total of 15 Linux machines)

3.4 E-Learning/E-Teaching in Academic Training

E-Learning is present in the Department of Mathematics in teaching and research. Standards and innovation of E-Learning and E-Teaching in the Department of Mathematics include:

- video capturing of selected lectures

- the learning material and exercises of most math-courses are adaptably accessible for the students on the Moodle platform
- support for individual assessment (diagnostic tests, project TELPS)
- two online-lessons (task-diversity (MAVIE) and task-training) for teacher education, available in German as well as in English.
- In some research projects new websites and digital tools as test- or/and learning environments are developed, see projects MAKOS, CODI, BASICS Mathematik, Basics2go
- 4 – 5 half-year-online teacher training courses (in service) are running each semester in cooperation with the DZLM, Berlin (www.dzlm.de), the course is taken by 60 – 80 teachers each year
- the task-database `www.madaba.de` with more than 1000 interesting math tasks supports teachers to prepare learning environments for math-lessons in school (secondary level I and II)
- In the summer term 2018 a project was carried out for teacher students and architecture students in cooperation with the department of Architecture. The aim was the development and test of city tours through Darmstadt (so called mathtrails) with the architecture as a central area of application of mathematics. The results are digitally available for schools `https://wwwdid.mathematik.tu-darmstadt.de/amustud/`.

Research and research-based development

In connection with the VEMA project (cooperation between TU Darmstadt (Bruder, Schaub), University of Paderborn (Biehler) and University of Kassel (Koepf)) and TU Hannover (Hochmuth), some new E-Learning elements, e.g., for self-regulation in cooperation with psychologists (Dr. Bellhaeuser) and for training of basic school knowledge in mathematics with initial differentiation in a new group formation (Project MOODLE-PEERS), were developed for the preparatory math courses for beginning students. Since 2009, the preparatory course has been presented online via Moodle each winter semester for nearly 800 new students of departments 4, 13, 16 and 20.

`https://www.mathematik.tu-darmstadt.de/studium/angebot/lehrveranstaltungen/vorkurs/index~1.de.jsp`
VEMA project homepage:
`http://www.mathematik.uni-kassel.de/~vorkurs/Willkommen1.html`.

MaViT: Mathematical Video Tutorials for Students of Engineering Sciences

Since the winter semester 2013/14 mathematical video tutorials have been produced to support students of Engineering Sciences to improve their mathematical basic skills single-handedly.
Especially within the service courses taken by students of other departments a large heterogeneity can be observed regarding previous knowledge as well as learning strategies. The videos are embedded into interactive digital learning environments that give graded

hints on how to solve the problem if required and provide a collection of additional exercises with sample solutions. In addition, assisted forums offer the possibility to ask and discuss questions regarding the respective content. Students can access the learning environments via Moodle.
Based on the know how of the project MaViT the presentation of solutions to the given tasks from the data bank is filmed now. More than 50 videos are stored on a central server. In the data bank of tasks weblinks to the videos are integrated. The evaluation shows that students appreciate the offered material for being valuable support of their learning process. Another new feature to support Mathematics I for electrical engineers was a weekly diagnostic test via Moodle. The task format was multiple choice. Indeed, the effort required is very high to construct of such tests. The effort stands in no satisfactory relation to the interest of the students in the tests.

3.5 Career-related Activities

In the series of lectures "Heute Mathe, morgen . . . ?" mathematicians present their current area of work, their vita and their employer. The main purpose is to give students a more personal insight into jobs for mathematicians outside the university than can be given by a job fair. A further intention is to give female students an easy opportunity to ask gender-specific questions and to present role models to the students.

24/01/2017 Lea Althaus (TWT),

31/01/2017 Dr. Kai Habermehl, Dr. Jane Ghiglieri, Dr. Thea Göllner (Continental),

07/02/2017 Prof. Dr. Priska Jahnke (Hochschule Heilbronn),

09/05/2017 Iris Ruhmann (Springer Spektrum),

16/05/2017 Stefanie Nattler (DB-Systel),

30/05/2017 Anne-Kathrin Karg (usd AG),

06/06/2017 Dr. Charlotte Habel, Simon Bartsch (SKS Group),

20/06/2017 Dr. Alexander Rath, Markus Hirsch (itk-engineering),

04/07/2017 Sascha Christiansen, René Wittmann (CGI),

24/10/2017 Dr. Christopher Bauer, Dr. Stefan Walter (Finbridge),

07/11/2017 Benjamin Fleckenstein, Jonas Weyer (CMORE Automotive),

14/11/2017 Anne Trutzel (BearingPoint),

21/11/2017 Sascha Bauer, Markus Schupp, Dr. Christoph Wockel (Ernst & Young),

28/11/2017 Dr. Stefan Hainz, Mirko Weißmann (Allolio & Konrad),

12/12/2017 David Kiesewalter (ESG (Elektroniksystem- und Logistik-GmbH)),

08/05/2018 Dr. Sadik Iliman, Elena Nagy (KPMG),

15/05/2018 Heino Kuhlmann (Helvetia),

22/05/2018 Franziska Wolf (McKinsey),

05/06/2018 Tobias Bauer, Daniel Stühn (Willis Towers Watson),

12/06/2018 Dr. Katharina Egert (Lokad),

26/06/2018 Dr. Waldemar Martens (ESA),

23/10/2018 Nicola Fujara, Dr. Winfried Geyer (DICOS),

06/11/2018 Christoph Bergen (HMS Analytical Software),

20/11/2018 Dr. Lisa Wagner (Siemens),

27/11/2018 Dr. Tobias Seitz (iba AG),

04/12/2018 Dr. Monika Bier, Jennifer Wilsverg (BaFin),

4 Publications

4.1 Co-Editors of Publications

4.1.1 Editors of Journals

Dieter Bothe

- *International Journal of Multiphase Flows* (Editorial Advisory Board)
- *Nonlinear Analysis: Real World Applications* (Editorial Board)
- *Journal of Evolution Equations, Special Issue Parabolic Evolution Equations, Maximal Regulatrity and Applications* (Guest editor)

Regina Bruder

- *mathematik lehren* (Associate Editor)

Jan H. Bruinier

- *Forum Mathematicum* (Managing Editor)
- *Research in Number Theory* (Associate Editor)
- *Journal of Algebra and its Applications* (Associate Editor)
- *Annali dell'Università di Ferrara* (Associate Editor)

Reinhard Farwig

- *Annali dell'Università di Ferrara, Sez. VII Sci. Mat.* (Associate Editor)
- *Mathematica Bohemica* (Associate Editor)
- *Analysis (Berlin)* (Associate Editor)
- *Mathematische Nachrichten* (Associate Editor)

Alf Gerisch

- *PLOS ONE* (Academic Editor)

Matthias Hieber

- *Differential Integral Equations* (Editor-in-Chief)
- *J. Mathematical Fluid Dynamics* (Associate Editor)
- *Advances in Diff. Equations* (Associate Editor)
- *Evolution Equations and Control Theory* (Associate Editor)
- *Springer Lecture Notes in Mathematical Fluid Dynamics* (Associate Editor)

Karl Heinrich Hofmann

– *Journal of Lie Theory* (Communicating Editor (until June 2018))

Ulrich Kohlenbach

– *Annals of Pure and Applied Logic* (Coordinating Editor)

– *Computability* (Member of Editorial Board)

– *Journal of Mathematical Logic* (Advisory Editor)

– *Logical Methods in Computer Science* (Member of Editorial Board)

Michael Kohler

– *AStA Advances in Statistical Analysis* (Associate Editor)

Jens Lang

– *Applied Numerical Mathematics* (Editor)

Martin Otto

– *ASL Lecture Notes in Logic (book series)* (Editor)

Marc Pfetsch

– *Operations Research Letters* (Associate Editor)

– *Mathematical Programming Computation* (Associate and Technical Editor)

– *INFORMS Journal on Computing* (Associate Editor)

Anna-Maria von Pippich

– *Elemente der Mathematik* (Member of the Editorial Board)

Ulrich Reif

– *Journal of Approximation Theory* (Associate Editor)

– *Computer Aided Geometric Design* (Associate Editor)

– *Jahresbericht der DMV* (Associate Editor)

Werner Schindler

– *Journal of Cryptographic Engineering* (Associate Editor)

Thomas Streicher

– *Applied Categorical Structures* (Associate Editor)

– *Mathematical Structures in Computer Science* (Associate Editor)

Stefan Ulbrich

– *Journal of Optimization Theory and Applications* (Associate Editor)

- *Optimization Methods and Software* (Senior Editor)
- *SIAM Journal on Optimization* (Associate Editor)
- *Asymptotic Analysis* (Associate Editor)
- *ESAIM: Control, Optimisation and Calculus of Variations* (Associate Editor)
- *SIAM Book Series: MOS-SIAM Series on Optimization* (Associate Editor)

Winnifried Wollner

- *International Journal of Applied and Computational Mathematics* (Editorial Board)

4.1.2 Editors of Proceedings

Jan H. Bruinier

- *L-Functions and Automorphic Forms. Proceedings of the conference LAF, Heidelberg, February 22–26, 2016. Contributions in Mathematical and Computational Sciences, vol. 10, Springer-Verlag (2017)* (jointly with jointly edited with Winfried Kohnen)

Yann Disser

- *Proceedings of the 4th International Symposium on Algorithmic Aspects of Cloud Computing (ALGOCLOUD 2018)* (jointly with V. Verykios)

Reinhard Farwig

- *Contemporary Mathematics Vol. 710 (2018), Mathematical Analysis in Fluid Mechanics: Selected Recent Results.* (jointly with J. Neustupa, P. Penel, R. Danchin)

Ulrich Kohlenbach

- *Special Issue of 'Journal of Computer and System Sciences', vol. 88 (2017), with selected papers from WoLLIC 2013* (jointly with Leonid Libkin, Ruy de Queiroz)
- *Special Issue of 'Information and Computation', vol. 255 (2017), with selected papers from WoLLIC 2014* (jointly with Pablo Barcelo, Ruy de Queiroz)
- *Mathematical Logic: Proof Theory, Constructive Mathematics. Oberwolfach Report 14 (2017)* (jointly with Sam Buss, Rosalie Iemhoff, Michael Rathjen)

Dieter Bothe

- *Transport Processes at Fluidic Interfaces* (jointly with Arnold Reusken, Birkhäuser-Springer)

Alf Gerisch

- *Multiscale Models in Mechano and Tumor Biology: Modeling, Homogenization, and Applications. Lecture Notes in Computational Science and Engineering, volume 122, Springer, Cham, 2018* (jointly with Raimondo Penta and Jens Lang)

4.2 Monographs and Books

[1] R. Bruder, B. Grave, U.-H. Krüger, and D. Meyer. *LEMAMOP – Lerngelegenheiten für Mathematisches Argumentieren, Modellieren und Problemlösen. Schülermaterialien und Lehrermaterialien und Lösungen (9 Bände)*. Westermann, 2017.

[2] M. Bucher. *Optimality Conditions and Numerical Methods for a Continuous Reformulation of Cardinality Constrained Optimization Problems*. TU Prints, 2018.

[3] M. Fischer. *Analysis and Numerical Approximation of Shape Optimization Problems Governed by the Navier-Stokes and the Boussinesq Equations*. Dr. Hut Verlag, 2017.

[4] T. Fischer. *Branch-and-Cut for Complementarity and Cardinality Constrained Linear Programs*. Dr. Hut Verlag, 2017.

[5] A. Gerisch, R. Penta, and J. Lang, editors. *Multiscale Models in Mechano and Tumor Biology: Modeling, Homogenization, and Applications*, volume 122 of *Lecture Notes in Computational Science and Engineering*. Springer, Cham, 2018.

[6] W. Herfort, K. H. Hofmann, and F. G. Russo. *Periodic Locally Compact Groups*. Walter DeGruyter GmbH, Berlin/Boston, 2019.

[7] M. Hieber. *Analysis I*. Springer Spektrum, 2018.

[8] M. Hieber. *Analysis II*. Springer Spektrum, to appear.

[9] C. Hojny. *Symmetries in Binary Programs – A Polyhedral Perspective*. sierke Verlag, 2018.

[10] J. Kramer and A.-M. von Pippich. *From natural numbers to quaternions*. Cham: Springer, 2017.

[11] A. K. Kuttich. *Robust Topology Optimization and Optimal Feedback Controller Design for Linear Time-Invariant Systems via Nonlinear Semidefinite Programming*. sierke Verlag, 2018.

[12] F. Ludovici. *Numerical Analysis of Parabolic Optimal Control Problems with Restrictions on the State and its First Derivative*. TU Prints, 2017.

[13] H. Meinlschmidt. *Analysis and Optimal Control of Quasilinear Parabolic Evolution Equations in Divergence Form on Rough Domains*. sierke Verlag, 2017.

[14] C. Müller. *Iterative Solvers for Stochastic Galerkin Discretizations of Stokes Flow with Random Data*. Dr. Hut Verlag, 2018.

[15] O. Schmitt. *Reflexionswissen zur linearen Algebra in der Sekundarstufe II*. Springer Spektrum Wiesbaden.

[16] Z. Sun. *Adaptive Moving Finite Element Method for Steady Low-Mach-Number Compressible Combustion Problems*. Dr. Hut Verlag, 2018.

4.3 Publications in Journals and Proceedings

4.3.1 Journals

[1] L. C. Altherr, T. Ederer, M. E. Pfetsch, and P. F. Pelz. Maschinelles Design eines optimalen Getriebes. *ATZ – Automobiltechnische Zeitschrift*, 120(10):72–77, 2018.

[2] B. Assarf, E. Gawrilow, K. Herr, M. Joswig, B. Lorenz, A. Paffenholz, and T. Rehn. Computing convex hulls and counting integer points with `polymake`. *Mathematical Programming Computation*, 9(1):1–38, 2017.

[3] F. Aurzada and M. Buck. Persistence probabilities of two-sided (integrated) sums of correlated stationary Gaussian sequences. *J. Stat. Phys.*, 170(4):784–799, 2018.

[4] F. Aurzada, A. Devulder, N. Guillotin-Plantard, and F. Pène. Random walks and branching processes in correlated Gaussian environment. *J. Stat. Phys.*, 166(1):1–23, 2017.

[5] F. Aurzada, N. Guillotin-Plantard, and F. Pène. Persistence probabilities for stationary increment processes. *Stochastic Process. Appl.*, 128(5):1750–1771, 2018.

[6] F. Aurzada and M. A. Lifshits. Small deviations of sums of correlated Gaussian sequences. *Theory Probab. Appl.*, 61(4):540–568, 2017.

[7] F. Aurzada and S. Schwinn. Improving the performance of polling models using forced idle times. *Probab. Engrg. Inform. Sci.*, 32(4):580–602, 2018.

[8] M. Bacak and U. Kohlenbach. On proximal mappings with Young functions in uniformly convex banach spaces. *Journal of Convex Analysis*, 25:1291–1318, 2018.

[9] S. W. Bae, J.-F. Baffier, J. Chun, P. Eades, K. Eickmeyer, L. Grilli, S.-H. Hong, M. Korman, F. Montecchiani, I. Rutter, and C. Tóth. Gap-planar graphs. *Theoretical Computer Science*, 745:36–52, October 2018.

[10] E. Bampas, C. Karousatou, A. Pagourtzis, and K. Potika. Minimum multiplicity edge coloring via orientation. *Discrete Applied Mathematics*, 247:380–388, 2018.

[11] E. Bampas, C. Karousatou, A. Pagourtzis, and K. Potika. Path multicoloring in spider graphs with even color multiplicity. *Information Processing Letters*, 133:1–4, 2018.

[12] A. Bärtschi, J. Chalopin, S. Das, Y. Disser, B. Geissmann, D. Graf, A. Labourel, and M. Mihalák. Collaborative delivery with energy-constrained mobile robots. *Theoretical Computer Science*, 2017.

[13] B. Bauer, L. Devroye, M. Kohler, A. Krzyżak, and H. Walk. Nonparametric estimation of a function from noiseless observations at random points. *Journal of Multivariate Analysis*, 160:90–104, 2017.

[14] V. Betz, S. Dereich, and P. Mörters". The shape of the emerging condensate in effective models of condensation. *Annales Henri Poincare*, pages 1869–1889, 2018.

[15] V. Betz, J. Ehlert, and B. Lees. Phase transition for loop representations of quantum spin systems on trees. *Journal of Mathematical Physics*, 59:113302, 2018.

[16] V. Betz and H. Schäfer. The number of cycles in random permutations without long cycles is asymptotically gaussian. *ALEA*, 14:427–444, 2017.

[17] Z. Bontick, O. Lass, S. Schöps, H. De Gersem, S. Ulbrich, and O. Rain. Robust Optimization Approaches for the Design of an Electric Machine. *IET Science, Measurement & Technology*, 12:939–948(9), November 2018.

[18] D. Bothe, A. Fischer, M. Pierre, and G. Rolland. Global wellposedness for a class of reaction-advection-anisotropic-diffusion systems. *J. Evol. Eqs.*, 17:101–130, 2017.

[19] D. Bothe, T. Kashiwabara, and M. Köhne. Strong well-posedness for a class of dynamic outflow boundary conditions for incompressible newtonian flows. *J. Evol. Eqs.*, 17:131–171, 2017.

[20] D. Bothe and J. Prüss. Modeling and analysis of reactive multi-component two-phase flows with mass transfer and phase transition: the isothermal incompressible case. *Discrete Continuous Dynamical Systems - Series S*, 10:673–696, 2017.

[21] A.-K. Bott, T. Felber, M. Kohler, and L. Kristl. Estimation of a time dependent density. *Journal of Statistical Planning and Inference*, 180:81–107, 2017.

[22] M. Branda, M. Bucher, M. Červinka, and A. Schwartz. Convergence of a scholtes-type regularization method for cardinality-constrained optimization problems with an application in sparse robust portfolio optimization. *Computational Optimization and Applications*, 70(2):503–530, Jun 2018.

[23] K. Bringmann, B. Kane, and A.-M. von Pippich. Regularized inner products of meromorphic modular forms and higher Green's functions. *Commun. Contemp. Math.*, to appear.

[24] R. Bruder. Wie weiß ich, dass ich's weiß? *mathematik lehren*, 211:25–27, 2018.

[25] R. Bruder, J. M. Heitzer, R. Hochmuth, M. Lippert, and S. Schiemann. Unterstützungsangebote vor und zum Studienbeginn – Ziele und Chancen. *Der Mathematikunterricht*.

[26] R. Bruder and J. Roth. Welche Methode passt? Passung von Methoden zu Unterrichtszielen in typischen Lehr-Lern-Situationen . *mathematik lehren*, 205:2 – 9, 2018.

[27] J. Bruinier, J. Funke, and S. Kudla. Degenerate Whittaker functions for $\mathrm{Sp}_n(\mathbb{R})$. *International Mathematics Research Notices*, 1:1–56, 2018.

[28] J. H. Bruinier. Borcherds products with prescribed divisor. *Bulletin of the London Mathematical Society*, 49:979–987, 2017.

[29] J. H. Bruinier, J. Funke, O. Imamoḡlu, and Y. Li. Modularity of generating series of winding numbers. *Research in the Mathematical Sciences*, 5:23pp., 2018.

[30] J. H. Bruinier and M. Schwagenscheidt. Algebraic formulas for the coefficients of mock theta functions and Weyl vectors of Borcherds products. *Journal of Algebra*, 478:38–57, 2017.

[31] F. Brunault and M. Neururer. Mahler measures of elliptic modular surfaces. *Transactions of the AMS*, 2018. To appear.

[32] M. Bucher and A. Schwartz. Second-order optimality conditions and improved convergence results for regularization methods for cardinality-constrained optimization problems. *Journal of Optimization Theory and Applications*, 178(2):383–410, Aug 2018.

[33] A. Buttenschön, T. Hillen, A. Gerisch, and K. Painter. A space-jump derivation for non-local models of cell-cell adhesion and non-local chemotaxis. *J. Math. Biol.*, 76:429–456, 2018.

[34] F. Castillo, F. Liu, B. Nill, and A. Paffenholz. Smooth polytopes with negative Ehrhart coefficients. *Journal of Combinatorial Theory. Series A*, 160:316–331, 2018.

[35] A. Celik and M. Kyed. Nonlinear Wave Equation with Damping: Periodic Forcing and Non-Resonant Solutions to the Kuznetsov Equation. *Z. Angew. Math. Mech*, 98:412 – 430, 2017.

[36] A. P. Choudhury, A. Hussein, and P. Tolksdorf. Nematic liquid crystals in lipschitz domains. *SIAM J. Math. Anal.*, 50 (4):4282–4310, 2018.

[37] S. Das, D. Dereniowski, and C. Karousatou. Collaborative exploration of trees by energy-constrained mobile robots. *Theory of Computing Systems*, 62(5):1223–1240, 2018.

[38] D. Deising, D. Bothe, and H. Marschall. Direct numerical simulation of mass transfer in bubbly flows. *Computers & Fluids*, 172:524–537, 2018.

[39] M. Dickson and M. Neururer. Spaces generated by products of Eisenstein series. *Journal of Number Theory*, Volume 188:p.137–164, 2018. To appear.

[40] K. Disser, M. Liero, and J. Zinsl. On the evolutionary Gamma-convergence of gradient systems modeling slow and fast chemical reactions. *Nonlinearity*, 31:3689–3706, 2018.

[41] K. Disser, T. ter Elst, and J. Rehberg. Hölder estimates for parabolic operators on domains with rough boundary. *Ann. Sc. Norm. Sup. Pisa*, XVII:65–79, 2017.

[42] K. Disser, T. ter Elst, and J. Rehberg. On maximal parabolic regularity for non-autonomous parabolic operators. *J. Differential Equations*, 262:2039–2072, 2017.

[43] Y. Disser, J. Fearnley, M. Gairing, O. Göbel, M. Klimm, D. Schmand, A. Skopalik, and A. Tönnis. Hiring secretaries over time: The benefit of concurrent employment. *Mathematics of Operations Research*, 2018. To appear.

[44] Y. Disser, M. Klimm, N. Megow, and S. Stiller. Packing a knapsack of unknown capacity. *SIAM Journal on Discrete Mathematics*, 31(3):1477–1497, 2017.

[45] Y. Disser, S. Kratsch, and M. Sorge. The minimum feasible tileset problem. *Algorithmica*, 2018.

[46] Y. Disser, F. Mousset, A. Noever, N. Škorić, and A. Steger. A general lower bound for collaborative tree exploration. *Theoretical Computer Science*, 2018.

[47] Y. Disser and M. Skutella. The simplex algorithm is NP-mighty. *ACM Transactions on Algorithms*, 15(1):5(19), 2018.

[48] M. Dittmann. Reflective automorphic forms on lattices of squarefree level. *Trans. Amer. Math. Soc.*, 2018. to appear.

[49] P. Domschke, A. Dua, J. J. Stolwijk, J. Lang, and V. Mehrmann. Adaptive refinement strategies for the simulation of gas flow in networks using a model hierarchy. *Electronic Transactions on Numerical Analysis*, 48:97–113, 2018.

[50] P. Domschke, D. Trucu, A. Gerisch, and M. A. J. Chaplain. Structured models of cell migration incorporating molecular binding processes. *Journal of Mathematical Biology*, 75(6-7):1517–1561, 2017.

[51] L. Drescher, H. Heumann, and K. Schmidt. A high order galerkin method for integrals over contour lines with an application to plasma physics. *SIAM Numer. Math.*, 55(6):2592–2615, 2017.

[52] H. Egger, C. Erath, and R. Schorr. On the non-symmetric coupling method for parabolic-elliptic interface problems. *SIAM J. Numer. Anal.*, 56(6):3510–3533, 2018.

[53] H. Egger and T. Kugler. Damped wave systems on networks: Exponential stability and uniform approximations. *Numer. Math.*, 138:839–867, 2018.

[54] H. Egger, T. Kugler, B. Liljegren-Sailer, N. Marheineke, and V. Mehrmann. On structure-preserving model reduction for damped wave propagation in transport networks. *SIAM Journal on Scientific Computing*, 40:A331–A365, 2018.

[55] H. Egger, T. Kugler, and N. Strogies. Parameter identification in a semilinear hyperbolic system. *Inverse Problems*, 33:055022, 2017.

[56] H. Egger and B. Radu. Super-convergence and post-processing for mixed finite element approximations of the wave equation. *Numer. Math.*, 140:427–447, 2018.

[57] H. Egger, T. Seitz, and C. Tropea. Enhancement of flow measurements using fluid-dynamic constraints. *J. Comp. Phys.*, 344:558–574, 2017.

[58] K. Eickmeyer, M. Elberfeld, and F. Harwath. Succinctness of order-invariant logics on depth-bounded structures. *ACM Transactions on Computational Logic*, 18(4), 2017.

[59] T. Eiter and M. Kyed. Estimates of Time-Periodic Fundamental Solutions to the Linearized Navier–Stokes Equations. *Journal of Mathematical Fluid Mechanics*, 20:517–529, 2018.

[60] C. Engwer, C. Stinner, and C. Surulescu. On a structured multiscale model for acid-mediated tumor invasion: the effects of adhesion and proliferation. *Math. Models Methods Appl. Sci.*, 27:1355–1390, 2017.

[61] C. Erath, G. Of, and F.-J. Sayas. On the non-symmetric coupling of the finite volume method and the boundary element method. *Numer. Math*, 135(3):895–922, 2017.

[62] C. Erath and D. Praetorius. Adaptive vertex-centered finite volume methods for general second-order linear elliptic pdes. *IMA J. Numer.Anal.*, published online, 2018.

[63] C. Erath and R. Schorr. An adaptive non-symmetric finite volume and boundary element coupling method for a fluid mechanics interface problem. *SIAM J. Sci. Comput.*, 39(3):A741–A760, 2017.

[64] S. Eriksson. Asymptotic expansion techniques for singularly perturbed boundary integral equations. *Journal of Scientific Computing*, 75(2):906–940, 2018.

[65] M. Falcone, D. Bothe, and H. Marschall. 3D direct numerical simulations of reactive mass transfer from deformable single bubbles: An analysis of mass transfer coefficients and reaction selectivities. *Chem. Eng. Sci.*, 177:523–536, 2018.

[66] R. Farwig. Jean Leray: Sur le mouvement d'un liquide visqueux emplissant l'espace. Acta Math. 63 (1934), 193–248. *Jahresber. Dtsch. Math.-Ver.*, 119:249–272, 2017.

[67] R. Farwig and Y. Giga. Well-chosen weak solutions of the instationary Navier-Stokes system and their uniqueness. *Hokkaido Math. J.*, 47:373–385, 2018.

[68] R. Farwig, Y. Giga, and P.-Y. Hsu. The Navier-Stokes equations with initial values in Besov spaces of type $B^{-1+3/q}_{q,\infty}$. *J. Korean Math. Soc.*, 54(5):1483–1504, 2017.

[69] R. Farwig, H. Kozono, and D. Wegmann. Decay of non-stationary Navier-Stokes flow with nonzero Dirichlet boundary data. *Indiana Univ. Math. J.*, 66:2169–2185, 2017.

[70] R. Farwig, H. Kozono, and D. Wegmann. Existence of strong solutions and decay of turbulent solutions of Navier-Stokes flow with nonzero Dirichlet boundary data. *J. Math. Anal. Appl.*, 453:271–286, 2017.

[71] R. Farwig, H. Kozono, and D. Wegmann. Maximal regularity of the Stokes operator in an exterior domain with moving boundary and application to the Navier-Stokes equations. *Math. Anal.*, 2018.

[72] R. Farwig and C. Qian. Asymptotic behavior for the quasi-geostrophic equations with fractional dissipation in $\mathbb{R}^2$. *J. Differential Equations*, 2018.

[73] R. Farwig, R. Schulz, and Y. Taniuchi. Spatial asymptotic profiles of solutions to the Navier-Stokes system in a rotating frame with fast decaying data. *Hokkaido Math. J.*, 47:501–529, 2018.

[74] M. Fischer, F. Lindemann, M. Ulbrich, and S. Ulbrich. Fréchet differentiability of unsteady incompressible Navier-Stokes flow with respect to domain variations of low regularity by using a general analytical framework. *SIAM Journal on Control and Optimization*, 55(5):3226–3257, 2017.

[75] T. Fischer and M. E. Pfetsch. Monoidal cut strengthening and generalized mixed-integer rounding for disjunctive programs. *Operations Research Letters*, 45(6):556–560, 2017.

[76] T. Fischer and M. E. Pfetsch. Branch-and-cut for linear programs with overlapping SOS1 constraints. *Mathematical Programming Computation*, 10(1):33–68, 2018.

[77] G. Freixas i Montplet and A.-M. von Pippich. Riemann–Roch isometries in the non-compact orbifold setting. *J. Eur. Math. Soc. (JEMS)*, to appear.

[78] A. Freund. A note on iterated consistency and infinite proofs. *Archive for Mathematical Logic*, to appear.

[79] A. Freund and F. Pakhomov. Short proofs for slow consistency. *Notre Dame Journal of Formal Logic*, to appear.

[80] M. Fujiwara and U. Kohlenbach. Interrelation between weak fragments of double negation shift and related principles. *Journal of Symbolic Logic*, 83:991–1012, 2018.

[81] G. Galdi, M. Hieber, and T. Kashiwabara. Strong time-periodic solutions to the 3d-primtitive equations subject to arbitrary large forces. *Nonlinearity*, 30:3979–3992, 2017.

[82] T. Gally, M. E. Pfetsch, and S. Ulbrich. A framework for solving mixed-integer semidefinite programs. *Optimization Methods and Software*, 33(3):594–632, 2018.

[83] Y. Giga, M. Gries, M. Hieber, A. Hussein, and T. Kashiwabara. Bounded h^∞-calculus for the hydrostatic stokes operator on l^p-spaces and applications. volume 145, pages 3865–3876. 2017.

[84] Y. Giga, M. Gries, M. Hieber, A. Hussein, and T. Kashiwabara. Bounded H^∞-calculus for the hydrostatic Stokes operator on L^p-spaces and applications. *Proceedings of the American Mathematical Society*, 145(9):3865–3876, 2017.

[85] Y. Giga, M. Gries, M. Hieber, A. Hussein, and T. Kashiwabara. Analyticity of solutions to the primitive equations. *Math. Nachrichten*, to appear.

[86] Y. Giga, M. Gries, M. Hieber, A. Hussein, and T. Kashiwabara. Analyticity of solutions to the primitive equations. *Mathematische Nachrichten*, to appear.

[87] C. Goll, T. Wick, and W. Wollner. DOpElib: Differential equations and Optimization Environment; A goal oriented software library for solving PDEs and optimization problems with PDEs. *Archive of Numerical Software*, 5(2):1–14, 2017.

[88] C. Gottschalk, H. Lüthen, B. Peis, and A. Wierz. Optimization problems with color-induced budget constraints. *Journal of Combinatorial Optimization*, 36(3):861–870, 2017.

[89] M. Grados and A.-M. von Pippich. On scattering constants of congruence subgroups. In J. H. Bruinier and W. Kohnen, editors, *L-functions and automorphic forms*, Contributions in Mathematical and Computational Sciences, Bd. 10, pages 115–137. Springer International Publishing, 2017.

[90] M. Groß, M. E. Pfetsch, and M. Skutella. On the complexity of instationary gas flows. *Operations Research Letters*, 46(3):286–290, 2018.

[91] M. Gugat and S. Ulbrich. The isothermal Euler equations for ideal gas with source term: product solutions, flow reversal and no blow up. *Journal of Mathematical Analysis and Applications*, 454(1):439–452, 2017.

[92] M. Gugat and S. Ulbrich. Lipschitz solutions of initial boundary value problems for balance laws. *Mathematical Models and Methods in Applied Sciences*, 28(5):921–951, 2018.

[93] U. Günther, W. Hess, B. M. Horn, and H. Lüthen. A holistic topology and shape optimization approach with an application to steel profiles. *Structural and Multidisciplinary Optimization*, 57(3):1267–1281, 2017.

[94] C. Haase, A. Paffenholz, L. C. Piechnik, and F. Santos. Existence of unimodular triangulations – positive results. *Memoirs of the AMS*, 2018. To appear.

[95] R. Haller-Dintelmann, H. Meinlschmidt, and W. Wollner. Higher regularity for solutions to elliptic systems in divergence form subject to mixed boundary conditions. *Ann. Math. Pura Appl.*, 2018. to appear, https://doi.org/10.1007/s10231-018-0818-9.

[96] H. Hamrouni and K. H. Hofmann. Locally compact groups approximable by subgroups isomorphic to Z. *Topology Appl.*, 251:58–77, 2017.

[97] M. Hansmann and M. Kohler. Estimation of quantiles from data with additional measurement errors. *Statistica Sinica*, 27:1661–1673, 2017.

[98] S. Herrero, O. Imamoglu, A.-M. von Pippich, and A. Tóth. A jensen–rohrlich type formula for the hyperbolic 3-space. *Trans. Amer. Math. Soc.*, 371(9):6421–6446, 2019.

[99] S. Herrero and A.-M. von Pippich. Mock modular forms whose shadows are eisenstein series of integral weight. *Math. Res. Lett.*, to appear.

[100] C. Herrmann and M. Ziegler. Definable relations in finite-dimensional subspace lattices with involution. *Algebra Universalis*, 79:68:1–29, 2018.

[101] R. Herzog and W. Wollner. A conjugate direction method for linear systems in banach spaces. *Journal of Inverse and Ill-posed Problems*, 25(5):553–572, 2017.

[102] M. Hieber. Analysis of viscous incompressible fluids: an approach by evolution equations. *In: Lecture Notes in Mathematics, CIME Foundation Subseries*, to appear.

[103] M. Hieber, A. Mahalov, and R. Takada. Time periodic and almost time periodic solutions to rotating stratified fluids subject to large forces. *J. Differential Equations*, to appear.

[104] M. Hieber, T. H. Nguyen, and A. Seyfert. On periodic and almost periodic solutions to incompressible, viscous fluid flow problems on the whole line. *Math. Nonlinear Phenomena*, 125:51–81, 2017.

[105] M. Hieber and J. Prüss. Dynamics of the ericksen-leslie equations with general leslie stress i: the incompressible isotropic case. *Math. Ann.*, 369:977–996, 2017.

[106] M. Hieber and J. Prüss. Modeling and analysis of the ericksen-leslie equations for nematic liquid crystal flows. *Handbook of Math. Analysis in Mechanics of Viscous Fluids, Springer*, pages 1075–1134, 2018.

[107] M. Hieber and J. Prüss. On the bidomain problem with FitzHugh-Nagumo transport. *Arch. Math*, 111:977–1002, 2018.

[108] M. Hieber and J. Saal. The Stokes equation in the L^p-setting: well posedness and regularity properties. *Handbook of Math. Analysis in Mechanics of Viscous Fluids, Springer*, pages 117–206, 2018.

[109] M. Hieber and H. Saito. Strong solutions to two-phase free boundary problems for a class of non-newtonian fluids. *J. Evol. Eq.*, 17:335–358, 2017.

[110] M. Hieber, H. Wen, and R. Zi. Optimal decay rates for solutions to thr incompressible oldroyd-b model in $\mathbb{R}^3$. *Nonlinearity*, to appear.

[111] S. Hill, D. Deising, T. Acher, H. Klein, D. Bothe, and H. Marschall. Boundedness-preserving implicit correction of mesh-induced errors for VOF based heat and mass transfer. *J. Comp. Phys.*, 352:285–300, 2018.

[112] A. Hodgkinson, M. A. J. Chaplain, P. Domschke, and D. Trucu. Computational approaches and analysis for a spatio-structural-temporal invasive carcinoma model. *Bulletin of Mathematical Biology*, 80(4):701–737, 2018.

[113] K. H. Hofman and J. D. Lawson. In memoriam: Klaus Keimel (1939–2017). *Semigroup Forum*, 96:199–202, 2018.

[114] K. H. Hofmann. Jimmie D. Lawson on the Occasion of his 75th Birthday. *Semigroup Forum*, 97:1–6, 2018.

[115] C. Hojny and M. E. Pfetsch. Polytopes associated with symmetry handling. *Mathematical Programming*, 2018.

[116] B. M. Horn, H. Lüthen, M. E. Pfetsch, and S. Ulbrich. Geometry and topology optimization of sheet metal profiles by using a branch-and-bound framework. *Materials Science & Engineering Technology*, 48:27–40, 2017.

[117] D. Horstmann, H. Meinlschmidt, and J. Rehberg. The full Keller–Segel model is well-posed on nonsmooth domains. *Nonlinearity*, 31(4):1560–1592, 2018.

[118] A. Hussein, M. Saal, and O. Sawada. Primitive equations with linearly growing initial data. *Annali della Scuola Normale Superiore di Pisa - Classe di Scienze*, to appear.

[119] R. G. Iagar, P. Laurençot, and C. Stinner. Instantaneous shrinking and single point extinction for viscous Hamilton-Jacobi equations with fast diffusion. *Math. Ann.*, 368:65–109, 2017.

[120] L. Iapichino, S. Ulbrich, and S. Volkwein. Multiobjective PDE-constrained optimization using the reduced-basis method. *Advances in Computational Mathematics*, 43(5):945–972, 2017.

[121] I. G. Ion, Z. Bontinck, D. Loukrezis, U. Römer, O. Lass, S. Ulbrich, S. Schöps, and H. De Gersem. Robust shape optimization of electric devices based on deterministic optimization methods and finite-element analysis with affine parametrization and design elements. *Electrical Engineering*, 100(4):2635–2647, Dec 2018.

[122] H. Ishihara, M. E. Maietti, S. Maschio, and T. Streicher. Consistency of the intensional level of the minimalist foundation with Church's thesis and axiom of choice. *Archive for Mathematical Logic*, 57:873–888, 2018.

[123] I. Joormann and M. E. Pfetsch. Complexity of minimum irreducible infeasible subsystem covers for flow networks. *Discrete Applied Mathematics*, 244:124–142, 2018.

[124] J. Jorgenson, A.-M. von Pippich, and L. Smajlović. Applications of Kronecker's limit formula for elliptic Eisenstein series. *Ann. Math. Québec*, pages 1–26, 2017.

[125] K. Jozsa, K. de With, W. Kern, C. Reinheimer, V. Kempf, C. Wichelhaus, and T. Wichelhaus. Intestinal carriage of multidrug-resistant bacteria among healthcare professionals in germany. *GMS Infectious Diseases*, 5, 2017.

[126] A. Kelava, M. Kohler, and A. Krzyżak. Nonparametric estimation of a latent variable model. *Journal of Multivariate Analysis*, 154:112–134, 2017.

[127] U. Kohlenbach. Recent progress in proof mining in nonlinear analysis. *IFCoLog Journal of Logics and its Applications*, 10:3357–3406, 2017.

[128] U. Kohlenbach. On the reverse mathematics and Weihrauch complexity of moduli of regularity and uniqueness. *Computability*, 2019. To appear.

[129] U. Kohlenbach. A polynomial rate of asymptotic regularity for compositions of projections in Hilbert space. *Foundations of Computational Mathematics*, 2019. to appear.

[130] U. Kohlenbach, L. Leustean, and A. Nicolae. Quantitative results on Fejér monotone sequences. *Communications in Contemporary Mathematics*, 20:42 pages, 2018.

[131] U. Kohlenbach, G. López-Acedo, and A. Nicolae. Quantitative asymptotic regularity for the composition of two mappings. *Optimization*, 66:1291–1299, 2017.

[132] U. Kohlenbach, G. López-Acedo, and A. Nicolae. Moduli of regularity and rates of convergence for fejer monotone sequences. *Israel Journal of Mathematics*, 2019. To appear.

[133] U. Kohlenbach and A. Nicolae. A proof-theoretic bound extraction theorem for CAT(κ)-spaces. *Studia Logica*, 105:611–624, 2017.

[134] M. Kohler and A. Krzyżak. Nonparametric regression based on hierarchical interaction models. *IEEE Transactions on Information Theory*, 63:1620–1630, 2017.

[135] M. Kohler and A. Krzyżak. Adaptive estimation of quantiles in a simulation model. *IEEE Transactions on Information Theory*, 64:501–512, 2018.

[136] M. Kohler, A. Krzyżak, S. Mallapur, and R. Platz. Uncertainty quantification in case of imperfect models: A non-bayesian approach. *Scandinavian Journal of Statistics*, 45:729–752, 2018.

[137] M. Kohler, A. Krzyżak, R. Tent, and H. Walk. Nonparametric quantile estimation using importance sampling. *Annals of the Institute of Statistical Mathematics*, 70:439–465, 2018.

[138] P. Kolvenbach, O. Lass, and S. Ulbrich. An approach for robust PDE-constrained optimization with application to shape optimization of electrical engines and of dynamic elastic structures under uncertainty. *Optimization and Engineering*, 19(3):697–731, 2018.

[139] P. Kolvenbach, S. Ulbrich, M. Krech, and P. Groche. Robust design of a smart structure under manufacturing uncertainty via nonsmooth PDE-constrained optimization. In *Uncertainty in Mechanical Engineering III*, volume 885 of *Applied Mechanics and Materials*, pages 131–144. Trans Tech Publications, 2018.

[140] J.-S. Koskivirta and T. Wedhorn. Generalized μ-ordinary Hasse invariants. *J. Algebra*, 502:98–119, 2018.

[141] J. Kramer and A.-M. von Pippich. Logarithm and dilogarithm. *Elem. Math.*, 74(1):10–23, 2019.

[142] B. Krauth and R. Bruder. Aufgaben zum Lernen und Leisten. *SchulVerwaltung spezial*, 19.Jhg:28–31, 2017.

[143] M. Kunimoto, D. Bothe, R. Tamura, T. Oyanagi, Y. Fukunaka, H. Nakai, and T. Homma. Spectroscopic and computational analyses for liquid-liquid interfacial reaction mechanism of boric acid esterification with 2,2,4-trimethyl-1,3-pentanediol in boron extraction. *Journal of Physical Chemistry C*, 122:10423–10429, 2018.

[144] J. Lang and W. Hundsdorfer. Extrapolation-based implicit-explicit Peer methods with optimised stability regions. *J. Comp. Phys.*, 337:203–215, 2017.

[145] J. Lang and P. Mindt. Entropy-preserving coupling conditions for one-dimensional Euler systems at junctions. *Netw. Heterog. Media*, 13:177–190, 2018.

[146] O. Lass and S. Ulbrich. Model order reduction techniques with a posteriori error control for nonlinear robust optimization governed by partial differential equations. *SIAM Journal on Scientific Computing*, 39(5):S112–S139, 2017.

[147] P. Le Bodic, J. W. Pavelka, M. E. Pfetsch, and S. Pokutta. Solving MIPs via scaling-based augmentation. *Discrete Optimization*, 27:1–25, 2018.

[148] N. Lehmann, L.-B. Maier, S. Odathuparambil, and U. Reif. Ambient approximation on hypersurfaces. *Constructive Approximation*, 49(1):175–190, 2019.

[149] L. Leuştean, A. Nicolae, and A. Sipoş. An abstract proximal point algorithm. *Journal of Global Optimization*, 72:553–577, 2018.

[150] L. Leuştean and A. Sipoş. Effective strong convergence of the proximal point algorithm in CAT(0) spaces. *Journal of Nonlinear and Variational Analysis*, 2:219–228, 2018.

[151] Y. Li. Restriction of coherent Hilbert Eisenstein series. *Mathematische Annalen*, 368:317–338, 2017.

[152] Y. Li. Petersson norm of cusp forms associated to real quadratic fields. *Forum Mathematicum*, 30:1097–1109, 2018.

[153] Y. Li and M. Neururer. A magnetic modular form. *International Journal of Number Theory*, 2018. To appear.

[154] Y. Li and S. Zemel. Shimura lifts of weakly holomorphic modular forms. *Mathematische Zeitschrift*, 290(1-2):37–61, 2018.

[155] A. Linke, C. Merdon, and W. Wollner. Optimal L^2 velocity error estimates for a modified pressure-robust Crouzeix-Raviart Stokes element. *IMA Journal of Numerical Analysis*, 37(1):354–374, 2017.

[156] F. Ludovici, I. Neitzel, and W. Wollner. A priori error estimates for state constrained semilinear parabolic optimal control problems. *Journal of Optimization Theory and Applications*, 178(2):317–348, 2018.

[157] A. A. Lukassen and M. Kiehl. Operator splitting for chemical reaction systems with fast chemistry. *Journal of Computational and Applied Mathematics*, 344:495–511, 2018.

[158] A. A. Lukassen and M. Kiehl. Parameter estimation with model order reduction for elliptic differential equations. *Inverse Problems in Science and Engineering*, 26(4):479–497, 2018.

[159] T. Maric, H. Marschall, and D. Bothe. An enhanced un-split face-vertex flux-based vof method. *J. Comp. Phys.*, 371:967–993, 2018.

[160] J. Marzec. Non-vanishing of fundamental Fourier coefficients of paramodular forms. *J. Number Theory*, 182:311–324, 2018.

[161] H. Meinlschmidt, C. Meyer, and J. Rehberg. Optimal control of the thermistor problem in three spatial dimensions, part 1: Existence of optimal solutions. *SIAM Journal on Control and Optimization*, 55(5):2876–2904, 2017.

[162] H. Meinlschmidt, C. Meyer, and J. Rehberg. Optimal control of the thermistor problem in three spatial dimensions, part 2: Optimality conditions. *SIAM Journal on Control and Optimization*, 55(4):2368–2392, 2017.

[163] F. Meyer, J. Giesselmann, and C. Rohde. A posteriori error analysis for random scalar conservation laws using the stochastic galerkin method. *IMA J. Numer. Anal.*, 2019.

[164] I. Neitzel, T. Wick, and W. Wollner. An optimal control problem governed by a regularized phase-field fracture propagation model. *SIAM Journal on Control and Optimization*, 55(4):2271–2288, 2017.

[165] I. Neitzel and W. Wollner. A priori L^2-discretization error estimates for the state in elliptic optimization problems with pointwise inequality state constraints. *Numerische Mathematik*, 138(2):273–299, 2018.

[166] E. Neumann, M. Pape, and T. Streicher. Computability in basic quantum mechanics. *Logical Methods in Computer Science*, 14, 2018.

[167] S. Nicaise and A. Semin. Density and trace results in generalized fractal networks. *ESAIM: Mathematical Modelling and Numerical Analysis*, 52(3):1023–1049, 2018.

[168] M. Niethammer, H. Marschall, C. Kunkelmann, and D. Bothe. A numerical stabilization framework for viscoelastic fluid flow using the finite volume method on general unstructured meshes. *Int. J. Numer. Meth. Fluids*, 86:131–166, 2018.

[169] P. Oliva and T. Powell. Spector bar recursion over finite partial functions. *Annals of Pure and Applied Logic*, 168(5):887–921, 2017.

[170] R. Penta and A. Gerisch. The asymptotic homogenization elasticity tensor properties for composites with material discontinuities. *Continuum Mechanics and Thermodynamics*, 29:187–206, 2017.

[171] C. Pesci, A. Weiner, H. Marschall, and D. Bothe. Computational analysis of single rising bubbles influenced by soluble surfactant. *J. Fluid Mech.*, 856:709–763, 2018.

[172] S. Pfaff and S. Ulbrich. Optimal control of scalar conservation laws by on/off-switching. *Optimization Methods & Software*, 32(4):904–939, 2017.

[173] C. Planchette, H. Hinterbichler, M. Liu, D. Bothe, and G. Brenn. Colliding drops as coalescing and fragmenting liquid springs. *J. Fluid Mech.*, 814:227–300, 2017.

[174] A.-T. Rauls and G. Wachsmuth. Generalized derivatives for the solution operator of the obstacle problem. *Set-Valued and Variational Analysis*, 2019. To appear.

[175] U. Reif and M. A. Sabin. Old problems and new challenges in subdivision. *Journal of Computational and Applied Mathematics*, 349:523 – 531, 2019.

[176] T. Richter and W. Wollner. An optimization framework for the computation of time-periodic solutions of partial differential equations. *Vietnam Journal of Mathematics*, 46(4):949–966, 2018.

[177] S. Roch. The universal algebra generated by a power partial isometry. *Operator Theory: Advances and Applications*, 259:649–662, 2017.

[178] S. Roch. Beyond fractality: piecewise fractal and quasifractal algebras. *Operator Theory: Advances and Applications*, 268:413–428, 2018.

[179] S. Roch. Extension-restriction theorems for algebras of approximation sequences. *Operator Theory: Advances and Applications*, 267:261–284, 2018.

[180] S. Roch and B. Silbermann. Toeplitz and Hankel algebras – axiomatic and asymptotic aspects. *Operator Theory: Advances and Applications*, 267:285–315, 2018.

[181] F. H. Rolf Gohm and B. Kümmerer. Universal preparability of states and asymptotic completeness. *Commun. Math. Phys.*, 352 (1):59–94, 2017.

[182] N. Scheithauer. Automorphic products of singular weight. *Compositio Mathematica*, 153:1855–1892, 2017.

[183] W. Schindler and A. Wiemers. Generic power attacks on RSA with CRT and exponent blinding: new results. *J. Cryptographic Engineering*, 7(4):255–272, 2017.

[184] K. Schmidt and R. Hiptmair. Asymptotic expansion techniques for singularly perturbed boundary integral equations. *Numer. Math.*, 137(2):397–415, 2017.

[185] K. Schmidt, A. Semin, A. Thöns-Zueva, and F. Bake. On impedance conditions for circular multiperforated acoustic liners. *J. Math. Industry*, 8(1):15, 2018.

[186] M. Schmidt, D. Aßmann, R. Burlacu, J. Humpola, I. Joormann, N. Kanelakis, T. Koch, D. Oucherif, M. E. Pfetsch, L. Schewe, R. Schwarz, and M. Sirvent. GasLib – A Library of Gas Network Instances. *Data*, 2(4):40, 2017.

[187] M. Schmidt, M. Sirvent, and W. Wollner. A decomposition method for MINLPs with lipschitz continuous nonlinearities. *Mathematical Programming*, 2018. online-first.

[188] M. Schneider, J. Lang, and W. Hundsdorfer. Extrapolation-based superconvergent implicit-explicit Peer methods with A-stable implicit part. *J. Comp. Phys.*, 367:121–133, 2018.

[189] D. Schröder, A. Gerisch, and J. Lang. Space-time adaptive linearly implicit peer methods for parabolic problems. *J. Comp. Appl. Math.*, 316:330–344, 2017.

[190] A. Semin, B. Delourme, and K. Schmidt. On the homogenization of the Helmholtz problem with thin perforated walls of finite length. *ESAIM Math. Model. Numer. Anal.*, 52(1):29–67, 2018.

[191] A. Semin and K. Schmidt. On the homogenization of the acoustic wave propagation in perforated ducts of finite length for an inviscid and a viscous model. *Proc. R. Soc. Lond. A*, 474(2210), 2018.

[192] A. Sipoş. The asymptotic behaviour of convex combinations of firmly nonexpansive mappings. *Journal of Convex Analysis*. To appear.

[193] A. Sipoş. Codensity and Stone spaces. *Mathematica Slovaca*, 68:57–70, 2018.

[194] C. Steffens, M. Pesavento, and M. E. Pfetsch. A compact formulation for the $\ell_{2,1}$ mixed-norm minimization problem. *Transactions on Signal Processing*, 66(6):1483–1497, 2018.

[195] T. Streicher. A classical realizability model arising from a stable model of untyped lambda calculus. *Logical Methods in Computer Science*, 13, 2017.

[196] M. Ulbrich, S. Ulbrich, and D. Bratzke. A multigrid semismooth Newton method for semilinear contact problems. *Journal of Computational Mathematics*, 35(4):486–528, 2017.

[197] S. Ulbrich and J. C. Ziems. Adaptive multilevel trust-region methods for time-dependent PDE-constrained optimization. *Portugaliae Mathematica*, 74(1):37–67, 2017.

[198] J. van Ekeren, S. Möller, and N. Scheithauer. Construction and classification of holomorphic vertex operator algebras. *To appear in Journal für die reine und angewandte Mathematik*.

[199] J. van Ekeren, S. Möller, and N. Scheithauer. Dimension formulae in genus 0 and uniqueness of vertex operator algebras. *To appear in International Mathematics Research Notices*.

[200] M. Vrzina. Cylinders as left invariant CMC surfaces in Sol_3 and $E(\kappa,\tau)$-spaces diffeomorphic to R^3. *Differential Geometry and its Applications*, 58:141–176, 2018.

[201] M. Walloth. A reliable, efficient and localized error estimator for a discontinuous Galerkin method for the Signorini problem. *Appl. Numer. Math.*, 135:276–296, 2019.

[202] T. Wedhorn. Spherical spaces. *Ann. Inst. Fourier (Grenoble)*, 68(1):229–256, 2018.

[203] A. Weiner and D. Bothe. Advanced subgrid-scale modeling for convection-dominated species transport at fluid interfaces with application to rising bubbles. *J. Comp. Phys.*, 347:261–289, 2017.

[204] B. Williams. Remarks on the theta decomposition of vector-valued Jacobi forms. *Journal of Number Theory*, 197:250–267, 2019.

4.3.2 Proceedings and Chapters in Collections

[1] F. Abed, L. Chen, Y. Disser, M. Groß, N. Megow, J. Meißner, A. Richter, and R. Rischke. Scheduling maintenance jobs in networks. In *Proceedings of the 10th International Conference on Algorithms and Complexity (CIAC)*, pages 19–30, 2017.

[2] L. C. Altherr, N. Brötz, I. Dietrich, T. Gally, F. Geßner, H. Kloberdanz, P. Leise, P. F. Pelz, P. Schlemmer, and A. Schmitt. Resilience in mechanical engineering – a concept for controlling uncertainty during design, production and usage phase of load-carrying structures. In P. F. Pelz and P. Groche, editors, *Uncertainty in Mechanical Engineering III*, volume 885 of *Applied Mechanics and Materials*, pages 187–198, 2018.

[3] L. C. Altherr, B. Dörig, T. Ederer, P. F. Pelz, M. E. Pfetsch, and J. Wolf. A mixed-integer nonlinear program for the design of gearboxes. In A. Fink, A. Fügenschuh, and M. J. Geiger, editors, *Operations Research Proceedings 2016*, pages 227–233. Springer International Publishing, 2018.

[4] L. C. Altherr, L. Joggerst, P. Leise, M. E. Pfetsch, A. Schmitt, and J. Wendt. On obligations in the development process of resilient systems with algorithmic design methods. In P. F. Pelz and P. Groche, editors, *Uncertainty in Mechanical Engineering III*, volume 885 of *Applied Mechanics and Materials*, pages 240–252. Trans Tech Publications, 2018.

[5] L. C. Altherr, P. Leise, M. E. Pfetsch, and A. Schmitt. Algorithmic design and resilience assessment of energy efficient high-rise water supply systems. In P. F. Pelz and P. Groche, editors, *Uncertainty in Mechanical Engineering III*, volume 885 of *Applied Mechanics and Materials*, pages 211–223. Trans Tech Publications, 2018.

[6] L. C. Altherr, P. F. Pelz, T. Ederer, and M. E. Pfetsch. Optimale Getriebe auf Knopfdruck: Gemischt-ganzzahlige nichtlineare Optimierung zur Entscheidungsunterstützung bei der Auslegung von Getrieben für Kraftfahrzeuge. *Tagungsband Antriebstechnisches Kolloquium ATK 2017*, 2017.

[7] S. W. Bae, J.-F. Baffier, J. Chun, P. Eades, K. Eickmeyer, L. Grilli, S.-H. Hong, M. Korman, F. Montecchiani, I. Rutter, and C. Tóth. Gap-planar graphs. In F. Frati and K.-L. Ma, editors, *Graph Drawing and Network Visualization*.

[8] E. Bampas, S. Das, D. Dereniowski, and K. Christina. Collaborative delivery by energy-sharing low-power mobile robots. In *Algorithms for Sensor Systems - 13th International Symposium on Algorithms and Experiments for Wireless Sensor Networks, ALGOSENSORS 2017, Vienna, Austria, September 7-8, 2017, Revised Selected Papers*, pages 1–12, 2017.

[9] A. Bärtschi, J. Chalopin, S. Das, Y. Disser, D. Graf, J. Hackfeld, and P. Penna. Energy-efficient delivery by heterogeneous mobile agents. In *Proceedings of the 34th International Symposium on Theoretical Aspects of Computer Science (STACS)*, page 10(14), 2017.

[10] I. Bausch and R. Bruder. MAKOS – Kompetenzorientierte Lehr- und Lernmaterialien für die Sekundarstufe II. In *Beiträge zum Mathematikunterricht*, pages 209–212. Münster: WTM-Verlag, 2018.

[11] A. Bernstein, K. Däubel, Y. Disser, M. Klimm, T. Mütze, and F. Smolny. Distance-preserving graph contractions. In *Proceedings of the 9th Innovations in Theoretical Computer Science conference (ITCS)*, page 51(14), 2018.

[12] A. Bernstein, Y. Disser, and M. Groß. General bounds for incremental maximization. In *Proceedings of the 44th International Colloquium on Automata, Languages, and Programming (ICALP)*, page 43(14), 2017.

[13] J. Biehl and S. Ulbrich. Multilevel optimization of fluid-structure interaction based on reduced order models. In M. Schäfer, M. Behr, M. Mehl, and B. Wohlmuth, editors, *Recent Advances in Computational Engineering*, pages 15–36. Springer International Publishing, 2017.

[14] A. Bjelde, Y. Disser, J. Hackfeld, C. Hansknecht, M. Lipmann, J. Meißner, K. Schewior, M. Schlöter, and L. Stougie. Tight bounds for online tsp on the line. In *Proceedings of the 28th Annual ACM-SIAM Symposium on Discrete Algorithms (SODA)*, pages 994–1005, 2017.

[15] Z. Bontick, O. Lass, O. Rain, and S. Schöps. Model order reduction for rotating electrical machines. In W. Keiper, A. Milde, and S. Volkwein, editors, *Reduced-Order Modeling (ROM) for Simulation and Optimization: Powerful Algorithms as Key Enablers for Scientific Computing*, pages 121–140. Springer International Publishing, 2018.

[16] R. Bruder. 'Brain Teaser Path as an Approach to Problem-Solving'. In M. Stein, editor, *A Life Time for Mathematics Education and Problem Solving. Festschrift of the Occasion of Andra's Ambrus' 75th Birthday*, pages 38–44. WTM Münster, 2017.

[17] R. Bruder. Fachliche Unterrichtsqualität im Kontext der Basisdimensionen guten Unterrichts aus mathematikdidaktischer Perspektive. In M. Martens, K. Rabenstein, K. Bräu, M. Fetzer, H. Gresch, I. Hardy, and C. Schelle, editors, *Konstruktionen von Fachlichkeit. Ansätze, Erträge und Diskussionen in der empirischen Unterrichtsforschung*, pages 203–2016. Julius Klinkhardt Bad Heilbrunn, 2018.

[18] R. Bruder. Nutzung von Mathematik im Erfahrungshorizont von Schülerinnen und Schülern - Ideen und Beispiele für Anwendungsbezüge im Mathematikunterricht der Sekundarstufe I. In H.-S. Siller, G. Greefrath, and W. Blum, editors, *Neue Materialien für einen realitätsbezogenen Mathematikunterricht 4. 25 Jahre ISTRON-Gruppe - eine*

Best-of-Auswahl aus der ISTRON-Schriftenreihe, pages 133–143. Springer Spectrum, 2018.

[19] R. Bruder. Theorie und Empirie des Entdeckenden Lernens im Mathematikunterricht. In *Beiträge zum Mathematikunterricht*, pages 361 – 364. Münster: WTM-Verlag, 2018.

[20] R. Bruder. Welche Inhalte und in welcher Ausprägung benötigt die Mathematiklehrkräfteausbildung zum Thema 'Problemlösen'? In *Problemlösen unterrichten und untersuchen*, pages 53–64. Münster: WTM-Verlag, 2018.

[21] R. Bruder, N. Feldt-Caesar, M. Kallweit, S. Krusekamp, C. Neugebauer, M. Schaub, and K. Winter. Digital Diagnostic Testing Tasks (DDTA) – Theoretical Design and interactive example. In B. Kaur, W. K. Ho, and T. L. Toh, editors, *Proc. 41th Conf. of the Int. Group for the Psychology of Mathematics Education (Vol. 2)*. PME, 2017.

[22] R. Bruder and U.-H. Krüger. Lerngelegenheiten für Mathematisches Argumentieren, Modellieren und Problemlösen (LEMAMOP). In *Mathematikfortbildungen professionalisieren. Konzepte, Beispiele und Erfahrungen des Deutschen Zentrums für Lehrerbildung Mathematik*, pages 225–248. Springer Wiesbaden, 2018.

[23] F. Canavoi and M. Otto. Common knowledge and multi-scale locality analysis in Cayley structures. In *32nd Annual ACM/IEEE Symposium on Logic in Computer Science, LICS 2017*, pages 1–12, 2017.

[24] I. Ciardelli and M. Otto. Bisimulation in inquisitive modal logic. In J. Lang, editor, *Theoretical Aspects of Rationality and Knowledge, TARK 2017*, 2017. See arXiv:1707.08742.

[25] Y. Disser and S. Kratsch. Robust and adaptive search. In *Proceedings of the 34th International Symposium on Theoretical Aspects of Computer Science (STACS)*, page 26(14), 2017.

[26] Y. Disser, F. Mousset, A. Noever, N. Škorić, and A. Steger. A general lower bound for collaborative tree exploration. In *Proceedings of the 24th International Colloquium on Structural Information and Communication Complexity (SIROCCO)*, pages 125–139, 2017.

[27] H. Egger and T. Kugler. An asymptotic preserving mixed finite element method for wave propagation in pipelines. In *Theory, Numerics and Applications of Hyperbolic Problems I*, pages 515–527. Springer International Publishing, Cham, 2017.

[28] H. Egger and B. Radu. A mass-lumped mixed fem for acoustic wave propagation with inhomogeneous coefficients. *PAMM*, 18:1–2, 2018.

[29] K. Eickmeyer, A. C. Giannopoulou, S. Kreutzer, O. joung Kwon, M. Pilipczuk, R. Rabinovich, and S. Siebertz. Neighborhood complexity and kernelization for nowhere dense classes of graphs. In I. Chatzigiannakis, P. Indyk, F. Kuhn, and A. Muscholl, editors, *44th International Colloquium on Automata, Languages, and Programming*. LIPIcs, 2017.

[30] K. Eickmeyer and K. Kawarabayashi. FO Model Checking on Map Graphs. In R. Klasing and M. Zeitoun, editors, *Fundamentals of Computation Theory*, volume 10472 of *Lecture Notes in Computer Science*, pages 204–216. Springer, 2017.

[31] T. Eiter and M. Kyed. Time-Periodic Linearized Navier–Stokes Equations: An Approach Based on Fourier Multipliers. In T. Bodnár, G. P. Galdi, and Š. Nečasová, editors, *Particles in Flows*, pages 77–137. Springer International Publishing, 2017.

[32] C. Erath and D. Praetorius. Céa-type quasi-optimality and convergence rates for (adaptive) vertex-centered FVM. In *Finite Volumes for Complex Applications VIII - Hyperbolic, Elliptic and Parabolic Problems*, volume 199, pages 210–223. Springer International Publishing, Cham, 2017.

[33] C. Erath and R. Schorr. Comparison of adaptive non-symmetric and three-field FVM-BEM coupling. In *Finite Volumes for Complex Applications VIII - Hyperbolic, Elliptic and Parabolic Problems*, volume 200, pages 337–345. Springer International Publishing, Cham, 2017.

[34] C. Erath and R. Schorr. A simple boundary approximation for the non-symmetric coupling of finite element method and boundary element method for parabolic-elliptic interface problems. In *Numerical Mathematics and Advanced Applications ENUMATH 2017*, pages 993–1001. Springer International Publishing, Cham, 2019.

[35] R. Farwig, H. Kozono, and H. Sohr. Stokes Semigroup, Strong, Weak And Very Weak Solutions For General Domains. In Y. Giga and A. Novotný, editors, *Handbook of Mathematical Analysis in Mechanics of Viscous Fluids, Chapter 8*, pages 419–459. Springer International Publishing AG, 2018.

[36] N. Feldt-Caesar and R. Bruder. Qualitätssicherung digitaler Lernangebote am Beispiel von mathematischen Videos zum (Nach-)Lernen in einführenden Ingenieursveranstaltungen. In *Festschrift Jörg Lange (Festschrift anlässlich des 60. Geburtstages von Herrn Prof. Dr.-Ing. Jörg Lange), TU Darmstadt, Institut für Stahlbau und Werkstoffmechanik. Abrufbar unter: https://tuprints.ulb.tu-darmstadt.de/7466/1/180611_Festschrift[19.03.2019*, pages 163–168, 2018.

[37] T. Fischer, G. Hegde, F. Matter, M. Pesavento, M. E. Pfetsch, and A. M. Tillmann. Joint antenna selection and phase-only beamforming using mixed-integer nonlinear programming. In *WSA 2018; 22nd International ITG Workshop on Smart Antennas*, pages 1–7, 2018.

[38] M. Fricke, M. Köhne, and D. Bothe. On the kinematics of contact line motion, proceedings in applied mathematics and mechanics. 2018.

[39] T. Gally, A. Kuttich, M. E. Pfetsch, M. Schaeffner, and S. Ulbrich. Optimal placement of active bars for buckling control in truss structures under bar failures. In P. F. Pelz and P. Groche, editors, *Uncertainty in Mechanical Engineering III*, volume 885 of *Applied Mechanics and Materials*, pages 119–130, 2018.

[40] M. Gerich, M. Trittel, S. Bruder, J. Klug, S. Hertel, R. Bruder, and B. Schmitz. Modeling, Measuring, and Training Teachers Counseling and Diagnostic Competencies. In D. Leutner, J. Fleischer, J. Grünkorn, and E. Klieme, editors, *Competence Assessment in Education: Research, Models and Instruments: Research, Models and Instruments. Methodology of Educational Measurement and Assessment*, pages 3149–166. Springer Amsterdam, 2017.

[41] B. Götz, A. Kuttich, and S. Ulbrich. Robust optimization of shunted piezoelectric transducers for vibration attenuation considering different values of electromechanical coupling. In *Model Validation and Uncertainty Quantification*, volume 3, pages 51–59, 2017.

[42] D. Gründing, D. Bothe, and H. Marschall. Wetting phenomena with ALE interface tracking, Proceedings in Applied Mathematics and Mechanics. 2018.

[43] G. Hegde, M. Pesavento, and M. E. Pfetsch. Joint active device identification and symbol detection using sparse constraints in massive MIMO systems. In *Proc. 25th European Signal Processing Conference (EUSIPCO)*, 2017.

[44] C. Hojny, M. E. Pfetsch, and A. Schmitt. Extended formulations for column constrained orbitopes. In N. Kliewer, J. F. Ehmke, and R. Borndörfer, editors, *Operations Research Proceedings 2017*, pages 197–203. Springer International Publishing, 2018.

[45] F. Johlke. Project EoM - The use of digital tools for an activation of Conceptual-Change-processes at mathematical misconceptions. In A. L. M. Louis Gómez Chova and I. C. Torre, editors, *Edulearn 17. Conference proceedings. Barcelona: IATED Academy (EDULEARN proceedings (Internet))*, pages 828–833, 2017.

[46] F. Johlke. Einsatz digitaler Werkzeuge zur Aktivierung von Conceptual-Change-Prozessen bei Fehlvorstellungen. In *Beiträge zum Mathematikunterricht*. Institut für Mathematik der Universität Potsdam (Hg.), 2017.

[47] F. Johlke. Fehlvorstellungen durch E-Feedback überwinden. Vorstellung eines Dissertationsprojekts. In G. Pinkernell and F. Schacht)., editors, *Arbeitstagung des Arbeitskreises Mathematikunterricht und digitale Werkzeuge in der Gesellschaft für Didaktik der Mathematik vom 22. - 24. September 2017 in Heidelberg*. Franzbecker Hildesheim, 2018.

[48] F. Johlke. Digitale (interaktive) und individuelle Feedbackvarianten zu Fehlern Lernender bei digital gestellten Mathematikaufgabenn. In F. D. der Mathematik der Universität Paderborn (Hg)., editor, *Beiträge zum Mathematikunterrich*, pages 891–894. WTM-Verlag Münster, 2018.

[49] F. Johlke, U. Roder, and R. Bruder. Projekt ELMA – Eine Untersuchung von Einflussfaktoren auf Leistungserfolge im Realschulabschluss Mathematik mit Hilfe der Analyse von Klassenarbeiten der Abschlussklassen. In *Beiträge zum Mathematikunterricht*. WTM-Verlag Münster, 2019 (in press).

[50] M. Kallweit, M. Schaub, N. Feldt-Caesar, R. Bruder, S. Krusekamp, C. Neugebauer, and K. Winter. Digitale Diagnostische Testaufgaben – Theoretisches Design und interaktives Beispiel. In *Beiträge zum Mathematikunterricht*, pages 1423 – 1424. WTM-Verlag Münster, 2017.

[51] L. Kastner, B. Lorenz, A. Paffenholz, and A.-L. Winz. Toric geometry in polymake. *ACM Communications in Computer Algebra*, 51(3):92–94, 2017.

[52] U. Kohlenbach. Kreisel's 'shift of emphasis' and contemporary proof mining. In M. Marfori and M. Petrolo, editors, *'Intuitionism, Computation, and Proof: Selected themes from the research of G. Kreisel'*. Springer, 2019.

[53] U. Kohlenbach. Proof-theoretic methods in nonlinear analysis. In P. N. de Souza et al., editor, *Proceedings ICM2018*. World Scientific, 2019.

[54] T. Leuders, R. Bruder, U. Kroehne, D. Naccarella, R. Nitsch, J. Henning-Kahmann, A. Kelava, and M. Wirtz. Development, Validation, and Application of a Competence Model for Mathematical Problem Solving by Using and Translating Representations of Functions. In D. Leutner, J. Fleischer, J. Grünkorn, and E. Klieme, editors, *Competence Assessment in Education: Research, Models and Instruments: Research, Models and Instruments. Methodology of Educational Measurement and Assessment*, pages 389–406. Springer Amsterdam, 2017.

[55] A. A. Lukassen and M. Kiehl. Parameter estimation with model order reduction and global measurements. *PAMM*, 17(1):773–774, 2017.

[56] A. A. Lukassen and M. Kiehl. Operator splitting for stiff chemical reaction systems. *PAMM*, 18(1):1–2, 2018.

[57] H. Lüthen, S. Gramlich, B. M. Horn, I. Mattmann, M. E. Pfetsch, M. Roos, S. Ulbrich, C. Wagner, and A. Walter. Finding the best: Mathematical optimization based on product and process requirements. In P. Groche, E. Bruder, and S. Gramlich, editors, *Manufacturing Integrated Design: Sheet Metal Product and Process Innovation*, pages 147–200. Springer International Publishing, 2017.

[58] A. Madzvamuse, A. Gerisch, and R. Barreira. Cross-diffusion in reaction-diffusion models: analysis, numerics and applications. In P. Quintela, P. Barrali, D. Gómez, et al., editors, *Progress in Industrial Mathematics at ECMI 2016*, pages 385–392. Springer International Publishing, Cham, 2017.

[59] H. Marschall, C. Falconi, C. Lehrenfeld, R. Abiev, M. Wörner, A. Reusken, and D. Bothe. Direct numerical simulations of taylor bubbles in a square mini-channel: detailed shape and flow analysis with experimental validation. In D. Bothe and A. Reusken, editors, *Transport Processes at Fluidic Interfaces*. Birkhäuser/Springer, 2017.

[60] C. Müller, S. Ullmann, and J. Lang. A Bramble-Pasciak conjugate gradient method for discrete Stokes problems with lognormal random viscosity. In M. Schäfer, M. Behr, M. Mehl, and B. Wohlmuth, editors, *Recent Advances in Computational Engineering - Darmstadt 2017*, volume 124 of *Lecture Notes in Computational Science and Engineering*, pages 63–87. Springer International Publishing, Cham, 2018.

[61] D. Nowak, T. Mahn, H. Al-Shatri, A. Schwartz, and A. Klein. A generalized Nash game for mobile edge computation offloading. In *6th IEEE International Conference on Mobile Cloud Computing, Services, and Engineering (MobileCloud)*, pages 95–102, March 2018.

[62] A. Paffenholz. `polyDB`: a database for polytopes and related objects. In *Algorithmic and experimental methods in algebra, geometry, and number theory*, pages 533–547. Springer International Publishing, 2017.

[63] R. Penta and A. Gerisch. An introduction to asymptotic homogenization. In A. Gerisch, R. Penta, and J. Lang, editors, *Multiscale Models in Mechano and Tumor Biology: Modeling, Homogenization, and Applications*, pages 1–26. Springer International Publishing, Cham, 2018.

[64] C. Pesci, H. Marschall, T. Kairaliyeva, V. Ulaganathan, R. Miller, and D. Bothe. Experimental and computational analysis of fluid interfaces influenced by soluble surfactant. In D. Bothe and A. Reusken, editors, *Transport Processes at Fluidic Interfaces*. Birkhäuser/Springer, 2017.

[65] T. Powell. Computational interpretations of classical reasoning: From the epsilon calculus to stateful programs. To appear in: Centrone, S., Negri, S., Sarikaya, D. and Schuster, P. eds., *Mathesis Universalis, Computability and Proof*, Synthesis Library, Springer., 2018.

[66] T. Powell. A functional interpretation with state. In *Proceedings of Logic in Computer Science (LICS 2018)*. ACM, 2018.

[67] T. Powell. Well quasi-orders and the functional interpretation. To appear in: Schuster, P., Seisenberger, M. and Weiermann, A. (eds.), *Well Quasi-Orders in Computation, Logic, Language and Reasoning*, Trends in Logic, Springer., 2018.

[68] L. M. Reitter, M. Liu, J. Breitenbach, K.-L. Huang, D. Bothe, G. Brenn, K.-L. Pan, I. V. Roisman, and C. Tropea. Experimental and computational investigation of binary drop collisions under elevated ambient pressure. In *ILASS 2017, Valencia, Spain*, 2017.

[69] U. Roder, I. Apel, and F. Johlke. Förderung von Grundwissen und Grundkönnen. In *Beiträge zum Mathematikunterrich*. WTM-Verlag Münster, 2019 (in print).

[70] M. Schaub. Zur Entwicklung eines förderwirksamen online-Feedbacks zum VEMINT-Eingangstest. In *Beiträge zum Mathematikunterrich*, pages 829–832. WTM-Verlag Münster, 2017.

[71] M. Schaub. Einsatz des Elementarisierenden Testens im Ein- und Ausgangstest des online-Vorkurses VEMINT. In *Beiträge zum Mathematikunterrich*, pages 1567–1570. WTM-Verlag Münster, 2018.

[72] M. Schaub and U. Roder. Arbeit mit optimierten Lerngruppen im Online-Vorkurs VEMINT. In *Beiträge zum Mathematikunterrich*, pages 841–844. WTM-Verlag Münster, 2017.

[73] I. Schreiber. Befragungsergebnisse zu Phänomenen am Übergang Schule-Hochschule bei Mathematikstudierenden. In F. D. der Mathematik der Universität Paderborn, editor, *Beiträge zum Mathematikunterrich*. WTM-Verlag Münster, 2019.

[74] C. Spannring, S. Ullmann, and J. Lang. A weighted reduced basis method for parabolic PDEs with random data. In M. Schäfer, M. Behr, M. Mehl, and B. Wohlmuth, editors, *Recent Advances in Computational Engineering - Darmstadt 2017*, volume 124 of *Lecture Notes in Computational Science and Engineering*, pages 145–161. Springer International Publishing, Cham, 2018.

[75] C. Steffens, M. Pesavento, and M. E. Pfetsch. A compact formulation for the $\ell_{2,1}$ mixed-norm minimization problem. In *2017 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, pages 4730–4734, 2017.

[76] A. M. Tillmann and M. E. Pfetsch. Computing the spark of a matrix. In M. A. T. Figueiredo and M. Plumbley, editors, *Proc. SPARS 2017*, 2017. Extended Abstract, Article 31.

[77] M. Walloth. Localized and efficient estimators for obstacle problems in the context of standard residual estimators. *PAMM*, 17:767–768, 2017.

[78] M. Walloth. Residual-type a posteriori estimator for a viscoelastic contact problem with velocity constraints. *PAMM*, 18, 2018.

4.4 Preprints

[1] J. Alex and K. Grosse-Brauckmann. Periodic Steiner networks minimizing length. Preprint, TU Darmstadt, 2017.

[2] A. Alla, M. Hinze, O. Lass, and S. Ulbrich. A certified model reduction approach for robust optimal control with PDE constraints. Preprint, arXiv:1703.01613, 2017.

[3] L. C. Altherr, P. Leise, M. E. Pfetsch, and A. Schmitt. Resilient layout, design and operation of energy-efficient water distribution networks for high-rise buildings using MINLP. Preprint, Optimization Online, 2018. To appear in Optimization and Engineering.

[4] F. Aurzada and M. Kettner. Persistence exponents via perturbation theory: AR(1)-processes. 2018+. Preprint, arXiv:1810.09861.

[5] F. Aurzada and M. Lifshits. How complex is a random picture? 2018+. Journal of Complexity, to appear, arXiv:1806.06597.

[6] F. Aurzada and C. Mönch. Persistence probabilities and a decorrelation inequality for the Rosenblatt process and Hermite processes. 2017+. Theory of Probability and Its Applications, to appear, arXiv:1607.04045.

[7] F. Aurzada, S. Mukherjee, and O. Zeitouni. Persistence exponents in Markov chains. 2017+. Preprint, arXiv:1703.06447.

[8] E. Bampas, J. Chalopin, S. Das, J. Hackfeld, and C. Karousatou. Maximal exploration of trees with energy-constrained agents. Preprint, arXiv:1802.06636, 2018.

[9] B. Bauer and M. Kohler. On deep learning as a remedy for the curse of dimensionality in nonparametric regression. Preprint, TU Darmstadt, 2017.

[10] S. Beckers, J. Behrens, and W. Wollner. Duality based error estimation in the presence of discontinuities. Preprint, SFB-TRR 154, 2017.

[11] V. Betz, J. Ehlert, and B. Lees. Explicit phase conditions for random loop models on trees using an exploration scheme. *preprint*, 2018.

[12] V. Betz, B. Goddard, and T. Hurst. Non-adiabatic transitions in multiple dimensions. *preprint*, 2018.

[13] V. Betz, H. Schäfer, and L. Taggi. Interacting self-avoiding polygons. *preprint*, 2018.

[14] V. Betz, H. Schäfer, and D. Zeindler. Random permutations without macroscopic cycles. *preprint*, 2018.

[15] V. Betz and L. Taggi. Scaling limit of a self-avoiding walk interacting with spatial random permutations. *preprint*, 2018.

[16] T. Bouganis and J. Marzec. Algebraicity of special L-values attached to Siegel-Jacobi modular forms. Preprint, Durham University and TU Darmstadt, 2018.

[17] T. Bouganis and J. Marzec. On the analytic properties of the standard L-function attached to Siegel-Jacobi modular forms. Preprint, Durham University and TU Darmstadt, 2018.

[18] O. Braun, K. H. Hofmann, and L. Kramer. Automatic Continuity of Algebraic Homomorphisms between Locally Compact Groups. Latex-Script accepted for publication by Transformation Groups, 32pp., Universität Münster, 2017.

[19] J. H. Bruinier, B. Howard, S. Kudla, M. Rapoport, and T. Yang. Modularity of generating series of divisors on unitary Shimura varieties. Preprint, 2017.

[20] J. H. Bruinier, B. Howard, S. Kudla, M. Rapoport, and T. Yang. Modularity of generating series of divisors on unitary Shimura varieties II: arithmetic applications. Preprint, 2017.

[21] J. H. Bruinier and M. Möller. Cones of Heegner divisors. Preprint, 2017.

[22] J. H. Bruinier and M. Schwagenscheidt. A converse theorem for Borcherds products on $X_0(N)$. Preprint, 2018.

[23] J. H. Bruinier and T. Yang. Arithmetic degrees of special cycles and derivatives of Siegel Eisenstein series. Preprint, 2018.

[24] F. Brunault and M. Neururer. Fourier expansions at cusps. Preprint, ENS Lyon and TU Darmstadt, 2018.

[25] M. Buck. Limit theorems for random walks with absorption. Preprint, arxiv:1811.11681, TU Darmstadt, 2018+.

[26] T. Burggraf, M. Joswig, M. E. Pfetsch, M. Radons, and S. Ulbrich. Semi-automatically optimized calibration of internal combustion engines. Technical report, arXiv:1806.10980, 2018.

[27] A. Celik and M. Kyed. Nonlinear acoustics: Blackstock-Crighton equations with a periodic forcing term. *arXiv:1710.06457*, 2017.

[28] A. Celik and M. Kyed. Time-periodic Stokes equations with inhomogeneous Dirichlet boundary conditions in a half-space. *arXiv:1809.02424*, 2017.

[29] I. Ciardelli and M. Otto. Inquisitive bisimulation. Preprint, TU Darmstadt, 2018. See arXiv:1803.03483, 57 pages.

[30] K. Disser. Global existence, uniqueness and stability for nonlinear dissipative bulk-interface interaction systems. Preprint, arXiv:1703.07616, 2017.

[31] K. Disser and J. Rehberg. The 3d transient semiconductor equations with gradient-dependent and interfacial recombination. Preprint, WIAS Preprint 2507, 2018.

[32] Y. Disser, A. E. Feldmann, M. Klimm, and J. Könemann. Travelling on graphs with small highway dimension. Preprint, arXiv:1902.07040, 2018.

[33] Y. Disser and A. V. Hopp. On Friedmann's subexponential lower bound for Zadeh's pivot rule. Technical report, TU Darmstadt, 2018. Available at `http://tuprints.ulb.tu-darmstadt.de/id/eprint/7557`.

[34] Y. Disser and J. Matuschke. The complexity of computing a robust flow. Preprint, arXiv:1704.08241, 2018.

[35] P. Domschke, B. Hiller, J. Lang, and C. Tischendorf. Modellierung von Gasnetzwerken: Eine Übersicht. Preprint 2717, Fachbereich Mathematik, TU Darmstadt, 2017.

[36] H. Egger, T. Kugler, and B. Liljegren-Sailer. Stability preserving approximations of a semilinear hyperbolic gas transport model. arXiv:1812.03726, 2018.

[37] H. Egger, T. Kugler, and V. Shashkov. An inexact Petrov-Galerkin approximation for gas transport in pipeline networks. arXiv:1811.05215, 2018.

[38] H. Egger, T. Kugler, and W. Wollner. Numerical optimal control of instationary gas transport with control and state constraints. TRR154 Report No. 214, 2017.

[39] H. Egger and B. Radu. A mass-lumped mixed finite element method for acoustic wave propagation. arXiv:1803.04238, 2018.

[40] H. Egger and B. Radu. A mass-lumped mixed finite element method for maxwell's equations. arXiv:1810.06243, 2018.

[41] H. Egger and B. Radu. A second order multipoint flux mixed finite element method on hybrid meshes. arXiv:1812.03938, 2018.

[42] H. Egger and L. Schöbel-Kröhn. Chemotaxis on networks: Analysis and numerical approximation. arXiv:1805.00925, 2018.

[43] H. Egger, V. Shashkov, and K. Schmidt. Multistep and Runge-Kutta convolution quadrature methods for coupled dynamical systems. arXiv:1811.09817, 2018.

[44] H. Egger and G. Teschner. On the stable estimation of flow geometry and wall shear stress from magnetic resonance images. arXiv:1812.09848, 2018.

[45] C. Erath, G. Gantner, and D. Praetorius. Optimal convergence behavior of adaptive FEM driven by simple $(h-h/2)$-type error estimators. arXiv:1805.00715, 2018.

[46] C. Erath and D. Praetorius. Optimal adaptivity for the SUPG finite element method. arXiv:1806.11000, 2018.

[47] C. Erath and R. Schorr. Stable non-symmetric coupling of the finite volume and the boundary element method for convection-dominated parabolic-elliptic interface problems. arXiv:1805.05142, 2018.

[48] R. Farwig, Y. Giga, and P.-Y. Hsu. On the continuity of the solutions to the Navier-Stokes equations with initial data in critical Besov spaces. *Ann. Mat. Pura Appl.*, 2018.

[49] R. Farwig and V. Rosteck. Maximal regularity of the Stokes system with Navier boundary conditions in general unbounded domains. *J. Math. Soc. Japan*, 2018.

[50] T. Fischer and M. E. Pfetsch. On the structure of linear programs with overlapping cardinality constraints. Technical report, Optimization Online, 2017. `http://www.optimization-online.org/DB_HTML/2017/01/5833.html`.

[51] F. Flandoli and M. Saal. mSQG equations in distributional spaces and point vortex approximation. Technical report, Scuola Normale Superiore and TU Darmstadt, 2018.

[52] A. Freund. A categorical construction of Bachmann-Howard fixed points. Preprint, TU Darmstadt, 2018.

[53] A. Freund. Computable aspects of the Bachmann-Howard principle. Preprint, TU Darmstadt, 2018.

[54] A. Freund. Π^1_1-comprehension as a well-ordering principle. Preprint, TU Darmstadt, 2018.

[55] M. Fricke, M. Köhne, and D. Bothe. A kinematic evolution equation for the dynamic contact angle and some consequences. Preprint, TU Darmstadt, 2019.

[56] K. Furukawa, Y. Giga, M. Hieber, A. Hussein, T. Kashiwabara, and M. Wrona. Rigorous justification of the hydrostatic approximation for the primitive equations by scaled Navier-Stokes equations. Preprint, 2018.

[57] Y. Giga, M. Gries, M. Hieber, A. Hussein, and T. Kashiwabara. The primitive equations in the scaling invariant space $L^\infty(L^1)$. Preprint, 2017.

[58] Y. Giga, M. Gries, M. Hieber, A. Hussein, and T. Kashiwabara. The hydrostatic Stokes semigroup and well-posedness of the primitive equations on spaces of bounded functions. Preprint, 2018.

[59] A. Gleixner, M. Bastubbe, L. Eifler, T. Gally, G. Gamrath, R. L. Gottwald, G. Hendel, C. Hojny, T. Koch, M. E. Lübbecke, S. J. Maher, M. Miltenberger, B. Müller, M. E. Pfetsch, C. Puchert, D. Rehfeldt, F. Schlösser, C. Schubert, F. Serrano, Y. Shinano, J. M. Viernickel, M. Walter, F. Wegscheider, J. T. Witt, and J. Witzig. The SCIP optimization suite 6.0. ZIB-Report 18-26, Zuse Institute Berlin, 2018.

[60] A. Gleixner, L. Eifler, T. Gally, G. Gamrath, P. Gemander, R. L. Gottwald, G. Hendel, C. Hojny, T. Koch, M. Miltenberger, B. Müller, M. E. Pfetsch, C. Puchert, D. Rehfeldt, F. Schlösser, F. Serrano, Y. Shinano, J. M. Viernickel, S. Vigerske, D. Weninger, J. T. Witt, and J. Witzig. The SCIP optimization suite 5.0. ZIB-Report 17-61, Zuse Institute Berlin, 2017.

[61] B. Götz, S. Kersting, and M. Kohler. Estimation of an improved surrogate model in uncertainty quantification by neural networks. Preprint, TU Darmstadt, 2018.

[62] M. Grados and A.-M. von Pippich. Self-intersection of the relative dualizing sheaf on modular curves $x(n)$. Preprint, TU Darmstadt, 2018.

[63] C. Gräßle, M. Hinze, J. Lang, and S. Ullmann. POD model order reduction with space-adapted snapshots for incompressible flows. arXiv:1810.03892, 2018.

[64] K. Grosse-Brauckmann and S. Kürsten. Construction of embedded periodic surfaces in R^n. Technical report, arXiv:1707.09176.

[65] O. Habeck, M. E. Pfetsch, and S. Ulbrich. Global optimization of ODE constrained network problems on the example of stationary gas transport. Preprint, SFB-TRR 154, 2017.

[66] M. Hansmann, M. Kohler, and H. Walk. On the strong universal consistency of local averaging regression estimates. Preprint, TU Darmstadt, 2017.

[67] F. Heimrich, M. Kohler, and L. Kristl. Nonparametric estimation of time-dependent quantiles in a simulation model. Preprint, TU Darmstadt, 2017.

[68] W. Herfort, K. H. Hofmann, L. Kramer, and F. G. Russo. The Sylow Structure of Scalar Automorphism Groups. Latex-Script accepted for publication by Topology Appl., 24 pp., Mathematisches Forschungsinstitut Oberwolfach, 2018.

[69] W. Herfort, K. H. Hofmann, and F. G. Russo. Locally Compact Abelian p-Groups. Latex-Script accepted for publication by Topology Appl., 52pp., TU Wien, 2018.

[70] W. Herfort, K. H. Hofmann, and F. G. Russo. When is the Sum of Two Closed Subgroups Closed in a Locally Compact Abelian Group? Latex-Script accepted for publication by Topology Appl., 30 pp., TU Wien, 2018.

[71] M. Hieber, M. Murata, and M. Wrona. Global strong well-posedness for the Q-tensor model: the case of arbitrary large alignment and tumbling effects. Preprint, 2018.

[72] M. Hieber and J. Prüss. Bounded H^∞-calculus for a class of non local operators: the bidomain operator in the L^q-setting. Preprint, 2018.

[73] M. Hieber and J. Prüss. Dynamics of the Ericksen-Leslie model subject to general Leslie stress: Part II. Preprint, 2018.

[74] C. Hojny. Packing, partitioning, and covering symresacks. Preprint, Optimization Online, 2017.

[75] C. Hojny. Strong IP formulations need large coefficients. Preprint, Optimization Online, 2018.

[76] C. Hojny, I. Joormann, H. Lüthen, and M. Schmidt. Mixed-integer programming techniques for the connected max-k-cut problem. Preprint, Optimization Online, 2018.

[77] C. Hojny, H. Lüthen, and M. E. Pfetsch. On the size of integer programs with bounded coefficients and sparse constraints. Preprint, Optimization Online, 2017.

[78] W. Huang, L. Kamenksi, and J. Lang. Conditioning of implicit Runge-Kutta integration for finite element approximation of linear diffusion equations on anisotropic meshes. arXiv:1703.06463, 2017.

[79] A. Hussein. Partial and full hyper-viscosity for Navier-Stokes and primitive equations. Preprint, Arxiv, 2018.

[80] P. Joly, M. Kachanovska, and A. Semin. Wave propagation in fractal trees. mathematical and numerical issues. hal archives ouvertes hal-01801394, 2018.

[81] K. Kellner, M. E. Pfetsch, and T. Theobald. Irreducible infeasible subsystems of semidefinite systems. Preprint, arXiv:1804.01327, 2018. http://arxiv.org/abs/1804.01327.

[82] W. R. Khudabukhsh, A. Auddy, Y. Disser, and H. Koeppl. Approximate lumpability for markovian agent-based models using local symmetries. Preprint, arXiv:1804.00910, 2018.

[83] U. Kohlenbach, G. Lopéz-Acedo, and A. Nicolae. A quantitative analysis of the 'Lion-Man' game. Preprint, arxiv:1806.04496, submitted, TU Darmstadt, 2018.

[84] U. Kohlenbach and A. Sipoş. The finitary content of sunny nonexpansive retractions. Preprint, arxiv:1812.04940, submitted, TU Darmstadt, 2018.

[85] M. Kohler and A. Krzyżak. Estimating quantiles in imperfect simulation models using conditional density estimation. Preprint, TU Darmstadt, 2017.

[86] M. Kohler and A. Krzyżak. Estimation of a density from an imperfect simulation model. Preprint, TU Darmstadt, 2017.

[87] M. Kohler and A. Krzyżak. Improving a surrogate model in uncertainty quantification by real data. Preprint, TU Darmstadt, 2018.

[88] J. M. Kroos, C. Stinner, C. Surulescu, and N. Surulescu. SDE-driven modeling of phenotypically heterogeneous tumors: the influence of cancer cell stemness. Preprint, 2018.

[89] J. Lang and R. Scheichl. Adaptive multilevel stochastic collocation method for randomized elliptic PDEs. Technical Report Technische Universität Darmstadt, Department of Mathematics, Preprint 2718, 2017.

[90] S. Langer and M. Kohler. Deep versus deeper learning in nonparametric regression. Preprint, TU Darmstadt, 2018.

[91] Y. Li. Average CM-values of Higher Green's Function and Factorization. 2018.

[92] Y. Li. Singular units and isogenies between CM elliptic curves. 2018.

[93] Y. Li, H. Narita, and A. Pitale. An explicit construction of non-tempered cusp forms on $o(1,8n+1)$. 2018.

[94] Y. Li and M. Neururer. A magnetic modular form. 2018.

[95] S. J. Maher, T. Fischer, T. Gally, G. Gamrath, A. Gleixner, R. L. Gottwald, G. Hendel, T. Koch, M. E. Lübbecke, M. Miltenberger, B. Müller, M. E. Pfetsch, C. Puchert, D. Rehfeldt, S. Schenker, R. Schwarz, F. Serrano, Y. Shinano, D. Weninger, J. T. Witt, and J. Witzig. The SCIP optimization suite 4.0. ZIB-Report 17-12, Zuse Institute Berlin, 2017.

[96] K. Mang, T. Wick, and W. Wollner. A phase-field model for fractures in incompressible solids. Preprint, arXiv:1901.05738, 2018.

[97] J. Marzec. Maass relations for Saito-Kurokawa lifts of higher levels. Preprint, TU Darmstadt, 2018.

[98] P. Mindt, J. Lang, and P. Domschke. Entropy-preserving coupling of hierarchical gas models. arXiv:1812.05927, 2018.

[99] M. Mohammadi and W. Wollner. A priori error estimates for a linearized fracture control problem. Technical Report SPP1962-90, SPP 1962, 2018.

[100] C. Müller, S. Ullmann, and J. Lang. A Bramble-Pasciak conjugate gradient method for discrete Stokes problems with random viscosity. arXiv:1801:01838, 2018.

[101] I. Neitzel, T. Wick, and W. Wollner. An optimal control problem governed by a regularized phase-field fracture propagation model. part II the regularization limit. Technical Report SPP1962-91, SPP 1962, 2018.

[102] M. Neururer and T. Oliver. Two converse theorems for maass forms. Preprint, TU Darmstadt and University of Oxford, 2018.

[103] M. Niethammer, G. Brenn, H. Marschall, and D. Bothe. An extended volume of fluid method and its application to single bubbles rising in a viscoelastic liquid. Preprint, TU Darmstadt, 2019.

[104] M. Niethammer, H. Marschall, and D. Bothe. Robust direct numerical simulation of viscoelastic flows. Preprint, TU Darmstadt, 2019.

[105] T. Powell. Sequential algorithms and the computational content of classical proofs. Preprint, available at `https://arxiv.org/abs/1812.11003`, 2018.

[106] A.-T. Rauls and S. Ulbrich. Subgradient computation for the solution operator of the obstacle problem. Preprint, SPP 1962, 2018.

[107] S. Roch. Beyond fractality: piecewise fractal and quasifractal algebras. Preprint, TU Darmstadt, 2017.

[108] S. Roch and B. Silbermann. Toeplitz and Hankel algebras - axiomatic and asymptotic aspects. Preprint, TU Darmstadt, 2017.

[109] M. Saal. Primitive equations with half horizontal viscosity. Preprint, TU Darmstadt, 2018.

[110] M. Schmidt, M. Sirvent, and W. Wollner. The cost of not knowing enough: Mixed-integer optimization with implicit lipschitz nonlinearities. Preprint, TU Darmstadt, 2018.

[111] J. M. Schmitt and S. Ulbrich. Optimal boundary control of hyperbolic balance laws with state constraints. Preprint, TRR 154, 2017. `https://opus4.kobv.de/opus4-trr154/frontdoor/index/index/docId/219`.

[112] S. Schweer and C. Wichelhaus. Nonparametric estimation of the service time distribution in discrete-time queueing networks. Preprint, TU Darmstadt, 2017.

[113] T. Streicher and J. Weinberger. Simplicial sets inside cubical sets. Preprint, TU Darmstadt, 2018.

[114] S. Ullmann and J. Lang. Stochastic Galerkin reduced basis methods for parametrized linear elliptic PDEs. arXiv:1812.08519, 2018.

[115] A.-M. von Pippich, M. Schwagenscheidt, and F. Völz. Kronecker limit formulas for parabolic, hyperbolic, and elliptic Eisenstein series via Borcherds products. Preprint, TU Darmstadt, 2017.

[116] M. von Rohrscheidt und Cornelia Wichelhaus. Bayesian nonparametric inference for M/G/1 queueing systems. Preprint, TU Darmstadt, 2018.

[117] M. Vrzina. On the existence problem for tilted unduloids in $H^2 \times R$. Technical report, arXiv:1702.02761 [math.DG].

[118] M. Walloth. Residual-type a posteriori error estimator for a quasi-static Signorini contact problem. Preprint 2721, Fachbereich Mathematik, TU Darmstadt, 2018.

[119] M. Walloth. Residual-type A Posteriori Estimators for a Singularly Perturbed Reaction-Diffusion Variational Inequality – Reliability, Efficiency and Robustness. arXiv:1812.01957, 2018.

[120] T. Wedhorn and P. Ziegler. Tautological rings of shimura varieties and cycle classes of ekedahl-oort strata. Preprint, TU Darmstadt, 2018.

[121] A. Weiner, D. Hillenbrand, H. Marschall, and D. Bothe. Data-driven subgrid-scale modeling for convection-dominated concentration boundary layers. Preprint, TU Darmstadt, 2019.

[122] A. Weiner, J. Timmermann, C. Pesci, J. Grewe, M. Hoffmann, M. Schlüter, and D. Bothe. Experimental and numerical investigation of reactive species transport around a small rising bubble. Technical report, TU Darmstadt, 2019.

[123] B. Williams. Computing antisymmetric modular forms and theta lifts. Preprint, TU Darmstadt, 2018.

[124] B. Williams. The rings of Hilbert modular forms for $\mathbb{Q}(\sqrt{29})$ and $\mathbb{Q}(\sqrt{37})$. Preprint, TU Darmstadt, 2018.

4.5 Reviewing and Refereeing

Björn Augner: Mathematical Reviews; Automatica, ESAIM: Mathematical Modelling and Numerical Analysis, IEEE Transactions on Automatic Control, Linear Operators and Linear Systems, Nonlinear Analysis: Real World Applications

Frank Aurzada: Mathematical Reviews; Annals of Applied Probability, Bernoulli, Electronic Communications in Probability, Electronic Journal of Probability, Journal of Physics A, Journal of Statistical Physics, Journal of Theoretical Probability, Theory of Probability and Mathematical Statistics

Dieter Bothe: Advances in Differential Equations, AIChE Journal, Applied Numerical Mathematics, Computers and Fluids, Interfaces and Free Boundaries, International Journal of Multiphase Flow, Journal of Computational Physics, Journal of Fluid Mechanics, Journal of Mathematical Physics

Regina Bruder: Journal für Didaktik der Mathematik; Journal mathematik lehren, Journal für Erziehungswissenschaft, Journal Zentralblatt für Didaktik der MathemtatikInternational Journal of Research in Undergraduate Mathematics Education; German Research Funding Organisation /DFG)

Jan H. Bruinier: Invent. Math., Ann. of Math., Acta Math., Journal of the AMS, Math. Ann., Duke Math. Journal, Crelle, Advances in Mathematics, Compositio Mathematica, etc.

Karoline Disser: Mathematical Reviews; Nonlinear Analysis: Real-World Applications, Journal of Mathematical Physics

Yann Disser: Mathematical Reviews; ALGOCLOUD 2018, Distributed Computing, ESA 2017, European Journal of Operational Research, ICPP 2018, Journal of Combinatorial Optimization, Journal of Experimental Algorithms, Journal of Parallel and Distributed Computing, Journal of the ACM, Mathematical Programming, PODC 2018, SIROCCO 2017, SPAA 2019, Transactions on Network Science and Engineering

Jürgen Dölz: SIAM Journal on Scientific Computing

Herbert Egger: Mathematical Reviews; Applied Mathematics and Computer Science, Applied Numerical Mathematics, Applied Mathematics and Computation, Computational and Applied Mathematics with Applications, BIT Numerical Mathematics, Computational and Applied Mathematics, Computers and Mathematics with Applications, ESAIM: Control Optimisation and Calculus of Variations, ESAIM:Mathematical Modelling and Numerical Analysis, Inverse Problems, Journal Applied Mathematics and Computing, Journal Inverse and Ill-posed Problems, Journal Mathematical Analysis and Applications, Mathematical and Compuational Applications, Mathematical Methods in the Applied Sciences, Numerische Mathematik, SIAM Journal on Numerical Analysis, SIAM Journal on Scientific Computing

Kord Eickmeyer: Journal of Symbolic Logic, Logical Methods in Computer Science,Transactions on Computational Logic,Fundamenta Informaticae

Christoph Erath: Mathematical Reviews; SIAM Journal Scientific Computing, Computers and Mathematics with Applications, Applied Mathematics and Computation, Monthly Weather Review, Science China Mathematics, Finite Volumes for Complex Applications 8

Reihard Farwig: Mathematical Reviews; Annali dell'Università di Ferrara Sez. VII Sci. Mat., Applied Mathematics (SCIRP), Communications in Partial Differential Equations, Electronic J. Differential Equations, J. Abstract Differential Equations and Applications, J. Differential Equations, J. Evolution Equations, J. Mathematical Analysis and Applications, J. Mathematical Fluid Mechanics, manuscripta mathematica, Mathematical Methods in the Applied Sciences, Mathematische Nachrichten, Mathematische Zeitschrift, Nonlinear Analysis, Nonlinearity, SIAM J. Mathematical Analysis, Zeitschrift für Angewandte Mathematik und Mechanik

Anton Freund: Zentralblatt MATH; Annals of Pure and Applied Logic, Mathematical Structures in Computer Science

Tristan Gally: 20th Conference on Integer Programming and Combinatorial Optimization (IPCO) 2019

Alf Gerisch: Biomechanics and Modeling in Mechanobiology, European Journal of Applied Mathematics, Journal of Theoretical Biology, Numerical Algorithms, Numerical Methods for Partial Differential Equations, The Fund for Scientific Research (FNRS, Belgium), Research Foundation - Flanders (FWO, Belgium), Netherlands Organisation for Scientific Research (NWO, The Netherlands)

Jan Giesselmann: Mathematical Reviews; Computational Methods in Applied Mathematics, Computational and Applied Mathematics, Networks and Heterogeneous Media, SIAM Journal on Numerical Analysis, Zeitschrift für Angewandte Mathematik und Physik

Karsten Grosse-Brauckmann: Mathematical Reviews; Communications in Analysis and Geometry, Springer Lecture Notes

Oliver Habeck: 20th Conference on Integer Programming and Combinatorial Optimization (IPCO) 2019

Robert Haller-Dintelmann: Journal of Evolution Equations, SIAM Journal on Mathematical Analysis

Christopher Hojny: 15th International Conference on the Integration of Constraint Programming, Artificial Intelligence, and Operations Research (CPAIOR) 2018, 20th Conference on Integer Programming and Combinatorial Optimization (IPCO) 2019, Discrete Applied Mathematics, Discrete Optimization, Graphs and Combinatorics, Mathematical Programming

Benjamin Horn: Structural and Multidisciplinary Optimization (2018) 57

Amru Hussein: MathSciNet Mathematical Reviews; Nonlinearity, Journal of Mathematical Physics, Advances in Differential Equations, Evolution Equations and Control, Journal of Evolution Equations

Christina Karousatou: ALGOCLOUD 2018, ALGOSENSORS 2017, SIROCCO 2017, Theoretical Computer Science

Ulrich Kohlenbach: Advances in Mathematics, Annals of Pure and Applied Logic, Archive for Mathematical Logic, Journal of the European Mathematical, Optimization Letters, SIAM Journal of Optimization

Michael Kohler: Annals of Statistics,Communications in Statistics - Simulation and Computation,International Journal of Uncertainty Quantification,IEEE Access,IEEE Transcations on Information Theory,Journal of Machine Learning Research,Journal of Multivariate Analysis,Metrika

Philip Kolvenbach: Optimization and Engineering (2018) 19

Burkhard Kümmerer: Journal of Functional Analysis, Communications in Mathematical Physics, Journal of Operator Theory, Journal of Statistical Physics, Journal of Mathematical Analysis and Applications, Journal of Mathematical Physics

Jens Lang: Applied Numerical Mathematics, Combustion Theory and Modelling, Journal of Physics A: Mathematical and General, Inverse Problems, Computing and Visualization in Science, International Journal of Hyperthermia, International Journal for Numerical Methods in Fluids, Transactions on Mathematical Software, Journal of Computational Physics, Computational and Applied Mathematics, IMA Journal of Numerical Analysis, Mathematics of Computation, SIAM Journal Numerical Analysis, SIAM Journal Scientific Computing

Oliver Lass: ACOM (Advances in Computational Mathematics), IEEE-Transmag (IEEE Transactions on Magnetics), KOMSO, OPTE (Optimization and Engineering)

Yingkun Li: Mathematical Reviews; Manuscripta Mathematica, Research in Number Theory, Documenta Mathematica, International Journal of Number Theory, Journal of Number Theory

Tomislav Marić: Computational Physics Reviews; Journal of Computational Physics, International Journal of Multiphase Flow

Holger Marschall: Applied Mathematical Modelling, Chemical Engineering Science, Computers & Fluids, International Journal for Numerical Methods in Engineering, International Journal of Computational Physics, International Journal of Multiphase Flow.

Frederic Matter: 20th Conference on Integer Programming and Combinatorial Optimization (IPCO) 2019

Hannes Meinlschmidt: SIAM Journal on Control and Optimization

Masoumeh Mohammadi: Journal of Optimization Theory and Applications, Mathematical Modelling and Analysis

Michalis Neururer: International Journal of Number Theory, Journal of Mathematical Analysis and Applications, Journal of Physics A, Advances of the AMS, Annali dell'Universitatà di Ferrara

Martin Otto: Journal of Symbolic Logic (JSL), Journal of Logic and Computation (JLC), Computer Science Logic (CSL), Logical Methods in Computer Science (LMCS), ACM/IEEE Symposium on Logic in Computer Science (LICS), Symposium on Theoretical Aspects of Computer Science (STACS), Artificial Intelligence, International Colloquium on Automata, Languages and Programming (ICALP), Studia Logica, ACM Transactions on Computational Logic (TOCL)

Andreas Paffenholz: American Mathematical Monthly, Electronic Journal of Combinatorics, Algebraic Combinatorics, Discrete and Computation Geometry, SIAM Journal on Discrete Mathematics, Journal of Combinatorial Theory, Series A

Marc Pfetsch: Applied Mathematical Modelling, Computational Optimization and Applications, Discrete Optimization, FOCS 2018, IEEE Transactions on Information Theory, Journal of Optimization Theory and Applications, Linear Algebra and its Applications, Mathematical Methods of Operations Research, Mathematical Programming, Mathematical Programming Computation, Operations Research, Optimization and Engineering, SIAM Journal on Applied Algebra and Geometry, SIAM Journal on Optimization, SODA 2019, Transportation Science

Anna-Maria von Pippich: Acta Arith., Compos. Math., Elem. Math., Lett. Math. Phys., Manuscr. Math., Ramanujan J.

Thomas Powell: Annals of Pure and Applied Logic, Archive for Mathematical Logic, International Conference on Formal Structures for Computation and Deduction (FSCD), ACM-IEEE Symposium on Logic in Computer Science (LICS), Notre Dame Journal of Formal Logic

Anne-Therese Rauls: Optimization Methods and Software

Ulrich Reif: Journal of Approximation Theory, Computer Aided Geometric Design, Graphical Models, NUMA, Advances in Computational Mathematics, Constructive Approximation, Linear Algebra and Applications

Steffen Roch: Mathematical Reviews; Complex Variables and Elliptic Equations, Integral Equations and Operator Theory, Journal of Functional Analysis, Journal of the London Mathematical Society, Journal of Mathematical Analysis and Applications, Mediterranean Journal of Mathematics, Operator Theory: Advances and Applications

Nils Scheithauer: Acta Arithmetica, Annals of Mathematics, Communications in Mathematical Physics, Communications in Number Theory and Physics, International Mathematics Research Notices, Journal of the AMS, Journal für die reine und angewandte Mathematik, The Ramanujan Journal, Transactions of the AMS

Werner Schindler: Journal of Cryptographic Engineering, Journal of Cryptology, IEEE Security & Privacy, CHES 2018, escar 2018

Kersten Schmidt: Advances in Computational Mathematics, Computers and Structures, SIAM Journal on Applied Mathematics, Zeitschrift für Angewandte Mathematik und Physik

Andreas Schmitt: 20th Conference on Integer Programming and Combinatorial Optimization (IPCO) 2019

Alexandra Schwartz: Optimization, SIAM Journal on Optimization, Journal of Global Optimization, Computational Optimization and Applications, Journal of Industrial and Management Optimization, Optimization Methods and Applications, Numerical Algorithms, Mathematical Methods of Operations Research, Mathematical Control and Related Fields, Journal of Optimization Theory and Applications, Computational Optimization and Applications

Andrei Sipoş: Mathematical Reviews, zbMATH; Soft Computing, Scientific Annals of Computer Science, Demonstratio Mathematica, Journal of Fixed Point Theory and Applications

Christian Stinner: Mathematical Reviews, Zentralblatt; Advances in Differential Equations, Discrete and Continuous Dynamical Systems - Series B, Discrete and Continuous Dynamical Systems - Series S, European Journal of Applied Mathematics, Journal of Differential Equations, Mathematical Methods in the Applied Sciences, Mathematische Nachrichten, Zeitschrift für angewandte Mathematik und Physik

Thomas Streicher: Mathematical Reviews; Applied Categorical Structures, Journal of Pure and Applied Algebra, Annals of Pure and Applied Logic, Theory and Applications of Categories, Journal of Symbolic Logic, Mathematical Logic Quarterly, Mathematical Structures in Computer Science

Stefan Ulbrich: Computers & Mathematics with Applications, Computational Optimization and Applications, ESAIM: Control, Optimisation and Calculus of Variations, Interfaces and Free Boundaries, Optimization Methods and Software, SIAM Journal on Control and Optimization, SIAM Journal on Optimization

Sebastian Ullmann: Advances in Computational Mathematics, Applied Numerical Mathematics, Computational and Applied Mathematics, ESAIM: M2AN: Mathematical Modelling and Numerical Analysis, SIAM/ASA Journal on Uncertainty Quantification

Mirjam Walloth: IMA Journal of Numerical Analysis, ESAIM: M2AN: Mathematical Modelling and Numerical Analysis, SIAM Journal on Numerical Analysis

Torsten Wedhorn: Inventiones Math., Math. Ann., Journal of Algebraic Geometry, Canadian Journal of Math., Documenta Math., Compositio Math., Pacific Journal of Math., Math. Zeitschrift, IMRN, CMB

Jonathan Weinberger: Logical Methods in Computer Science

Cornelia Wichelhaus: Bernoulli, Electronic Journal of Statistics, Scandinavian Actuarial Journal, Stochastic Systems

Winnifried Wollner: Mathematical Reviews; Applied Mathematics and Computation, Applied Numerical Mathematics, Bulletin of the Iranian Mathematical Society, Calcolo, Computational Optimization and Applications, IMA Journal of Numerical Analysis, International Journal for Numerical Methods in Engineering, Journal of Optimization Theory and Applications, ESAIM: Mathematical Modelling and Numerical Analysis, Numerical Algorithms, Numerische Mathematik, Numerical Mathematics: Theory, Methods and Applications, Results in Mathematics, SIAM Journal on Control and Optimization, SIAM Journal on Numerical Analysis, SIAM Journal on Optimization

4.6 Software

ANACONDA: *Solving Hyperbolic Partial Differential Algebraic Equations on Networks*
ANACONDA is a software package to solve hyperbolic partial differential algebraic equations on networks. Particularly, it is designed to solve simulation and optimal control tasks for gas and water supply networks.

Contributor at TU Darmstadt: Pia Domschke, Jens Lang, Lisa Wagner, and formerly Oliver Kolb (now at Universität Mannheim)

SCIP-SDP: *A mixed integer semidefinite programming plugin for SCIP*
SCIP-SDP is a plugin for SCIP to solve mixed integer semidefinite programs (MISDPs). It combines the branch-and-bound framework of SCIP with interior-point SDP-solvers to solve MISDPs using either a nonlinear branch-and-bound approach or an LP-based cutting-plane approach. It extends SCIP by several heuristics, propagators, file readers and the handling of SDP-constraints.
For more information, see `http://www.opt.tu-darmstadt.de/scipsdp/`

Contributor at TU Darmstadt: Tristan Gally, Marc E. Pfetsch

FastCOIN: *Fast adaptive stochastic COllocation INfrastructure*

FastCOIN is a software package that implements an adaptive, anisotropic stochastic collocation approach on sparse grids for the quantification of uncertainty in PDEs or other models with random parameters described by finitely many random variables. This includes, in particular, finite-dimensional parametrizations of correlated random fields. Similar to a Monte Carlo simulation, this approach decouples and, hence, parallelizes the stochastic problem into a set of deterministic problems. FastCOIN is able to resolve a stochastic parameter space of dimensions up to $20-50$.

Contributor at TU Darmstadt: Jens Lang, Alf Gerisch, Sebastian Ullmann, and formerly Bettina Schieche (now at COMSOL)

KARDOS: *Solving Time-Dependent Partial Differential Equations*

KARDOS is a software package to solve partial differential equations in one, two and three space dimension adaptively in space and time. Linearly implicit one-step methods of Rosenbrock type or two-step PEER-methods are coupled with standard Finite Elements of various orders. Extensions that we are working on include: incorporation of computational fluid dynamics, optimisation and moving finite elements.

Contributor at TU Darmstadt: Jens Lang, Alf Gerisch, Zhen Sun

SCIP: *Software for Solving Constraint Integer Programs*

SCIP is a framework for solving constraint integer programs and performing branch-cut-and-price. It allows total control of the solution process and the access of detailed information. SCIP is also currently one of the fastest non-commercial mixed integer programming (MIP) solvers. It is developed together with the Zuse-Institut Berlin and Universität Erlangen-Nürnberg.
For more information, see `https://scip.zib.de`

Contributor at TU Darmstadt: Tristan Gally, Christopher Hojny, Marc E. Pfetsch

TCM: *Teaching Calculus with Matlab*

TCM provides a series of interactive programs illustrating basic concepts from calculus and linear algebra, see `https://de.mathworks.com/matlabcentral/fileexchange/58391-teaching-calculus-with-matlab`

Contributor at TU Darmstadt: Ulrich Reif

CONCEPTS: *High-order and generalized finite element library*

The numerical C++ library provides finite element methods of higher order, generalized finite element methods and boundary element methods in common object-oriented structures. We developed hp-adaptive finite element methods on curved quadrilateral and hexadredal meshes with locally varying and anisotropic polynomial orders for Poisson and Helmholtz problems, problems in elektromagnetics, quantum physics, viscous acoustics (based on Navier-Stokes equations), elasticity and coupling of those models. The matrices can be assembled and linear systems solved in parallel where we also give access to external direct solvers. There is is a number of time integration schemes for dynamical modelling. CONCEPTS has got a large class documentation and various tutorials are available.
For more information, see `https://wiki.math.ethz.ch/Concepts`

Contributor at TU Darmstadt: Kersten Schmidt, Adrien Semin, Vsevolod Shashkov

donlp2: *Solving general smooth nonlinear optimization problems, last revision January 2015*
donlp2 is a software for the solution of general nonlinear programming problems. Different versions exist concerning the programming language (strict f77, f90, C99), the user interface and some options (for example elimination of redundant linear equality constraints and an interfacing known as "reverse communication"). donlp2 is free for research, whereas commercial use requires licensing by TU Darmstadt. During the report period 21 academic (free) licenses were given. There were 7 commercial requests, but due to misconceptions concerning the royalty fee from the partners side these were not satisfied. For more information, see `www.mathematik.tu-darmstadt.de/fbereiche/numerik/staff/spellucci/DONLP2/`

Contributor at TU Darmstadt: Peter Spellucci

numawww: *Interactive computing exercises for numerical methods and continuous optimization*
Numawww is a cgi/html-based computing device for general numerical methods and methods of continuous optimization. In operation since 1996 it has been continuously further developed. It may be used for exercises during a numerical methods course, as a self teaching aid or even as a small scale computing device, requiring minimal knowledge of programming which is presented inside the system itself. It is accessible from anywhere in the world. During 2017 there were 33620 visits from 44 countries viewing 163132 pages and in 2018 29442 visits from 39 countries viewing 166548 pages. Any application comes with predefined test cases which can be used without programming knowledge at all. Presently only the English version receives further development, but the German version will be maintained. In the current report period some minor improvements were done, but presently a major revision making it even more comfortably to use is under development. For more information, see `numawww.mathematik.tu-darmstadt.de`

Contributor at TU Darmstadt: Peter Spellucci

TriangularTaylorHood: *Triangular Taylor Hood finite elements, version 1.5.0.0*
This Matlab toolbox solves PDE problems with mixed P2/P1 (Taylor Hood) finite elements. The capabilities of the toolbox are demonstrated with an unsteady thermally driven flow in a tall cavity, as described in `http://dx.doi.org/10.1002/fld.395` (Christon et al., 2002). Source code and license: `https://de.mathworks.com/matlabcentral/fileexchange/49169-triangular-taylor-hood-finite-elements`

Contributor at TU Darmstadt: Sebastian Ullmann

DOpElib: *Differential Equations and Optimization Environment*
DOpElib is a software library for the solution of optimization problems subject to partial differential equations.
For more information, see `www.dopelib.net`

Contributor at TU Darmstadt: Mirjam Walloth, Winnifried Wollner

5 Theses

5.1 Habilitations

2018

Schmidt, Kersten, *Asymptotic and numerical analysis of impedance and absorbing boundary conditions* (Umhabilitation von TU Berlin)

5.2 PhD Dissertations

2017

Fischer, Michael H., *Analysis and numerical approximation of shape optimization problems governed by the Navier-Stokes and the Boussinesq equations* (Stefan Ulbrich)

Fischer, Tobias, *Branch-and-Cut for Complementarity and Cardinality Constrained Linear Programs* (Marc Pfetsch)

Hansmann, Matthias, *Nichtparametrische Schätzung von (bedingten) Quantilen und bedingten Verteilungen ausgehend von Daten mit zusätzlichen Messfehlern* (Michael Kohler)

Kristl, Lisa, *Nichtparametrische Schätzung zeitvarianter Dichten und zeitvarianter Quantile in einem Simulationsmodell* (Michael Kohler)

Ludovici, Francesco, *Numerical analysis of parabolic optimal control problems with restrictions on the state variable and its first derivative* (Winnifried Wollner)

Marić, Tomislav, *Lagrangian/Eulerian Numerical Methods for Fluid Interface Advection on unstructured Meshes* (Dieter Bothe)

Meinlschmidt, Hannes, *Analysis and Optimal Control of Quasilinear Parabolic Evolution Equations in Divergence Form on Rough Domains* (Stefan Ulbrich)

Müller, Florian, *Nichtparametrische Kurvenschätzung für latente Variablen* (Michael Kohler)

Seitz, Tobias, *Geometry identification and data enhancement for distributed flow measurements* (Herbert Egger)

Sokoli, Florian, *Topological Tensor Products and Quantum Entanglement* (Burkhard Kümmerer)

Tent, Reinhard, *Nichtparametrische Schätzung von Quantilen unter Verwendung von Importance-Sampling und Ersatzmodellen* (Michael Kohler)

Wagner, Lisa Sabine, *Second-Order Implicit Methods for Conservation Laws with Applications in Water Supply Networks* (Jens Lang)

Walter, Stefan , *Curve Shortening Flow for Spatial Random Permutations* (Volker Betz)

2018

Alex, Jerome, *The periodic Steiner problem* (Herbert Egger)

Bauer, Benedikt, *Statistische Aspekte der Schätzung von Ersatzmodellen und des Deep Learnings in hohen Dimensionen* (Michael Kohler)

Bucher, Max, *Optimality Conditions and Numerical Methods for a Continuous Reformulation of Cardinality Constrained Optimization Problems* (Alexandra Schwartz)

Canavoi, Felix, *Cayley Structures and the Expressiveness of Common Knowledge Logic* (Martin Otto)

Dittmann, Moritz Christopher, *Reflective Automorphic Forms and Siegel Theta Series for Niemeier Lattices* (Nils Scheithauer)

Gries, Mathis Y., *On the primitive equations and hydrostatic Stokes operator* (Matthias Hieber)

Hojny, Christopher, *Symmetries in Binary Programs - A Polyhedral Perspective* (Marc Pfetsch)

Kolvenbach, Philip, *Robust optimization of PDE-constrained problems using second-order models and nonsmooth approaches* (Stefan Ulbrich)

Kuttich, Anja Katharina, *Robust Topology Optimization and Optimal Feedback Controller Design for Linear Time-Invariant Systems via Nonlinear Semidefinite Programming* (Stefan Ulbrich)

Lübbers, Jan-Erik, *Displacement of biased random walk in a one-dimensional percolation model* (Volker Betz)

Lüthen, Hendrik, *Partitioning into Isomorphic or Connected Subgraphs* (Marc Pfetsch)

Lukassen, Axel Ariaan, *Simulation von chemischen Reaktionssystemen mit schnellen chemischen Reaktionen* (Martin Kiehl)

Maier, Lars-Benjamin, *Ambient Approximation of Functions and Functionals on Embedded Submanifolds* (Ulrich Reif)

Mindt, Pascal, *Hierarchical Gas Model Coupling on Networks* (Jens Lang)

Müller, Christopher, *Iterative solvers for stochastic Galerkin discretizations of Stokes flow with random data* (Jens Lang)

Opitz, Sebastian, *Computation of Eisenstein series associated with discriminant forms* (Jan Hendrik Bruinier)

Schäfer, Helge, *The Cycle Structure of Random Permutations without Macroscopic Cycles* (Volker Betz)

Schmitt, Johann Michael, *Optimal Control of Initial-Boundary Value Problems for Hyperbolic Balance Laws with Switching Controls and State Constraints* (Stefan Ulbrich)

Schwagenscheidt, Markus, *Regularized Theta Lifts of Harmonic Maass Forms* (Jan Hendrik Bruinier)

Schwinn, Sebastin, *Mathematical analysis of models from communications engineering* (Frank Aurzada)

Seyfert, Anton, *The Helmholtz-Hodge Decomposition in Lebesgue Spaces on Exterior Domains and Evolution on the Whole Real Time Axis* (Matthias Hieber)

Spannring, Christopher, *A weighted reduced basis method for parabolic PDEs with random input data* (Jens Lang)

Sun, Zhen, *Adaptive Moving Finite Element Method for Steady Low-Mach-Number Compressible Combustion Problems* (Jens Lang)

Völz, Fabian, *Realizing hyperbolic and elliptic Eisenstein series as regularized theta lifts* (Anna-Maria von Pippich)

Wegmann, David, *The Stokes and Navier-Stokes Equations in Exterior Domains: Moving Domains and Decay Properties* (Reinhard Farwig)

5.3 Master Theses

2017

Adner, Robin, *Entwicklung eines Mathematischen Modells zur Optimierung des Build-Ups und Break-Downs von Luftfracht am Beispiel der Lufthansa Cargo AG* (Simon Emde)

Alaca, Sevda, *Estimation of quantiles in a simulation model based on artifical neural networks* (Michael Kohler)

Antons, Yannic, *Lösung von zeitexpandierten Fahrplanerzeugungsmodellen mittels Spaltengenerierung* (Marc Pfetsch)

Barg, Angelika, *Ziel-orientierte Adaptivität für eine stochastische Galerkin-Finite-Elemente-Methode* (Sebastian Ullmann)

Bechtel, Sebastian, *The Kato Square Root Property for Mixed Boundary Conditions* (Robert Haller-Dintelmann)

Becker, Julia, *Rough Paths and Renormalization* (Volker Betz)

Berndt, Aileen, *Automatische Aufgabengenerierung für Grundlehre in Mathematik* (Karsten Weihe)

Birx, Alexander Marcel, *Graphical Models with Total Cardinality Constraint* (Marc Pfetsch)

Brandy, Malte Johannes Alexander, *Eine Perron-Frobenius-Theorie für Markovoperatoren auf Matrixalgebren* (Burkhard Kümmerer)

Bridi, Michelle Germaine, *Stochastic partial differential equations and rough paths* (Volker Betz)

Bube, Georg, *Vector-valued Theta Functions for Non-degenerate Lattices* (Jan Hendrik Bruinier)

Bugge, Sebastian Rainhard, *Solving learning with errors instances using quantum reductions* (Johannes Buchmann)

Butschek, Christian, *Optimierungsverfahren zur zeitlichen Verkürzung von Stromverläufen für Batterieprüfungen unter Erhaltung vergleichbarer Charakteristiken* (Christian Debes)

Cakkalkurt, Sezan Dila, *Schätzung von Dichten ausgehend von einem fehlerbehafteten Simulationsmodell* (Michael Kohler)

Celik, Safak, *Verbesserung eines Modells zur Quantifizierung von Unsicherheit mit Hilfe realer Daten* (Michael Kohler)

Chojnowska, Lars, *Approximation des Motorisierten Travelling Salesman Problems* (Marc Pfetsch)

Dietrich, Kevin, *Quasi-Wahrscheinlichkeitsverteilungen in der Quantenmechanik* (Burkhard Kümmerer)

Dietzel, Anne, *Adaptive Schätzung von Dichten basierend auf verbesserten Simulationsmodellen* (Michael Kohler)

Dincer, Faruk, *Aussagen zur Konvergenzgeschwindigkeit des L1-Fehlers in der nichtparametrischen Dichteschätzung* (Michael Kohler)

Du, Qian, *Optimization methods with stochastic Hessian information for handwritten digits recognition problem* (Stefan Ulbrich)

Eryasar, Gülay, *Schätzung von Konfidenzbändern von Dichten basierend auf verbesserten Simulationsmodellen* (Michael Kohler)

Fladung, Marc, *0, 1/2-Ungleichungen für binäre lineare Codes* (Marc Pfetsch)

Follert, Felix, *Konvergenzanalyse des Multi-Block ADMM ohne strenge Konvexität, dessen Varianten und vergleichbare Algorithmen in der strukturierten konvexen Optimierung* (Stefan Ulbrich)

Friske, Felix, *Learning to Sample* (Gerhard Neumann)

Fuhrländer, Mona, *Design Centering im Kontext der Hochfrequenzsimulation* (Alexandra Schwartz)

Getrost, Marco, *Schätzung einer Funktion ausgehend von fehlerfreien Beobachtungen an zufälligen Punkten* (Michael Kohler)

Göbel, Rebecca, *Numerische Verfahren für Chemotaxis Modelle* (Herbert Egger)

Haftstein, Markus, *Runden von Relaxierungslösungen für gemischt-ganzzahlige Optimierungsprobleme* (Marc Pfetsch)

Hahn, Jens, *Adaptive Schätzung von Quantilen in einem Simulationsmodell* (Michael Kohler)

Hasler, Daniel, *Die Feynman-Kac-Formel für Sprungprozesse* (Volker Betz)

Heckwolf, Jan, *Ein mehrseitiges Relaxierungsverfahren für Optimierungsprobleme mit Kardinalitätsrestriktion* (Alexandra Schwartz)

Heininger, Tim Uwe, *Optimales Experimentendesign für unendlich dimensionale nichtlineare Baysian Problems* (Winnifried Wollner)

Heldmann, Anica, *Berücksichtigung von Transportlosen zur Lösung des Economic Lot Scheduling Problem nach dem Time-Varying Lot-Size Approach von Dobson* (Christoph Glock)

Hitzel, Yana, *Berufliches Lernen mit einem Experimentalgetriebe* (Ralf Tenberg)

Holzer, Patrick, *Recovering Short Generators of Principal Fractional Ideals in Cyclotomic Fields of Conductor* $p^\alpha q^\beta$ (Johannes Buchmann)

Hubert, Daniela Katharina, *Kreditrisiko-Optimierung basierend auf dem Conditional-Value-at-Risk* (Stefan Ulbrich)

Käfer, Sebastian, *Schätzung von Konfidenzintervallen für Quantile basierend auf verbesserten Simulationsmodellen* (Michael Kohler)

Kersting, Sebastian, *Konsistente Schätzung einer zu latenten Variablen gehörenden Regressionsfunktion* (Michael Kohler)

Kiefer, Paul, *Eisenstein Series and Automorphic Forms of Singular Weight* (Jan Hendrik Bruinier)

Kilian, Johannes Andreas Karl, *Inexakte Bundle-Verfahren für die Formoptimierung bei elastischen Kontaktproblemen* (Stefan Ulbrich)

Klimm, Svenja, *A mixed integer linear programming approach for horizontal trajectory optimization in a free route airspace considering restricted airspaces* (Alexandra Schwartz)

Knoll, Steven, *Konvex-Konkave Dekompositionsmethoden für nichtlineare semidefinite Programme mit Anwendung auf aktive Stabwerke* (Stefan Ulbrich)

Köster, Thorben, *Runge-Kutta-Verfahren mit optimaler Stabilität für unstetige, räumliche Diskretisierungen* (Jens Lang)

Kroker, Gregor Peter, *Stabilität optimaler Portfolios* (Alexandra Schwartz)

Kullmann, Felix Peter, *Disjunktive Schnittebenen für Kardinalitätsrestriktionen* (Marc Pfetsch)

Kunz, Johannes Georg, *Schätzung einer multivariaten Funktion mit Hilfe von neuronalen Netzen* (Michael Kohler)

Kupka, Jennifer, *Mock Modular Forms and Traces of Singular Moduli* (Jan Hendrik Bruinier)

Langer, Sophie, *Konvergenzrate von Smoothing-Splineschätzern mit gewichteten Daten mit zusätzlichen Messfehlern in der abhängigen Variablen* (Michael Kohler)

Le, Thi Dieu Hien, *Reduzierte Modelle zur Zustandsschätzung in Advektions-Diffusions-Gleichungen* (Stefan Ulbrich)

Luckhaupt, Lars, *Using NLP Features for Difficulty Prediction in C-tests* (Ulf Brefeld)

Luu, Thuy Linh, *Shape optimization with a level set method* (Stefan Ulbrich)

Markina, Julia, *Stochastische Gradientenverfahren im Kontext des maschinellen Lernens* (Stefan Ulbrich)

Matei, Alexander, *Verschwindende Viskosität für die gradientenbasierte optimale Steuerung von skalaren Erhaltungsgleichungen* (Stefan Ulbrich)

Mauthe, Axinja Laura, *Optimierungsmethoden für die seismische Inversion* (Winnifried Wollner)

Menche, Julian, *Adjungierte-basierte Multilevel Monte Carlo Kalibrierung von Finanzmarktmodellen* (Stefan Ulbrich)

Michaelis, Niklas, *Proximale stochastische koordinatenweise Abstiegsverfahren* (Stefan Ulbrich)

Müller, Christian, *Relaxed Constant Rank und verwandte Constraint Qualifications für nichtlineare Programme und Programme mit Gleichgewichtsrestriktionen* (Alexandra Schwartz)

Nowak, Tara Selina, *Application of column generation to interview scheduling at konaktiva job fair* (Marc Pfetsch)

Pavlovic, Gabriel, *Analysis of a time-dependent density estimator* (Michael Kohler)

Prager, Monika Simone Renate, *Kürzeste Wege und Flüsse unter Kardinalitätsrestriktionen* (Marc Pfetsch)

Remmel, Patrick, *Diskretisierung quasilinearer Optimierungsprobleme mit Zustandsschranken* (Winnifried Wollner)

Rohrbach, Felix Jonathan, *Complexity-theoretic Implications of Indistinguishability Obfuscation* (Marc Fischlin)

Romberg, Kathrin Stefanie, *Transportoptimierung im Hauptlauf der Paketlogistik* (Marc Pfetsch)

Schachler, Sohejl, *Adaptive Schätzung von Quantilen in einem Simulationsmodell unter Verwendung von Spline-Quasi-Interpolanten* (Michael Kohler)

Schmidt, Robert Paul, *Schätzung einer multivariaten Funktion durch stückweise konstante Funktionen* (Michael Kohler)

Schneider, Thomas, *TSP, TRP and Dial-a-Ride on the Circle* (Yann Disser)

Schultheiß, Ina, *Alternative Modelle zur periodischen Fahrplanoptimierung* (Marc Pfetsch)

Schwarzkopf, Marie-Christine Alice, *A Reformulation of Cardinality Constrained Optimization Problems with Semi-continuous Variables* (Alexandra Schwartz)

Seibert, Anna-Maria, *Schätzung von Quantilen in einem Simulationsmodell unter Verwendung von neuronalen Netzen* (Michael Kohler)

Sorokin, Dmitry, *Optimization Methods for Deep Learning* (Stefan Ulbrich)

Spohn, Nadine Fabienne, *Nichtparametrische Schätzung zeitabhängiger Quantile* (Michael Kohler)

Stern, Alexandra, *Analyzing integral decisions in gas networks* (Marc Pfetsch)

Strauch, Elisa, *Stochastische finite Elemente zur Berechnung von Spannungen in der oberen Erdkruste* (Sebastian Ullmann)

Strauss, Jessica, *Untersuchung der Kapitalmarktreaktionen infolge von Directors' Dealings mithilfe von GARCH-Modellen* (Dirk Schiereck)

Thomas, Roman, *Lebenskunstintervention an einer berufsbildenden Schule zur Steigerung des Wohlbefindens* (Bernhard Schmitz)

Thoß, Florian, *Sequential Convex Programming with Application to Robust Truss Topology Design* (Stefan Ulbrich)

Tran, Thao Vi, *Adaptive Schätzung von Quantilen in hochdimensionalen Simulationsmodellen* (Michael Kohler)

van Spankeren, Moritz, *On Acyclicity Conditions in Finite Cayley Groups* (Martin Otto)

Veltcheva, Ioanna, *Verbesserung von Ersatzmodellen zur Quantifizierung von Unsicherheit durch reale Daten* (Michael Kohler)

Voigt, Felix, *Asymptotische Vollständigkeit des Micromasers in Wechselwirkung mit Multilevel-Atomen* (Burkhard Kümmerer)

Walz, Benedikt Marius, *Computing stationary distributions of metastable Markov chains* (Volker Betz)

Weibrecht, Nadine, *Evaluation of Sensor Data with Machine Learning Algorithms* (Jan Peters)

Wickel, Sebastian, *Schätzung von Quantilen ausgehend von einem fehlerbehafteten Simulationsmodell* (Michael Kohler)

Wolf, Franziska Doris, *Adaptive Schätzung von Quantilen unter Verwendung von neuronalen Netzen* (Michael Kohler)

Zelch, Christoph, *Model-based optimization of whole-body-poses for human robots in challenging environments* (Oskar Stryk)

Zimmer, Petra, *Detektion des Gefahrenpotentials für die Schieneninfrastruktur durch Vegetation anhand automatisierter Identifizierung von Orthofotos* (Volker Betz)

2018

Altenburg, Florian, *Cost-effective job-splitting in parallized systems* (Frank Aurzada)

Assing, Charlotte, *ADMM und Augmented ADMM für das Lasso-Problem* (Stefan Ulbrich)

Avramidis, Dimitrios, *Exact and Online Algortihms for Robust Spotter Scheduling* (Simon Emde)

Bahlke, Philipp, *Stochastische Gradientenverfahren für neuronale Netzwerke* (Stefan Ulbrich)

Belhadj, Khalid, *Maximale Regularität in gewichteten LP-Räumen* (Matthias Hieber)

Bier, Lisa, *Zur starken universellen Konsistenz des Kernschätzers in der nichtparametrischen Regressionsschätzung* (Michael Kohler)

Braun, Alina, *A Linear Neural Network Regression Estimate* (Michael Kohler)

Büchling, Alexandra, *Parallele Verfahren für das maschinelle Lernen* (Stefan Ulbrich)

Büttgenbach, Frank Gert, *Gemischt-ganzzahlige nichtlineare Optimierung mit Anwendung in der Head-Up-Display Konfiguration* (Stefan Ulbrich)

Ceylan, Eren, *Importance ordering via reachability: algorithmic aspects* (Volker Betz)

Cuca, Aleksandar, *Numerische Untersuchung von Blowup in einem Keller-Segel System* (Jens Lang)

Dietz, Alexander, *Integration singulärer Splineflächen* (Ulrich Reif)

Du Bois, Sophie Ann, *Convergence analysis of a Sequential Response Surface Method* (Stefan Ulbrich)

Eckardt, Marcel Steffen, *Versicherungsmodelle mit Lévy-Prozessen* (Frank Aurzada)

Ewering, Andreas Jörg, *Efficiency of FO Model Checking on Planar Graphs* (Kord Eickmeyer)

Füchtenhans, Marc, *A game theoretic model for harvesting decisions for vanilla farming* (Alexandra Schwartz)

Gabel, Fabian Nuraddin Alexander, *On Resolvent Estimates in Lp for the Stokes Operator in Lipschitz Domains* (Robert Haller-Dintelmann)

Gao, Xiqiang, *Uncertainty Quantification in Case of Imperfect Models: A Non-Bayesian Approach* (Michael Kohler)

Habrich, Oliver André, *Numerical Approximation and Parameter Identification for the Cahn-Hilliard Equation* (Herbert Egger)

Hald, Martin, *Kryptographische Analyse des Bitmessage-Protokolls* (Marc Fischlin)

Herzog, Janine, *Ein exponentielles Relaxierungsverfahren für kardinalitätsrestringierte Optimierungsprobleme* (Alexandra Schwartz)

Hettig, Stella, *Semiglatte Newton-CG Augmented-Lagrange-Verfahren für das Lasso-Problem und ein Vergleich mit Verfahren erster Ordnung* (Stefan Ulbrich)

Hey, Julius-Benjamin, *Stochastische Approximation in der nichtkonvexen Optimierung* (Winnifried Wollner)

Hoeboer, Julia, *The Preemptive Dial-a-Ride Problem with Release Times* (Yann Disser)

Hoffmann, Timo, *Lokales SQP-Verfahren bei Optimierungsproblemen mit Gleichgewichtsnebenbedingungen* (Winnifried Wollner)

Hofmann, Adrian, *Development of algorithms for individualized order assignment in manual order picking* (Ralf Elbert)

Hohgräfe, Jan, *How to choose friends even better: Extensions to the Maximum Influence with Links problem* (Yann Disser)

Kaddar, Sara, *Zur Lösung hochdimensionaler Regressionsprobleme mit Hilfe von Deep Learning* (Michael Kohler)

Kiel, Steffen, *Das Vorgehen von Bayes für Inverse Probleme* (Jens Lang)

Kirmse, Sascha, *Quantifizierung von Unsicherheit basierend auf Ersatzmodellen mit nichtdeterministischer abhängender Variable* (Michael Kohler)

Klein, David Christian, *Ramanujan's Mock Theta Functions and Harmonic Maass Forms* (Jan Hendrik Bruinier)

Klimmek, Franziska, *Eisenstein Series of the Weil Representation* (Jan Hendrik Bruinier)

Knoff, Peter, *Konvexe Relaxationen für ODE-Nebenbedingungen in der gemischt-ganzzahligen nichtlinearen Optimierung* (Stefan Ulbrich)

Könen, Mareike Gisela, *Risk models based on compound Poisson distributed innovations* (Cornelia Wichelhaus)

Kohlmeyer, Ines, *Theoretischer und numerischer Vergleich der augmentierten Lagrange-Methode mit allgemeinen Penalty- und SQP-Verfahren* (Alexandra Schwartz)

Krasnianski, Maria, *Haptotaxis systems with volume-filling effect* (Christian Stinner)

Kreß, Johanna, *Schätzung von Quantilen in Simulationsmodellen unter Verwendung von numerischer Integration* (Michael Kohler)

Leis, Annabel, *Ein semiglattes Newton-CG Augmented Lagrange-Verfahren für das Lasso Problem* (Stefan Ulbrich)

Lenhart, Patric, *Generalized mixed-integer rounding cuts and disjunctions* (Marc Pfetsch)

Lin, Yongguang, *Ein-Fourier-Multiplier-Theorem auf Räumen endlichen Typs und Cotyps* (Robert Haller-Dintelmann)

Loiero, Mirjam, *Fault Attacks on Multivariate Signature Schemes* (Johannes Buchmann)

Mesvat, Anil, *Tiefe neuronale Netze als nichtparametrische Regressionschätzer* (Michael Kohler)

Muehlbauer, Julian Maximilian, *Analytische Kombinatorik für Permutationen ohne makroskopische Zykel* (Volker Betz)

Müller, Erik Jörn, *Zur Schätzung der Unsicherheit in fehlerbehafteten Simulationsmodellen unter Verwendung von bedingter Dichteschätzung* (Michael Kohler)

Müller, Fabian, *Numerical quadrature on irregular domains and application in the Finite Cell Method* (Herbert Egger)

Olumee, Mesih, *Formale Validierung der Aktualität von Nachrichten in Automotive Protokollen* (Michael Waidner)

Pfeifer, Markus, *Viterbi-Algorithms, Glättung und versteckte Markovmodelle* (Volker Betz)

Pohlmann, Diana, *Konstruktion konvexer Relaxationen für die Optimierung von Gastransport mit Spatial Branching* (Stefan Ulbrich)

Polenz, Björn, *Robuste SDP-Löser für Branch and Bound Verfahren* (Stefan Ulbrich)

Respondek, Robert Dominique, *Innere Punkte Verfahren in der Topologieoptimierung* (Winnifried Wollner)

Roth, Lukas, *Phase transition for loop models on trees* (Volker Betz)

Rudloff, Niklas, *Risk models with dependence structure* (Cornelia Wichelhaus)

Schickentanz, Dominic Tobias Raphael, *On Perron-Frobenius-Type Theorems and Their Application to Markov Chains* (Frank Aurzada)

Schmidt, Benjamin Burkhard, *Berufliche Übergänge Jugendlicher mit Hochschulzugangsberechtigung* (Birgit Ziegler)

Schmitt, Sören, *Roboter-Evakuierung durch einen unbekannten Ausgang auf dem Kreisrand* (Yann Disser)

Schmollgruber, Alan Stefan, *Training Neuronaler Netze mit stochastischen Abstiegsverfahren* (Stefan Ulbrich)

Schnarz, Anna, *Algorithmen zur automatischen Systemtrassenbildung und -belegung für den Jahresfahrplan im Güterverkehr* (Andreas Oetting)

Seker, Nusret, *Existenz, Eindeutigkeit und Charakterisierung von Nash-Gleichgewichten für kapazitätsbeschränkte Cournot Spiele* (Alexandra Schwartz)

Serra da Silva, Anita, *Zur optimalen Konvergenzrate des L1-Fehlers des Kerndichteschätzers* (Michael Kohler)

Steinbach, Philipp, *Adaptive Finite Elemente Verfahren für Erdwärmesonderspeicher* (Jens Lang)

Tautz, Hendrik, *Kongruenzen für die Koeffizienten von schwach holomorphen Modulformen* (Jan Hendrik Bruinier)

Uftring, Patrick Jürgen, *Proof-theoretic characterization of Weihrauch reducibility* (Ulrich Kohlenbach)

Williams, Jack Peter Richard, *Population Growth with Catastrophes* (Volker Betz)

Wolfenstetter, Franziska Renate, *Schätzung von Quantilen in fehlerbehafteten Simulationsmodellen mit Hilfe bedingter Dichteschätzer* (Michael Kohler)

Yang, Guang, *Estimation of multivariate regression functional by multilayer neural networks* (Michael Kohler)

Zeuch, Marcel, *Trust-Region Verfahren zur Optimierung unter Unsicherheiten* (Winnifried Wollner)

Zhu, Zhu, *Gesetze des iteriertenLogarithmus für Brownsche Bewegung und andere Prozesse* (Frank Aurzada)

Zinn, Timo, *Das inverse Problem der Finanzmathematik unter bayesscher Statistik* (Winnifried Wollner)

5.4 Staatsexamen Theses

2017

Genc, Ömer, *Interviewstudie zu Fehlerphänomenen im online-Vorkurs VEMINT* (Regina Bruder)

Kösterke, Lena, *Bruchrechnung erklären – ein Videokonzept* (Regina Bruder)

Kolb, Cora, *Ein Videokonzept zur Einführung des Arbeitens mit Funktionen* (Regina Bruder)

Schachtsiek, Niklas, *Entwicklung digitaler diagnostischer Testaufgaben im Bereich Termumformungen für den VEMINT-Vorkurs* (Regina Bruder)

Ullmann, Alexander, *Analysen zur Leistungsentwicklung im Vorkursprojekt VEMINT* (Regina Bruder)

Wätschker, Daniel, *Potentiale von STACK zur Bewertung von Schülerleistungen* (Regina Bruder)

2018

Guba, Stefanie, *Mathematikbezogenes Selbstkonzept und Vorerfahrungen zum mathematischen Argumentieren am Übergang Schule – Universität* (Regina Bruder)

Lippert, Johannes Michael, *Entwicklung und Erprobung von Feedbackelementen zum Diagnosetest BASICS-Mathematik* (Regina Bruder)

Maatz, Tina, *Ausgewählte numerische Lösungsverfahren und Polynomdivision im Mathematikunterricht – Binnendifferenziernde Bausteine zur Umsetzung des KCGO Hessen* (Regina Bruder)

Reinmüller, Lars, *Blütenaufgaben im Stochastikunterricht – Aufgabenentwicklung im Rahmen des Projekts MAKOS* (Regina Bruder)

Rolf, Felix, *Zur Analyse des Kompetenzprofils in Mathematiktests niedersächsischer Realschulen* (Regina Bruder)

Schmidt, Christopher, *Gestaltung von digitalem Feedback zur Diagnose von Fehlermustern im BASICS-Test* (Regina Bruder)

Stolz, Daniel, *Längsschnittliche Wirkungsanalyse zum Vorkursangebot VEMINT (2014-2017)* (Regina Bruder)

Teuber, Marc, *Differenzierte Gestaltung des Themas Ableitungsregeln im MAKOS-Projekt* (Regina Bruder)

Wagner, Eric, *Zur Analyse der Aufgabenschwierigkeit von Mathematiktests im Projekt ELMA* (Regina Bruder)

5.5 Bachelor Theses

2017

Altin, Hakki, *Schätzung der Verteilung des Gesamtschadens* (Michael Kohler)

Arif, Zaheer, *The Spectral Theorem for Unbounded Linear Operators* (Robert Haller-Dintelmann)

Ast, Sebastian, *Scheduling Unrelated Parallel Machines and Graph Balancing* (Marc Pfetsch)

Avenarius, Alexander Friedrich Wilhelm, *Berechnung kürzester Wege auf Flächen* (Marc Pfetsch)

Becker, Johannes, *Decomposition of quasi-compact operator semigroups* (Robert Haller-Dintelmann)

Becker, Sophia, *Markov Processes on Electrical Networks and Domains* (Frank Aurzada)

Bieker, Patrick, *Canonisation procedures for two-variable logics* (Martin Otto)

Bielmeier, Silvan Laurin, *Generalized Galois groups* (Torsten Burkhard Wedhorn)

Bischof, Matthias, *The Steiner Problem in Several Dimensions* (Karsten Große-Brauckmann)

Blum, Hendrik Jan Reiner, *Routing in Netzwerken mit Kapazitäten* (Marc Pfetsch)

Borchers, Felix Paul Daniel, *Varianten des klassischen Sekretärinnenproblems* (Volker Betz)

Braun, Joschka Julius, *Class invariants for certain non-holomorphic modular functions* (Anerkennung aus Schülerstudium TU Darmstadt. Jan Hendrik Bruinier)

Brockschmidt, Clara Maria, *Convergence of the Cox-Ross-Rubinstein model to the Black-Scholes model* (Matthias Meiners)

Buchholz, Johannes Christian, *Analysis an application of the Stochastic Gradient Method on strongly convex and general objectives* (Stefan Ulbrich)

Buck, Carin Christine, *Eine Einführung in die Dichteschätzung* (Michael Kohler)

Bukatin, Katharina, *Numerische Methoden von Compressed Sensing* (Stefan Ulbrich)

Dautenheimer, Lukas, *Der Satz von Stone und seine Anwendung auf den Partitionenschätzer* (Michael Kohler)

Dick, Fabian, *Eine Einführung in die Lebensversicherungsmathematik* (Michael Kohler)

Diehl, Marie Cathrine, *Modelle der Versicherungsmathematik* (Volker Betz)

Eckardt, Marcel Steffen, *Preisfindung für amerikanische Optionen* (Matthias Meiners)

Fichtlscherer, Christopher Paul, *Improving Bounds for Incremental Maximization* (Yann Disser)

Fürstenau, Peter Anton, *Indices of a Vector Field - Homotopy Invariance and the Law of Vector Fields* (Karsten Große-Brauckmann)

Gabel, Adrian Salahaddin, *Bewertung Amerikanischer Optionen durch Lösen eines optimalen Stoppproblems* (Michael Kohler)

Georgi, Philipp Ulrich, *Hilbertsche Eisensteinreihen kleinen Gewichts* (Jan Hendrik Bruinier)

Gerlach, Isabelle, *On the Effect of Emission Trading and Renewables on Energy Markets* (Alexandra Schwartz)

Grobe, Philip, *Über KC-Räume* (René Bartsch)

Groß, Vera, *Estimation of the distribution of the total claim in non-life insurance* (Michael Kohler)

Günter, Anna, *Solving Linear Generalized Nash Equilibrium Problems using the Nikaido-Isoda Function* (Alexandra Schwartz)

Gußmann, Lars, *Max Flows in O(nm) Time, or Better* (Marc Pfetsch)

Hainz, Claudia, *Gezielte Werbung in sozialen Netzen in Gegenwart konkurrierender Firmen* (Alexandra Schwartz)

Hamann, Philipp, *Approximationsalgorithmen für das Scheduling auf parallelen Maschinen* (Marc Pfetsch)

Hintner, Clara, *Lösen verallgemeinerter linearer Nash-Gleichgewichtsprobleme mit Hilfe von KKT-Systemen* (Alexandra Schwartz)

Jacob, Isabel, *Congruent Numbers, Elliptic Curves and L-Functions* (Jan Hendrik Bruinier)

Junker, Markus Peter, *Das Chain-Ladder-Verfahren* (Michael Kohler)

Kaiser, Kim Doreen, *Exponentielle Konvergenz der zusammengesetzten Trapezregel und ihre Anwendung* (Alf Gerisch)

Kiel, Steffen, *The Nyström method for Fredholm integral equations of the second kind* (Christoph Erath)

Kilian, Martin Alexander Dennis, *Das Invarianz-Prinzip für Maxima: Konvergenz gegen Extremwertprozesse im Skorokhod-Raum* (Matthias Meiners)

Knof, Isburg Käthe, *Quasiperiodicity of projected lattices* (Karsten Große-Brauckmann)

Kober, Kyrill Benedikt, *Adaptive Reduktion von Nebenbedingungen bei Training Support Vector Machines* (Stefan Ulbrich)

Kosara, Thomas, *Fast Fourier Transform zur effizienten Berechnung von Matrix-Vektor-Produkten mit zirkulanten Matrizen* (Alf Gerisch)

Kovacevic, Jovan, *Darstellungstheorie halbeinfacher Lie-Algebren* (Nils Scheithauer)

Krasnianski, Maria, *The Ising Model* (Volker Betz)

Kreh, Melissa, *Fourierreihen und die isoperimetrische Ungleichung* (Robert Haller-Dintelmann)

Krüger, Jens Lukas, *Die Schadenzahl-Verteilungen der Panjer-Klasse* (Frank Aurzada)

Kunkel, Teresa, *Simulation von Ionentransport durch biologisches Gewebe* (Herbert Egger)

Latocha, David Peter, *Team Semantics in Modal Logics* (Martin Otto)

Lenz, Jonas Christopher, *Fourier Transform on the Schwartz class and on Tempered Distributions* (Matthias Hieber)

Mauritz, Marco Jonas, *Stabilitätseigenschaften linearer thermoelastischer Platten* (Matthias Hieber)

Mc Cracken, Gabriel Simon, *Noether-Invariants of CMC-Surfaces in Homogeneous 3-Manifolds* (Karsten Große-Brauckmann)

Mesfun, Yonas, *Die einfaktorielle Varianzanalyse und ihre Anwendung in der Schadenversicherungsmathematik* (Michael Kohler)

Mesvat, Anil, *Berechnung der impliziten Volatilität amerikanischer Optionen mit Hilfe von Optimierung unter Equilibriumsnebenbedingungen* (Stefan Ulbrich)

Möll, Michelle Christin, *Darstellungsanzahlen binärer quadratischer Formen. Die Berechnung der dirichletschen Klassenzahlformel* (Jan Hendrik Bruinier)

Mugler, Philipp, *Determining the locations of e-bike rental stations with a path based heuristic* (Stefan Ulbrich)

Pellmann, Oliver, *Belegunsplanung mit ressourcenabhängigen Bearbeitungszeiten* (Marc Pfetsch)

Philippi, Nora Marie, *Splitting Methods for Transport Equations* (Christoph Erath)

Pilz, Maximilian Robert Urs Leonard, *Der Satz von Stone und seine Anwendung auf den Kernschätzer* (Michael Kohler)

Proschmann, Dominik, *Fluid Limits for Queues* (Cornelia Wichelhaus)

Rasch, Fabian, *Universelle, schwache Konsistenz des Kernschätzers* (Michael Kohler)

Rehlich, Lea Charlotte, *Semidefinite Programmierung mit Anwendung auf Tracking Probleme* (Winnifried Wollner)

Rödl, Francesca Jeanette, *Nichtkonvexe robuste Optimierung für restringierte Probleme mit Fachwerk als Anwendungsbeispiel* (Stefan Ulbrich)

Schadt, Stefan, *Polynomieller Netzwerksimplexalgorithmus für Kosten-minimale Flüsse* (Marc Pfetsch)

Schmalz, Tobias, *SLOCC-Äquivalenz von reinen Zuständen multipartiter Systeme* (Burkhard Kümmerer)

Schmidt, Fabian, *Eine gewichtete Lotterie zur effizienten Finanzierung öffentlicher Güter* (Alexandra Schwartz)

Schmitt, Miriam, *Sesquilinearformen und abgeschlossene Operatoren* (Reinhard Farwig)

Schoch, Viktor, *Black-Scholes Formel* (Volker Betz)

Schwartz, Daniel, *Polynomielle Approximationsschemata für das budgetierte Matching-Problem und das budgetierte Matroid-Intersektions-Problem* (Marc Pfetsch)

Seipp, Sebastian, *Das Greenwood-Modell - Trefferwahrscheinlichkeiten und Dualität* (Frank Aurzada)

Simon, Nicolai, *The method of moving asymptotes in structural optimization* (Winnifried Wollner)

Spahn, Christopher Daniel, *Theorie der großen Abweichungen* (Volker Betz)

Steinberg, Nico Alexander, *Automorphisms of 2-Adic Discriminant Forms* (Nils Scheithauer)

Steiof, Yannick, *The Glivenko-Cantelli Theorem* (Michael Kohler)

Storzer, Matthias, *Wachstumsabschätzungen für Fourier-Koeffizienten von Spitzenformen* (Jan Hendrik Bruinier)

Strelow, Erik Laurin, *Spektralmethoden und Zeitintegration höherer Ordnung* (Alf Gerisch)

Tsiouris, Alexandros, *Random walks on networks and reduction laws* (Lorenzo Taggi)

Viering, Johannes Niklas, *The Inductive Limit Topology and the Space of Distributions* (Mads Kyed)

Wagner, Sophia Janine, *On a minimisation problem for graphs in R4* (Karsten Große-Brauckmann)

Weber, Julia Ute, *Der Satz von Stone* (Michael Kohler)

Weckbecker, David Michael, *Ein Algorithmus zur Bestimmung aller Lösungen eines verallgemeinerten linearen Nash-Gleichgewicht-Problems* (Alexandra Schwartz)

Woznik, Saskia Sophia, *Maaß-Formen und invariante Differentialoperatoren* (Jan Hendrik Bruinier)

Wrba, Philipp Fritz, *Kummer Theory for Graded Galois Extensions* (Torsten Burkhard Wedhorn)

Xiong, Danfeng, *Innere Punkte Verfahren für kontrollbeschränkte Optimierungsprobleme mit partiellen Differentialgleichung* (Winnifried Wollner)

Youmbi NKomegni, Audrey Laetitia, *Einführung in die Schadenversicherungsmathematik* (Michael Kohler)

Zierau, Darja-Maria, *Methoden zur Bestimmung von diskreter mittlerer Krümmung* (Karsten Große-Brauckmann)

2018

Accorsini, Lisamarie, *Integralapproximation auf einem periodischen Gitter* (Alf Gerisch)

Alban, Alexander, *Potential Theory and Metastability of Markov Chains* (Volker Betz)

Beckmann, Markus, *Schätzung einer Dichte mit Kernen* (Michael Kohler)

Beck, Robin Alexander, *Blockierende Vereinigungen von Arboreszenzen* (Marc Pfetsch)

Beck, Tobias, *Der Kerndichteschätzer nach Rosenblatt und Parzen* (Michael Kohler)

Benedikt, Barbara Jiabao, *Die Wärmeleitungsgleichung auf einem Intervall* (Robert Haller-Dintelmann)

Biermann, Jens Peter, *LP-theory for Calderón-Zygmund kernels* (Robert Haller-Dintelmann)

Bocksnick, Lara Elisabeth Caroline, *Optimal location planning for charging stations in electric car sharing systems* (Stefan Ulbrich)

Buch, Bilke, *Die Rolle des Deckungskapitals in der Lebensversicherungsmathematik* (Michael Kohler)

Cisternas Seeger, Valentina, *Support Vector Machines and their application in disease classification* (Stefan Ulbrich)

Corbean, Elisa, *Efficient Recovery of Block-Sparse Signals* (Marc Pfetsch)

Detzel, Andreas, *Mustererkennung mit Support-Vektor-Maschinen* (Burkhard Kümmerer)

Deutschen, Matthias, *Parallel Coordinate Descent Methods for Machine Learning Applications* (Stefan Ulbrich)

de Witte, Dominik Samuel, *The Voter Model* (Volker Betz)

Gabriel, Dennis, *Optimierung der Standorte von Ladestationen für Elektroautos in Car-Sharing Netzwerken* (Stefan Ulbrich)

Ganeshkumar, Akilavan, *Der Satz von Radon-Nikodým* (Robert Haller-Dintelmann)

Gehrunger, Tim, *Construction of invariant valuations* (Torsten Burkhard Wedhorn)

Gerlach, Dominique Nadine, *Containment of Virus Expansion in Graphs* (Yann Disser)

Gopp, Katharina Sophie, *Analyzing Solution Concepts of a Game Theoretical Model of Non-convex Cognitive Radio Games* (Alexandra Schwartz)

Grabinat, Saskia, *Rekonstruktionsgarantien und -algorithmen für Block-Sparsity* (Marc Pfetsch)

Heimrich, Johanna Simone, *Matching Interdiction* (Marc Pfetsch)

Herr, Lennart, *Effiziente Lösungen für gewichts-balancierten Partitionierungsproblemen* (Marc Pfetsch)

Jabi, Antonia, *Ein Vergleich zweier Scholtes-artiger Relaxierungsmethoden für mathematische Programme mit Komplementaritätsrestriktionen* (Alexandra Schwartz)

Jendrysiak, Jan Patrick, *Random Graphs and Local Weak Limits* (Frank Aurzada)

Jiang, Haolin, *Extensions of Dedekind domains* (Nils Scheithauer)

Jordan, Felix, *Some Remarks on Convergence Criteria in Hyperspaces by Means of Choice Functions* (René Bartsch)

Käsbohrer, Cornelia Carmen, *Optimizing Support Vector Machines with Coordinate Descent* (Stefan Ulbrich)

Käse, Philipp, *Möbiusbänder minimaler Biegeenergie* (Karsten Große-Brauckmann)

Kamgaing, Yvon Delored, *Universelle Konsistenz des Partitionenschätzers* (Michael Kohler)

Kanski, Tobias, *Optimal Control of an Obstacle Problem* (Winnifried Wollner)

Kappesser, Maximilian Christoph Batho, *Zentralmengen polygonaler Gebiete* (Karsten Große-Brauckmann)

Keinrath, Julian, *Application of the combinatorial method to conditional kernel density estimates* (Michael Kohler)

Klein, Johanna, *Ein zentraler Grenzwertsatz für Markov-Ketten auf Basis der Poisson-Gleichung* (Cornelia Wichelhaus)

Klein, Lisa Christel, *On Lower Minimax Rate of Convergence in Nonparametric Regression* (Michael Kohler)

Klopp, Adrian, *Simulation and control of epidemics of influenza-like diseases* (Martin Kiehl)

Knutsen, Laura Kathrina, *Die Stetigkeit der Hilberttransformation auf LP* (Robert Haller-Dintelmann)

Komkowski, Luisa, *Semismooth Newton method for the lifted reformulation of mathematical programs with complementarity constraints* (Winnifried Wollner)

Kreh, Clarissa, *The maximal function on Hardy spaces* (Robert Haller-Dintelmann)

Kühne, Sandra Kristin, *On the Computation of Fluctuation Loadings in non-life Insurance Mathematics* (Michael Kohler)

Latocha, Simon Jan, *Shortest Distances on Undirected Graphs* (Marc Pfetsch)

Leichthammer, Lorenz Carl, *The Pivot-Algorithm for sampling self-avoiding walks* (Volker Betz)

Lind, Jenny Ida, *Das Bochner-Integral und der Satz von Dunford-Pettis* (Robert Haller-Dintelmann)

Litzinger, Carsten Jochem, *Conservation laws* (Christian Stinner)

Luckas, Michelle Melanie, *Bessel Capacities and Traces of Sobolev Functions* (Robert Haller-Dintelmann)

Mair, Johanna Catrin Cornelia Ute Christina Margarethe Luise Katharina Rosel, *Group actions on valuation spectra* (Torsten Burkhard Wedhorn)

Meißner, Silke Anne, *On the Model Theory of Inquisitive Modal Logic* (Martin Otto)

Moser, Yannik, *Globale Konvergenz des konjugierten Gradientenverfahrens* (Winnifried Wollner)

Neuberger, Laura, *Schätzung der Verteilungen von Schadenszahl und Schadenshöhe im kollektiven Model* (Michael Kohler)

Neumann, Nils, *The Kepler Problem and its Symmetries* (Karsten Große-Brauckmann)

Neuthard, Tobias Joachim, *Kürzeste Wege für planare Graphen* (Marc Pfetsch)

Nguyen, Thi Hoang Kim, *Optimierungsverfahren für Sparse Reconstruktion* (Stefan Ulbrich)

Nützenadel, Anna Christiane, *Der Simplex Algorithmus in der Mehrzieloptimierung* (Winnifried Wollner)

Polzer, Steffen Robert, *Correlation inequalities and infinite-volume measures for the loop O(n) model* (Lorenzo Taggi)

Posta, Aurora Silvana, *Runge-Kutta Verfahren in der optimalen Steuerung* (Winnifried Wollner)

Pritzel, Kristin, *Schadenreservierung bei lang andauernder Schadenabwicklung* (Michael Kohler)

Racky, Maximilian Joachim, *Implicit Space Curves* (Ulrich Reif)

Rausch, Janes, *Erweiterte Lagrange Verfahren für SDP* (Winnifried Wollner)

Rosswinkel, Benjamin, *Grothendieck's Spectral Sequence* (Torsten Burkhard Wedhorn)

Rückert, Katharina, *State of the Art for the List Update Problem* (Yann Disser)

Schneidereit, Jan Felix, *Donskers Invarianzprinzip* (Volker Betz)

Schröder, Jan Philipp, *Interpolation mit Klothoiden* (Ulrich Reif)

Schwaab, Carolin, *Über das robuste kürzeste-Wege Problem* (Marc Pfetsch)

Seiche, Timo, *The combinatorial Method of Devroye and Lugosi* (Michael Kohler)

Seifert, Lukas Henry, *Überdeckungsprobleme mit kanten- und knotengewichteten Graphen* (Marc Pfetsch)

Sitnikov, Konstantin, *Poincaré Inequalities in the Sobolev Setting* (Robert Haller-Dintelmann)

Steinhardt, Marcel Maximilian, *Regression-based Monte Carlo Methods for Pricing American Options* (Michael Kohler)

Struve, Johannes Philipp Manuel, *Structure Results and Generators for Congruence Subgroups and Applications to the Weil Representation* (Nils Scheithauer)

Thomas, Sven, *Wie bewertet man eine amerikanische Option?* (Michael Kohler)

Tibke, Jonas Michael, *On a Generalisation of Connection Components and Quasi-components* (René Bartsch)

Uihlein, Andrian Gerhard, *Calderón-Zygmund-Theorie und Anwendungen* (Matthias Hieber)

Vetter, Sukie-Christin, *Der Jordansche Kurvensatz* (Karsten Große-Brauckmann)

Werring, Carl-Friedrich, *Differences between maximum degrees and clique numbers in graphs* (Marc Pfetsch)

Wesch, Daniel, *Ein Algorithmus zur Lösung parametrischer Flussmaximierungsprobleme* (Marc Pfetsch)

Wilde, Julian, *Ein uniformes Gesetz der großen Zahlen* (Michael Kohler)

Wilhelm, Janik, *The K- and J-method of real interpolation* (Robert Haller-Dintelmann)

Yaylali, Can, *Elliptic Curves over Schemes* (Torsten Burkhard Wedhorn)

Zaiser, Moritz Leon, *Optimierung unter Wahrscheinlichkeitsrestriktionen* (Winnifried Wollner)

Zheng, Anny Ning, *Eine Aussage zur universellen Konsistenz in der nichtparametrischen Regressionsschätzung* (Michael Kohler)

6 Presentations

6.1 Talks and Visits

6.1.1 Invited Talks and Addresses

Frank Aurzada

27/11/2017 *Persistence probabilities for fractional processes*
Probability seminar, Bochum

20/04/2018 *Persistence probabilities*
Probability and stochastic geometry seminar, Karlsruhe

06/07/2018 *Persistence exponents in Markov chains*
Invited session talk, 12th Vilnius Conference on Probability and Statistics and IMS Annual Meeting, Vilnius

Volker Betz

22/08/2017 *The shape of the emerging condensate in effective models of condensation*
Workshop, Venice

01/11/2017 *The geometry of cycles in spatial random permutations*
Seminar, Osnabrück

10/11/2017 *Spatial random Permutations*
Colloquium

23/01/2018 *Spatial random permutations*
Sminar, MPI Leipzig

08/04/2018 *Hydrodynamic limits of nearest neighbour particle systems*
Seminar, Bad Boll

22/05/2018 *Spatial Random Permutations*
Conference, Lancaster University

05/12/2018 *Cycle structure of random permutations without long cycles*
Universität Mannheim

Dieter Bothe

15/05/2017 *Modeling and VOF-based simulation of transport processes at fluid interfaces*
Seminar MSII-ICube, University of Strasbourg, Strasbourg, France

04/06/2017 *Sharp-Interface Continuum Physics of Two-Phase Flows*
Oberwolfach Seminar "Compressible and Incompressible Multiphase Flows: Modelling, Analysis, Numerics", Oberwolfach Research Institute for Mathematics, Oberwolfach

30/11/2017 *Numerical simulation of transport processes at fluid interfaces*
ERCOFTAC Technologietag Süd- und Norddeutschland, Stuttgart

10/01/2018 *Thermodynamically consistent modeling of multicomponent diffusion*
15th Japanese-German International Workshop on Mathematical Fluid Dynamics, Waseda University, Tokyo, Japan

07/05/2018 *A kinematic evolution equation for the dynamic contact angle and some consequences*
Conference on Mathematical Fluid Dynamics, Bad Boll

07/11/2018 *A kinematic evolution equation for the dynamic contact angle*
Séminaire Applications des Mathématiques ENS Rennes, Rennes, France

Regina Bruder

01/03/2017 *'Which specialised didactic knowledge delivers model projects?'*
Talk to the 51st conference of the society for didactics of mathematics, Potsdam

04/03/2017 *'Learning opportunities for mathematics understanding'*
Workshop on the Hessian school day (GGG), Riedstadt

06/03/2017 *'Cognitive activation and quality of lessons - the same side of the medallion? Or, nevertheless, two sides of a medallion? Comment from specialised didactic perspective'*
Keynote on the conference of the commission school research and didactics in the DGfE, Frankfurt am Main

24/01/2018 *'Topical developments in the subject didactics and challenges to specialised didactic research - with examples from the didactics of mathematics'*
Network of the subject didactics of the School of Education, University of Salzburg

06/02/2018 *'Mathematical grounding and basic skills in the curriculum development'*
Cosh conference, Stuttgart-Esslingen

07/03/2018 *'Theory and Empirie of the discovering learning'*
Annual conference of GDM and DMV, Paderborn

17/05/2018 *'Variation of tasks as a didactic element to deal with heterogenity in math lessons on secondary level'*
Didactic colloquium, KIT Karlsruhe

22/09/2018 *'BASICs–Support of mathematical grounding and basic knowledge'*
Annual conference DZLM, Dortmund

28/09/2018 *'One can count on differences...'*
10-years anniversary of the foundation of the regional professional didactics centre for mathematics and geometry, Graz

Jan H. Bruinier

12/01/2017 *Generating series of special divisors on arithmetic ball quotients*
Oberseminar für Algebraische Geometrie und Arithmetik, Universität Duisburg-Essen

05/04/2017 *Generating series of special divisors on arithmetic ball quotients*
British Mathematical Colloquium 2017, Durham University

27/06/2017 *An introduction to the Kudla program*
Institut Fourier, Grenoble, Parts 3 and 4 of the lecture series *Arakelov theory on Shimura varieties*, joint with J. Burgos, 26.06.17–30.06.17

06/09/2017 *Regularized theta lifts*
Simons Conference on *Number Theory, Geometry, Moonshine and Strings*, Simons Foundation, New York City, 06.09.17–08.09.17

20/12/2017 *Generating series of special divisors on arithmetic ball quotients*
Conference *Trends in modular forms*, National Institute of Mathematical Sciences, Korea, 19.12.17–22.12.17

17/01/2018 *Generating series of special divisors on arithmetic ball quotients*
Conference *Analyic and arithmetic theory of automorphic forms*, RIMS, Kyoto, 15.01.18–19.01.18

20/02/2018 *Geometrische und arithmetische Siegel-Weil-Formeln*
Winterseminar der AG Algebra, Manigod, 18.02.18–24.02.18

03/05/2018 *Arithmetic degrees of special cycles and derivatives of Eisenstein series*
Simons Symposium on *Periods and L-values of Motives*, Schloss Elmau, 29.04.18–04.05.18

13/06/2018 *Generating series of special divisors on arithmetic ball quotients*
Number theory seminar, EPFL Lausanne

28/06/2018 *Generating series of special divisors on arithmetic ball quotients*
Conference *N-cube week*, Mittag-Leffler-Institute, Stockholm, 25.06.18–29.06.18

05/09/2018 *Higher Green functions and their CM values*
Conference on *Elementare und Analytische Zahlentheorie (ELAZ)*, MPIM, Bonn, 03.09.18–07.09.18

13/11/2018 *Arithmetic degrees of special cycles and derivatives of Eisenstein series*
Arithmetic and Algebraic Geometry Seminar, Paris-Sud University, Orsay

Aday Celik

30/05/2017 *Blackstock-Crighton Equation*
Seminar Talk, Paderborn

08/05/2018 *Resonance in nonlinear acoustics*
Workshop on Mathematical Fluid Dynamics, Bad Boll

18/10/2018 *Resonance in nonlinear acoustics*
Seminar Talk, Wien

Karoline Disser

02/10/2017 *Stability of rigid bodies with a cavity filled by a viscous liquid*
Conference on Analysis and Control of Fluid-Structure Interaction Systems, Bordeaux

13/12/2017 *Stability of rigid bodies with a cavity filled by a viscous liquid*
Kolloquium, FB Mathematik, TU Darmstadt

11/01/2018 *Zhukovskiis Theorem in der Fluid-Struktur-Interaktion*
Universität Kassel

06/03/2018 *Extrapolation of maximal regularity for non-autonomous and quasilinear parabolic problems*
Minisymposium on Nonlinear Evolution Equations and Applications, DMV-Jahrestagung 2018, Paderborn

09/05/2018 *Extrapolation of maximal regularity for non-autonomous parabolic problems*
Conference on Mathematical Fluid Dynamics, Bad Boll

28/09/2018 *Global existence and stability for dissipative processes coupled across volume and surface*
Analysis of evolutionary and complex systems, WIAS Berlin

Yann Disser

15/05/2017 *An Introduction to Graph Exploration*
Kolloquium Mathematische Informatik, Universität Frankfurt

Pia Domschke

10/10/2018 *Error-controlled adaptive simulation of large gas networks*
2nd Conference Mathematics of Gas Transport (MoG2), Berlin

Herbert Egger

31/03/2017 *A scatter correction algorithm for computed tomography in semi-transparent media*
100 Years Radon Workshop, RICAM Linz

03/04/2017 *On compressible flow in pipeline networks: Variational principles and numerical approximation*
Seminar in Applied Mathematics, Eindhoven University of Technology, The Netherlands

06/04/2017 *On compressible flow in pipeline networks: Variational principles and numerical approximation*
Seminar 4TU, University of Twente, The Netherlands

28/06/2017 *Accelerated image reconstrucion algorithms in fluorescence optical tomography*
PASC, Lugano, Switzerland

03/11/2017 *A mixed finite element approximation for the isentropic Euler equations*
Seminar in Mathematics, Universität Basel

15/12/2017 *Inverse problems for partial differential equations*
TRR 146 Lecture Series, Universität Mainz

07/05/2018 *Structure preserving numerical approximation of dissipative evolution problems*
Workshop on Mathematical Fluid Dynamics, Bad Boll

25/07/2018 *Optimal control of instationary gas transport*
IFIP, Essen

26/07/2018 *Tikhonov regularization under conditional stability*
IFIP, Essen

31/07/2018 *Variational methods for radiative transfer*
Seminar in Applied Mathematics, Universität Innsbruck

18/10/2018 *Structure preserving numerical approximation of dissipative evolution problems*
IGPM Seminar, RWTH Aachen

30/11/2018 *Estimation of geometry and flow characteristics from magnetic resonance measurements*
Analysis, Control and Inverse Problems for PDEs, Naples, Italy

Kord Eickmeyer

20/06/2018 *Logics with Invariantly Used Relations*
Workshop on Sparsity, Logic, and Algorithms, University of Warwick

04/10/2018 *Model Checking on Sparse Structures and Beyond*
Joint Meeting of KMS and DMV, Seoul

Thomas Eiter

19/01/2017 *Time-Periodic Fundamental Solutions to the Linearized Navier–Stokes Equations*
Seminar talk, IRTG 1529, Darmstadt

28/11/2017 *Falling Drop in an unbounded liquid reservoir: Steady-state solutions*
International Workshop on Multi-Phase Flows: Analysis, Modeling and Numerics, Tokyo

08/05/2018 *Falling Drop in an unbounded liquid reservoir: Steady-state solutions*
Workshop on Mathematical Fluid Dynamics, Bad Boll

29/11/2018 *Motion of a liquid drop under time-periodic forcing*
International Workshop on Multi-Phase Flows: Analysis, Modeling and Numerics, Tokyo

Christoph Erath

07/06/2018 *Efficient solving of a time-dependent interface problem*
Universität Innsbruck

Sofia Eriksson

01/06/2017 *A dual consistent finite difference method*
Workshop "Numerical methods for PDEs and their applications", Uppsala University, Sweden

Reinhard Farwig

06/02/2017 *Mathematische Strömungsmechanik - die fundamentale Arbeit von Jean Leray in Acta Math. 1934 und ihr Einfluss bis heute*
Colloquium at Universität Kassel

12/06/2017 *Asymptotic behavior for the quasi-geostrophic equations with fractional dissipation in* $\mathbb{R}^2$
"Partial Differential Equations Seminar" at University of Oxford

23/08/2017 *The global attractor for autonomous quasi-geostrophic equations with fractional dissipation in* $\mathbb{R}^2$
Conference "The Last 60 Years of Mathematical Fluid Mechanics: Longstanding Problems and New Perspectives?", Vilnius (Lithuania)

06/11/2017 *Optimal initial values and regularity conditions for weak solutions to the Navier-Stokes system*
Invited Talk at Zhejiang Normal University, Jinhua, China

08/11/2017 *The Navier-Stokes system in general unbounded domains I: Introduction: The problem of Navier-Stokes equations in general unbounded domains*
Zhejiang Normal University, Jinhua, China

09/11/2017 *The Navier-Stokes system in general unbounded domains II: The Helmholtz decomposition in general unbounded domains*
Zhejiang Normal University, Jinhua, China

10/11/2017 *The Navier-Stokes system in general unbounded domains III: The Stokes operator in general unbounded domains*
Zhejiang Normal University, Jinhua, China

16/11/2017 *The global attractor for autonomous quasi-geostrophic equations with fractional dissipation in* $\mathbb{R}^2$
"International Conference on Analysis of Complex Fluids", Fudan University, Shanghai

17/11/2017 *Optimal initial values for weak solutions to the Navier-Stokes system*
Seminar Talk at Shanghai University, Shanghai

21/11/2017 *Optimal and almost optimal initial values for the Navier-Stokes equations I*
Institute of Mathematics, Academy of Mathematics and Systems Science, Chinese Academy of Sciences, Beijing

23/11/2017 *Optimal and almost optimal initial values for the Navier-Stokes equations II*
Institute of Mathematics, Academy of Mathematics and Systems Science, Chinese Academy of Sciences, Beijing

27/11/2017 *Optimal and almost optimal initial values for the Navier-Stokes equations III*
Institute of Mathematics, Academy of Mathematics and Systems Science, Chinese Academy of Sciences, Beijing

27/11/2017 *The Navier-Stokes System in General Unbounded Domains*
Seminar Talk at Institute of Applied Physics and Computational Mathematics (IAPCM), Beijing

28/11/2017 *Optimal and almost optimal initial values for the Navier-Stokes equations IV*
Institute of Mathematics, Academy of Mathematics and Systems Science, Chinese Academy of Sciences, Beijing

15/12/2017 *The quasi-geostrophic with fractional dissipation in $\mathbb{R}^2$: existence of the global attractor*
Invited Talk at Universität Jena

20/01/2018 *The fundamental solution of compressible viscous fluid flow past a rotating obstacle*
Workshop at Hirosaki University, Hirosaki, Japan

23/01/2018 *The two-dimensional quasi-geostrophic equations with fractional dissipation in the subcritical range I*
Tohoku University Sendai, Sendai, Japan

24/01/2018 *The two-dimensional quasi-geostrophic equations with fractional dissipation in the subcritical range II*
Tohoku University Sendai, Sendai, Japan

25/01/2018 *The two-dimensional quasi-geostrophic equations with fractional dissipation in the subcritical range III*
Tohoku University Sendai, Sendai, Japan

06/03/2018 *Optimal and almost optimal initial values for the Navier-Stokes equations*
GDMV-Tagung 2018, Minisymposium "Fluid Mechanics", Paderborn

28/08/2018 *Global attractors for non-autonomous quasi-geostrophic equations in $\mathbb{R}^2$*
Seminar Talk at Institute of Mathematical Sciences, The Chinese University of Hong Kong

05/09/2018 *Global attractors for non-autonomous quasi-geostrophic equations in $\mathbb{R}^2$*
Conference "Mathematical Fluid Mechanics and Related Topics", Tokyo Institute of Technology

08/09/2018 *Incompressible inhomogeneous fluids in bounded domains in $\mathbb{R}^3$ with bounded density*
Conference "Harmonic analysis and the Navier-Stokes equations", Waseda University, Tokyo

Anton Freund

12/04/2018 *On Polynomial Consistency Proofs*
International Workshop on Computational Approaches to the Foundations of Mathematics, LMU München

14/09/2018 *Type-Two Well-Ordering Principles, Admissible Sets, and Π^1_1-Comprehension*
PhD Colloquium of Colloquium Logicum 2018, Universität Bayreuth

Tristan Gally

22/05/2017 *SCIP-SDP: A Framework for Solving Mixed-Integer Semidefinite Programs*
SIAM Conference on Optimization (SIOPT), Vancouver, Canada

07/09/2017 *SCIP-SDP: A General-Purpose Solver for Mixed-Integer Semidefinite Programming*
International Conference on Operations Research (OR), Berlin

11/01/2018 *Applications and Solution Approaches for Mixed-Integer Semidefinite Programming*
MOSEK Workshop on Mixed Integer Conic Optimization, Copenhagen, Denmark

02/07/2018 *Knapsack Constraints over the Positive Semidefinite Cone*
International Symposium on Mathematical Programming (ISMP), Bordeaux, France

Alf Gerisch

21/02/2017 *A nonlocal model for adhesion in cancer invasion: modelling and numerics*
Workshop *Mathematical Models for Cell Migration and Dispersal*, TU Kaiserslautern

01/12/2017 *Nonlocal PDE models for cellular adhesion with application in cancer invasion*
International Conference *Current Trends in Theoretical and Computational Differential Equations with Applications*, South Asian University, New Delhi, India

06/12/2017 *Nonlocal PDE models for cellular adhesion with application in cancer invasion*
Mathematics Colloquium, Indian Institute of Technology (IIT) Roorkee, India

07/03/2018 *A comparison of integro-PDE models of cellular adhesion derived from a space-jump process*
Gemeinsame Jahrestagung der DMV und der GDM 2018, Paderborn

25/10/2018 *Attraction and Repulsion in Biological Tissues: Challenges for Models, Analysis, and Numerics*
ZIH Colloquium, TU Dresden

Karsten Grosse-Brauckmann

16/08/2017 *New minimal surfaces in the 3-sphere*
Higgs fields, harmonic maps, integrable systems, Tagung Hannover

24/11/2017 *Triply periodic minimal surfaces in the metric Lie group Sol*
Geometry Seminar, University of Leicester, UK

23/08/2018 *From triply periodic minimal surfaces to networks*
Minimal surfaces, integrable systems and visualisation, Workshop TU München

Robert Haller-Dintelmann

24/04/2017 *The Kato square root property for mixed boundary conditions*
Workshop "Operator Semigroups in Analysis: Modern Developments" in Bedlewo, Polen

Matthias Hieber

17/01/2017 *The primtive equations in critical spaces*
Banach Center, Bedlewo, Poland

14/03/2017 *Global strong well-posedness of the Q-tensor model I*
Waseda University, Tokyo, Japan, Analysis Seminar

15/03/2017 *Global strong well-posedness of the Q-tensor model II*
Waseda University, Tokyo, Japan, Analysis Seminar

25/04/2017 *Periodic solutions to semilinear evolution equations*
Banach Center, Bedlewo, Poland

22/05/2017 *Analysis of the Ericksen-Leslie model with general Leslie stress*
Int. Conference PDE, Bologna, Italy

15/06/2017 *Thermodynamics of atmospheric flows*
W. Pauli Institute, Vienna, Austria

04/09/2017 *Analysis of incompressible, viscous fluids I*
Cetraro Summer School, Italy

05/09/2017 *Analysis of incompressible, viscous fluids II*
Cetraro Summer School, Italy

06/09/2017 *Analysis of incompressible, viscous fluids III*
Cetraro Summer School, Italy

07/09/2017 *Analysis of incompressible, viscous fluids IV*
Cetraro Summer School, Italy

08/09/2017 *Analysis of incompressible, viscous fluids V*
Cetraro Summer School, Italy

13/09/2017 *A general approach to periodic evilution equations*
Int. Conference PDE, Petropolis, Brasil

29/11/2017 *Thermodynamical modeling of Liquid Crystal Flows*
Int. Conference Fluid Dynamics, Tokyo, Japan

05/12/2017 *Well-posedness of the primitive equations*
Int. Conference on PDE, RIMS, Kyoto, Japan

12/01/2018 *Periodic solutions in Fluid Dynamics*
IRTG-Conference, Tokyo, Japan

03/04/2018 *Analysis and Modelling of Liquid Crystal Flows*
Analysis-Seminar, Waseda University, Tokyo, Japan

13/04/2018 *The quaslilinear version of the Arendt-Bu theorem*
Workshop Evolution Equations, Ulm

12/07/2018 *Analysis and Modeling of Liquid Crystal Flows*
Analysis-Seminar, Chinese University, Hongkong

02/08/2018 *Global well-posedness of the bidomain equations with FitzHugh-Nagumo transport*
Euler Institute, St. Petersburg, Russia

03/09/2018 *Analysis of the compressible Ericksen-Leslie model*
Int. Conference on Fluid Dynamics, Porquerolles, France

05/09/2018 *A journey through the world of incompressible, viscous fluid flows*
Int.Conference on Analysis, Tokyo, Japan

08/08/2018 *The bidomain equations with FitzHugh-Nagumo transport*
Int.Conference on Fluid Mechanics, Tokyo, Japan

29/11/2018 *Stability analysis for evolution equations*
Int.Conference on Fluid Mechanics, Tokyo, Japan

Karl Heinrich Hofmann

29/07/2017 *Locally Compact Groups—Traditions and Trends*
SUMTOPO2017=Summer Conference on Topology in 2017. University of Dayton, Dayton, OH, USAS

Christopher Hojny

08/09/2017 *Polyhedral Symmetry Handling Techniques Exploiting Problem Information*
International Conference on Operations Research (OR), Berlin

03/07/2018 *Symmetry Breaking Polytopes: A Framework for Symmetry Handling in Binary Programs*
International Symposium on Mathematical Programming (ISMP), Bordeaux, France

Benjamin Horn

06/09/2017 *Shape Optimization for Isogeometric Contact Problems with Application to Fatigue Strength*
International Conference on Computational Plasticity (COMPLAS) 2017, Barcelona, Spain

Amru Hussein

09/02/2017 *Mathematical analysis of the primitive equations*
Kolloquium der Atmosphärenwissenschaften, Johannes Gutenberg-Universität Mainz

03/03/2017 *Strong L^p well-posedness of the 3D primitive equations*
Seminar des Mathematischen Instituts der Tohoku University, Sendai, Japan

14/05/2018 *The primitive equations of ocean and atmosphere and beyond*
Oberseminar Mathematik in den Naturwissenschaften, Universität Würzburg

Martin Kiehl

25/02/2017 *Die Mathematik im Puzzlestein – Warum Mathematiker ein Leben lang spielen?*
Mathematikolympiade Hessen, Darmstadt

11/03/2017 *Mathematische Modellierung mit Funktionen.*
Tag der Mathematik, Reinheim

24/03/2017 *Mathematische Modellierung mit Schülern beim Zentrum für Mathematik.*
Forum für Begabung, Hochschule Darmstadt

10/03/2018 *Wie gewinnt man mit Mathematik eine Goldmedaille im Skifliegen?*
MINT Tagung für junge Lehrer, Hochschule Darmstadt

10/03/2018 *Von Galileo und Kepler zu Newton – Spass an Physik durch Mathematik*
MINT Tagung für junge Lehrer, Hochschule Darmstadt

Ulrich Kohlenbach

24/02/2017 *Computability, proof mining and metric regularity*
Dagstuhl Seminar on Computability Theory, Dagstuhl.

08/03/2017 *Proof mining in Convex Optimization*
Mathematical Colloquium, U Sevilla, Spain.

11/04/2017 *From Hilbert's program to 'proof mining'*
Proof Theory Afternoon, University of Chieti-Pescara, Italy.

14/09/2017 *Proof mining in Convex Optimization*
Minisymposium Applied Proof Theory and the Computational Content of Mathematics (as part of the 19th ÖMG Congress and Annual DMV Meeting), Salzburg, Austria.

26/09/2017 *Proof Mining*
Autumn School 'Proof and Computation' (3 lectures), Herrsching.

07/11/2017 *Polynomial rate of convergence in Bauschke's solution of the zero displacement conjecture*
Oberwolfach Workshop on Mathematical Logic: Proof Theory, Constructive Mathematics. Oberwolfach.

12/04/2018 *Proof-theoretic methods in Convex Optimization*
Computational approaches to the Foundations of Mathematics, Munich.

09/05/2018 *Proof Mining: Extraction of Information from Proofs (3 lectures)*
School on 'Types, Sets and Constructions', HIM Bonn.

17/05/2018 *Proof-theoretic methods in convex optimization*
ASL Annual Meeting, Macomb (IL), USA.

08/08/2018 *Proof-theoretic methods in nonlinear analysis*
International Congress of Mathematicians, Rio de Janeiro, Brazil.

11/08/2018 *Recent uses of proof theory in Convex Optimization and Pursuit-Evasion Games*
Conference on Mathematical Logic, Niteroi, Brazil.

14/08/2018 *Local proof-theoretic foundations and proof-theoretic tameness in ordinary mathematics*
Kreisel's Interests. On the Foundations of Logic and Mathematics. A conference in honour of Georg Kreisel, Salzburg, Austria.

18/09/2018 *From proof-theoretic foundations to applications in core mathematics*
Colloquium Lecture, Gran Sasso Science Institute, L'Aquila, Italy.

Burkhard Kümmerer

20/01/2017 *Unendlich: Unglaublich – Unheimlich – Unmöglich*
Berufsschulzentrum Gelnhausen

28/02/2017 *Wie man mathematisch schreibt*
Jahrestagung der Gesellschaft für Didaktik der Mathematik (GDM), Potsdam

02/03/2017 *Mathematik, die beleidigte Königin der Wissenschaften*
Volkshochschule Dieburg

09/05/2017 *Mathematik, die beleidigte Königin der Wissenschaften*
Cauchy-Forum Nürnberg und Nicolaus-Copernicus-Planetarium, Nürnberg

22/06/2017 *Markov Chains in the Long Run – An Interplay between Classical and Quantum Probability*
Workshop on Quantum Probability and Information Theory, Nijmegen

17/07/2017 *Weißt Du, wo die Sterne stehen?*
Vortrag anläßlich der Eröffnung der Ausstellung "Geheimnis – Herrschaft – Wissen. Forscherdrang hessischer Landgrafen", ULB Darmstadt

05/10/2017 *Mathematik als gemeinsame Sprache der Naturwissenschaften*
Tagung "Systematischer und vernetzter Kompetenzaufbau", Darmstadt

12/10/2017 *Führung für den Präsidenten der TU Darmstadt, Prof. Dr. Prömel durch die Ausstellung "Geheimnis – Herrschaft – Wissen. Forscherdrang hessischer Landgrafen", ULB Darmstadt*

27/10/2017 *Unendlich: Unglaublich – Unheimlich – Unmöglich*
Humboldt-Schule, Bad Homburg

06/11/2017 *Scattering Theory for Markov Processes – An Interplay between Classical and Quantum Probability*
Conference "The Message of Quantum Science II", ZiF Bielefeld

16/01/2018 *Scattering Theory for Markov Processes – An Interplay between Classical and Quantum Probability*
University Erlangen

17/04/2018 *Verknotete Mathematik – Why Knot?*
Cauchy-Forum Nürnberg und Nicolaus-Copernicus-Planetarium, Nürnberg

04/05/2018 *Mathematik verbindet: “Mathematik als gemeinsame Sprache der Naturwissenschaften” für MINT-Studierende*
RWTH Aachen

07/06/2018 *Verknotete Mathematik – Why Knot?*
Mathematik-Zentrum Wetzlar, Phantastische Bibliothek, Wetzlar

01/11/2018 *Unendlich: Unglaublich – Unheimlich – Unmöglich*
Odenwald-Akademie und Gymnasium Michelstadt, Michelstadt

Jens Lang

08/05/2017 *Adaptivity in numerical methods for ODEs and PDEs*
University of Bath, UK

18/05/2017 *Adaptive modelling, simulation and optimization of complex water and gas flow in supply networks*
University of Bath, UK

19/07/2017 *Reduced-order models with space-adapted snapshots*
Quantification of Uncertainty: Improving Efficiency and Technology, Trieste, Italy

12/09/2017 *Rosenbrock-Wanner-methods: construction and mission*
International Conference on Scientific Computation and Differential Equations (SciCADE) 2017, Bath, UK

01/03/2018 *Adaptivity in numerical methods for ODEs and PDEs*
Isaac Newton Institute Cambridge, UK

06/03/2018 *Adaptive multilevel stochastic collocation method for randomized elliptic PDEs*
Isaac Newton Institute Cambridge, UK

16/06/2018 *Adaptivity in numerical methods for ODEs and PDEs: Towards the simulation of a full heartbeat*
Universität Innsbruck

26/07/2018 *Reduced-order models with space-adapted snapshots*
World Congress of Computational Mechanics 2018, New York, USA

05/09/2018 *IMEX-Peer methods based on extrapolation*
Conference on the Numerical Solution of Differential and Differential-Algebraic Equations (NUMDIFF-15) 2018, Halle (Saale)

Oliver Lass

28/02/2017 *Nonlinear Robust PDE Constrained Optimization Using Approximation Techniques and Model Order Reduction with Application to Electric Motor Design*
SIAM Conference on Computational Science and Engineering (CSE), Atlanta, USA

22/05/2017 *Nonlinear Robust PDE Constrained Optimization Using a Second Order Approximation Technique and Model Order Reduction*
SIAM Conference on Optimization (SIOPT), Vancouver, Canada

Yingkun Li

16/09/2017 *Harmonic Maass forms associated to real quadratic fields and application*
Joint International Meeting of the German Mathematical Society and the Romanian Mathematical Society/Ovidius University of Constanta, Romania

21/11/2017 *Average Values of Higher Green's Function and Their Factorizations*
3rd Japanese-German Number Theory Workshop/Max-Planck-Institut für Mathematik

20/12/2017 *Modularity of generating series of winding numbers*
Trends in Modular Forms/National Institute for Mathematical Sciences (NIMS), Daejeon, Korea

10/09/2018 *Mock modular forms of small weights*
Workshop on Moonshine, ESI Vienna

Holger Marschall

20/02/2017 *Numerical Simulation of Bubble Flows*
National OpenFOAM User Meeting (Stammtisch United), Kassel

04/06/2017 *High Resolution Schemes in OpenFOAM - Rationale and Design Principles*
Oberwolfach Seminar "Compressible and Incompressible Multiphase Flows: Modelling, Analysis, Numerics", Oberwolfach Research Institute for Mathematics, Oberwolfach

26/06/2017 *Direct Numerical Simulation of Bubbly Flow*
3rd International Conference on Numerical Methods in Multiphase Flows, Tokyo, Japan

11/10/2017 *Numerical description of wetting processes*
Short Course on Complex Wetting, Darmstadt

21/02/2018 *Development of Sharp and Diffuse Interface Methods*
OpenFOAM, 2nd German OpenFOAM User meetiNg (GOFUN 2018), Braunschweig

21/11/2018 *Sharp and Diffuse Interface Methods for DNS of Interfacial Transport Processes*
Institut de Mécanique des Fluides de Toulouse, Toulouse, France

Frederic Matter

02/07/2018 *Solving Complex-Valued ℓ_0 Minimization Problems with Constant Modulus Constraints*
International Symposium on Mathematical Programming (ISMP), Bordeaux, France

Hannes Meinlschmidt

18/04/2017 *Optimal Control of Quasilinear Parabolic Equations with State Constraints*
Seminar on Optimization, Karl-Franzens Universität Graz, Austria

25/05/2017 *Optimal Control of Quasilinear Parabolic Equations with State Constraints*
SIAM Conference on Optimization (SIOPT), Vancouver, Canada

Masoumeh Mohammadi

15/12/2017 *Discretization Error for Linearized Fracture Problems*
Workshop on Adaptive Discretizations, Solvers and Optimization of fracture propagation problems, Universität Hannover

Christopher Müller

28/11/2018 *What is...? Reduced order modeling*
What is...? Seminar, Fachbereich Mathematik, TU Darmstadt

Michalis Neururer

08/02/2017 *Mahler measures of elliptic surfaces*
Heilbronn Seminar, Bristol

16/01/2018 *Mahler measures of elliptic surfaces*
AG-Seminar, Universität Köln

15/03/2018 *Fourier expansions of modular forms at cusps*
Jacobi forms workshop, Nottingham

27/03/2018 *Mahler measures of elliptic surfaces*
Special values of L-functions workshop, Durham

30/08/2018 *Mahler measures of elliptic surfaces*
Mahler measures Masterclass, Copenhagen

Martin Otto

25/07/2018 *Inquisitive Bisimulation*
Inquisitive Logic Workshop, Amsterdam

17/09/2018 *ABC: Amalgamation, Bisimulation, Cycles*
Symposium in Honour of Erich Grädel's 60th Birthday, Berlin 2018

Andreas Paffenholz

21/04/2017 *Polyhedral Adjunction and Finiteness of the $\mathbb{Q}$-Codegree Spectrum*
3CinG-Workshop on Computational Algebra, King's College Cambridge, UK

Marc Pfetsch

08/05/2017 *Symmetry Handling for Integer Programs*
DOS Optimization Seminars, Georgia Tech, Atlanta, USA

14/06/2017 *Compressed Sensing and Discrete Optimization*
Seminar, L'Aquila, Italy

22/06/2017 *Compressed Sensing and Discrete Optimization*
Seminar, TU Kaiserslautern

23/01/2018 *Symmetry Handling for Integer Programs*
ABC-Workshop on Combinatorial Optimization, Aachen

12/02/2018 *Verifying Optimization Solutions*
Optimization Day, MPI Leipzig

07/03/2018 *Global Optimization of ODE Constrained Network Problems*
SCIP Workshop, Aachen

16/08/2018 *Symmetry Handling for Integer Programs*
COGA Seminar, TU Berlin

Anna-Maria von Pippich

20/01/2017 *Lauschen zwecklos!*
Berufliche Schulen, Gelnhausen

23/01/2017 *Faszination Primzahlen*
Max-Planck-Gymnasium, Groß-Umstadt

12/03/2017 *A Rohrlich-type formula for the hyperbolic 3-space*
Winter-workshop of the Darmstadt algebra group, La Plagne

28/06/2017 *An analytic class number type formula for* $\mathrm{PSL}_2(\mathbb{Z})$
Summer school "Géométrie d'Arakelov et applications diophantiennes", Institut Fourier, Grenoble

07/09/2017 *An analytic class number type formula for* $\mathrm{PSL}_2(\mathbb{Z})$
Workshop "Automorphic forms and arithmetic", Mathematisches Forschungsinstitut Oberwolfach

20/09/2017 *An arithmetic Riemann-Roch theorem on modular curves via zeta regularization*
Joint international meeting of the German Mathematical Society and the Romanian Mathematical Society, University Constanta

26/02/2018 *Über die Sommerschule "Faszination Mathematik"*
Tag der Mathematik, Bensheim

05/06/2018 *An analytic class number type formula for* $\mathrm{PSL}_2(\mathbb{Z})$
Arithmetic Geometry Seminar, HU Berlin

06/11/2018 *Modular forms: geometric, arithmetic, and analytic aspects*
Mathematical Colloquium, University of Groningen

12/11/2018 *Spezielle Zetawerte in Zahlentheorie und Geometrie*
Seminar, Universität Paderborn

19/11/2018 *Zetawerte in Zahlentheorie und Geometrie*
Mathematical Colloquium, Eberhard Karls Universität Tübingen

22/11/2018 *The special value* $Z'(1)$ *of the Selberg zeta function for the modular group*
Workshop "Geometric and analytic number theory", Georg-August-Universität Göttingen

27/11/2018 *The special value* $Z'(1)$ *of the Selberg zeta function for the modular group*
Oberseminar "Analysis und Zahlentheorie", Eberhard Karls Universität Tübingen

Thomas Powell

12/07/2017 *Some applications of monads in proof theory*
Mathematical Logic Seminar, LMU München

25/07/2017 *Gödel's functional interpretation and the extraction of imperative programs from proofs*
Humboldt Kolleg Workshop: Proof Theory as Mathesis Universalis, Como

06/11/2017 *Functional interpretations with imperative features*
Oberwolfach Workshop on Mathematical Logic: Proof Theory, Constructive Mathematics

13/04/2018 *Ideal objects and abstract machines*
Workshop on Computational Approaches to the Foundations of Mathematics, LMU München

16/09/2018 *Proof mining*
Three day lecture course: Autumn School on Proof and Computation, Fischbachau

Anne-Therese Rauls

16/01/2018 *Subgradient Computation for the Solution Operator of the Obstacle Problem*
Research Seminar Numerics, TU Chemnitz

24/07/2018 *Subgradient Calculus for the Obstacle Problem*
IFIP TC7 Conference on System Modelling and Optimization, Essen

Ulrich Reif

01/03/2017 *Automatic Differentiation with MATLAB*
2nd IM-Workshop on Applied Approximation, Signals and Images, Bernried

31/05/2017 *Moments of Sets with Refinable Boundary*
Dagstuhl workshop on Geometric Modelling, Interoperability and New Challenges

03/07/2017 *Ambient Spline Approximation*
Cime Summer School on Splines and PDEs, Cetraro, Italy

23/08/2017 *Multivariate Polynomial Interpolation*
Colloquium, University of Cambridge

18/09/2017 *Subdivision Volumes*
SMART workshop, Gaeta, Italy

19/09/2017 *Old Problems and New Challenges in Subdivision (jointly with M. Sabin)*
SMART workshop, Gaeta, Italy

28/09/2017 *Approximation with Ambient B-Splines and Intrinsic PDEs on Manifolds*
BIRS workshop on Geometry and Computation for Interactive Simulation, Oaxaca, Mexico

22/02/2018 *Moments of Sets with Refinable Boundary*
3nd IM-Workshop on Applied Approximation, Signals and Images, Bernried

15/09/2018 *Subdivision Volumes*
ICNAAM 2018, Symposium on Approximation of Curves and Surfaces, Rhodes

Steffen Roch

14/08/2017 *Beyond fractality: Piecewise fractal and quasifractal algebras*
IWOTA 2017, TU Chemnitz

Martin Saal

15/03/2017 *The primitive equations with partial viscosity*
German-Japanese Workshop on Partial Differential Equations/University of Konstanz

14/09/2017 *A Galerkin approach for the primitive equations with partial viscosity*
Workshop on PDE XVI/LNCC Petropolis

20/02/2018 *A Galerkin approach for the primitive equations with partial viscosity*
The 19th Northeastern Symposium on Mathematical Analysis/Hokkaido University

28/06/2018 *Regularity Structures for the primitive equations*
Seminar talk/Scuola Normale Superiore di Pisa

06/09/2018 *Primitive equations with only horizontal viscosity*
Seminar talk/Londrina State University

13/09/2018 *White noise solutions for mSQG*
Workshop on PDE XVII/LNCC Petropolis

29/11/2018 *White noise solutions for mSQG*
Seminar talk/University of Konstanz

Nils Scheithauer

30/10/2017 *Construction and classification of vertex algebras*
Conference on Arithmetic, geometry, automorphic forms and physics, National Research University HSE, Moscow

12/12/2017 *Construction and classification of holomorphic vertex operator algebras*
Workshop on Affine, Vertex and W-algebras, University of Rome, La Sapienza, Rome

12/06/2018 *A dimension formula for orbifolds and some applications*
Conference on Vertex operator algebras, number theory and related topics, Sacramento State University, Sacramento

12/09/2018 *Generalised deep holes in the vertex operator algebra associated with the Leech lattice*
Workshop on Moonshine, ESI, Wien

Werner Schindler

06/11/2017 *RNGs for Resource-Constrained Devices*
Workshop on Crypto for the IoT-Cloud, Bochum

30/10/2018 *Einsatzmöglichkeiten der Künstlichen Intelligenz in der IT-Sicherheit*
bitcom AK Sicherheitsmanagement, Berlin

29/11/2018 *Security Evaluation of Physical RNGs*
SantaCrypt 2018, Prag

Kersten Schmidt

23/04/2018 *Asymptotic and numerical analysis of absorbing and impedance boundary conditions*
Department of Mathematics, University of Zagreb

06/07/2018 *A high order Galerkin method for the approximation of contour integrals*
Rhein-Main Arbeitskreis, Darmstadt

11/07/2018 *Einfach Randbedingungen – asymptotische und numerische Analysis von absorbierenden und Impedanzrandbedingungen*
Fachbereich Mathematik, TU Darmstadt

Johann Michael Schmitt

25/05/2017 *Optimal Control of Hyperbolic Balance Laws with State Constraints*
SIAM Conference on Optimization (SIOPT), Vancouver, Canada

Alexandra Schwartz

17/01/2018 *A Nonconvex Approach to Cardinality-Constrained Optimization*
Mathematical Colloquium, Dresden

19/02/2018 *Mathematische Programme mit Kardinalitätsrestriktionen und verwandte Problemklassen*
Fraunhofer ITWM, Kaiserslautern

26/02/2018 *Mathematical Programs with Complementarity Constraints and Related Problems I*
Winterschool on Modern Methods in Nonsmooth Optimization, Würzburg

27/02/2018 *Mathematical Programs with Complementarity Constraints and Related Problems II*
Winterschool on Modern Methods in Nonsmooth Optimization, Würzburg

28/02/2018 *Mathematical Programs with Complementarity Constraints and Related Problems III*
Winterschool on Modern Methods in Nonsmooth Optimization, Würzburg

01/03/2018 *Mathematical Programs with Complementarity Constraints and Related Problems IV*
Winterschool on Modern Methods in Nonsmooth Optimization, Würzburg

26/09/2018 *A Nonlinear Approach to Sparse Optimization*
French–German–Italian Conference on Optimization (FGI), Paderborn

19/10/2018 *A Complementarity-Based Approach to Cardinality-Constrained Optimization*
GdR Workshop, Pau, France

Tobias Seitz

15/12/2017 *Data enhancement for distributed flow measurements*
TRR 146 Lecture Series, Universität Mainz

Adrien Semin

09/05/2018 *Asymptotic and numerical analysis of absorbing and impedance boundary conditions*
Universität Halle-Wittenberg, Halle (Saale)

24/10/2018 *What are... PML and ABC?*
What is? Seminar, Fachbereich Mathematik, TU Darmstadt

Andrei Sipoş

07/11/2017 *Proof mining and the proximal point algorithm*
MFO Workshop no. 1745 (on Proof Theory and Constructive Mathematics), Oberwolfach, Germany

03/07/2018 *Quantitative results on the method of averaged projections*
Workshop on Proofs and Computation (part of the HIM Trimester Program on Types, Sets and Constructions), Bonn, Germany

Christian Stinner

22/02/2017 *Global existence for some chemotaxis-haptotaxis models*
The 2nd International Workshop on Mathematical Analysis of Chemotaxis, Tokyo University of Science

26/07/2017 *Global existence for a structured nonlocal model for tumor invasion*
Conference “Equadiff 2017”, Bratislava

23/10/2017 *On a structured nonlocal model for tumor invasion*
Mini-Workshop on PDE models of motility and invasion in active biosystems, Mathematisches Forschungsinstitut Oberwolfach

13/02/2018 *Global existence for some chemotaxis-haptotaxis models*
Workshop on Mathematical aspects of chemotaxis, cross-diffusion effects and concentration phenomena, Banach Center Warsaw

22/02/2018 *A critical mass phenomenon for chemotaxis systems with volume filling effect*
The 3rd International Workshop on Mathematical Analysis of Chemotaxis, Tokyo University of Science

10/10/2018 *An unusual critical mass phenomenon for a quasilinear chemotaxis system*
Workshop on Analysis and PDE, Leibniz Universität Hannover

Thomas Streicher

09/03/2017 *Classical Realizability*
OST17 Universität Bern

20/09/2018 *How Unique are Ground Models*
ENS Lyon

27/09/2018 *Simplicial Sets within Cubical Sets*
Paris Diderot University (Paris VII)

Gabriel Teschner

13/06/2018 *What is...? Spannungsbasierte Modellierung*
What is...? Seminar, Fachbereich Mathematik, TU Darmstadt

Stefan Ulbrich

08/02/2017 *Preconditioners for Time-Dependent PDE-Constrained Optimization based on Parareal Time-domain Decomposition*
Domain Decomposition DD24, Longyearbyen, Norway

13/02/2017 *Preconditioners for Time-Dependent PDE-Constrained Optimization and an Implementation based on Parareal Time-Domain Decomposition*
SPOT Seminar, INP ENSEEIHT, Toulouse, France

27/02/2017 *Preconditioners for Time-Dependent PDE-Constrained Optimization based on Parareal Time-Domain Decomposition*
SIAM Conference on Computational Science and Engineering (CSE), Atlanta, USA

16/05/2017 *Optimization of Elastoplastic Contact Problems with Application to Deep Drawing Processes*
HCM Workshop: Nonsmooth Optimization and its Applications, Bonn

18/05/2017 *Optimal Boundary Control of Nonlinear Hyperbolic Conservation Laws with State Constraints*
Optimal Control of Dynamical Systems, Mariatrost, Austria

31/05/2017 *Robust PDE-Constrained Optimization based on Approximation Techniques and Reduced Order Models*
International Conference on Engineering and Computational Mathematics (ECM), Hongkong, China

27/06/2017 *Robust Nonconvex PDE-Constrained Optimization based on Approximation Techniques and Reduced Order Models*
Scientific Computing Seminar, TU Kaiserslautern

06/02/2018 *Adaptive Multilevel Methods for Optimization with Partial Differential Equations with and without Data Uncertainty*
Department of Mathematics, Universität Erlangen-Nürnberg

20/03/2018 *Model Order Reduction Techniques with A Posteriori Error Control for Robust Nonlinear PDE-Constrained Optimization*
Annual Meeting of the International Association of Applied Mathematics and Mechanics (GAMM), München

26/03/2018 *Global Optimization of Mixed-Integer ODE-Constrained Network Problems with Application to Stationary Gas Transport*
Copper Mountain Conference On Iterative Methods (CM), Copper Mountain, USA

10/04/2018 *Optimal Boundary Control of Nonlinear Hyperbolic Conservation Laws with State Constraints*
Workshop Challenges in Optimal Control of Nonlinear PDE-Systems, Oberwolfach

10/05/2018 *Optimal Boundary Control of Entropy Solutions for Nonlinear Hyperbolic Conservation Laws with State Constraints*
Workshop on Mathematical Fluid Dynamics, Bad Boll

04/07/2018 *Preconditioners for Unsteady PDE-Constrained Optimization and Parallel Variants*
International Symposium on Mathematical Programming (ISMP), Bordeaux, France

30/07/2018 *Summer School on PDE-Constrained Optimization I*
Peking University, Beijing, China

31/07/2018 *Summer School on PDE-Constrained Optimization II*
Peking University, Beijing, China

01/08/2018 *Summer School on PDE-Constrained Optimization III*
Peking University, Beijing, China

02/08/2018 *Summer School on PDE-Constrained Optimization IV*
Peking University, Beijing, China

03/08/2018 *Summer School on PDE-Constrained Optimization V*
Peking University, Beijing, China

Mirjam Walloth

07/07/2017 *Residual-type a posteriori estimators for continuous and discontinuous Galerkin methods for Signorini problems.*
Rhein-Main Arbeitskreis, Mannheim

12/10/2017 *Adaptive finite elements for contact problems based on efficient and reliable residual-type a posteriori estimators.*
7th GACM Colloquium on Computational Mechanics, Stuttgart

23/01/2018 *Residual-type a posteriori estimator for a quasi-static contact problem.*
Mathematisches Institut, Universität Freiburg

Torsten Wedhorn

30/06/2017 *Variation of invariants of reductive group actions*
Universität Bonn

12/09/2018 *The tautological ring of Shimura varieties of Hodge type*
University Stockholm

01/10/2018 *The tautological ring of Shimura varieties of Hodge type*
Universität Bonn

Brandon Williams

12/06/2018 *Class number sums*
Seminar, Universität Köln

21/11/2018 *Hilbert modular forms and Borcherds products*
Seminar, Chalmers University of Technology

Winnifried Wollner

15/12/2017 *Higher Regularity of Phase-Field Fracture Solutions*
Workshop Adaptive Discretizations, Solvers and Optimization of Fracture Propagation Problems, Hannover

12/03/2018 *Discretization Error in the Optimization of Damage-Processes*
Seminar, TU Kaiserslautern

18/05/2018 *Optimal Control for Fracture Propagation Modeled by a Phase-Field Approach*
Seminar, Universität Augsburg

19/06/2018 *Optimal Control of Phase-Field Fracture Evolution*
International Workshop on PDEs: Analysis and Modelling, Zagreb, Croatia

23/06/2018 *Mathematische Optimierung in Darmstadt*
Recent Advances in Numerical Analysis, Universität Heidelberg

24/09/2018 *Optimal Control of Phase-Field Fracture Evolution*
DK Seminar, Klagenfurt, Austria

28/09/2018 *Optimal Control of Phase-Field Fracture Evolution*
Seminar, Universidad de Deusto, Bilbao, Spain

17/12/2018 *Optimization of Phase-Field Samage and Fracture - and its Discretization*
Mini-Workshop: Numerical Analysis for Non-Smooth PDE-Constrained Optimal Control Problems, Oberwolfach

6.1.2 Contributed Talks

Paloma Schäfer Aguilar

18/05/2018 *Numerical Approximation for Optimal Control Problems of Hyperbolic Balance Laws*
Optimization Seminar, TU Darmstadt

05/07/2018 *Numerical Approximation for Optimal Control Problems of Conservation Laws*
International Symposium on Mathematical Programming (ISMP), Bordeaux, France

Björn Augner

10/01/2018 *Control of Infinite Dimensional Systems of Port-Hamiltonian Type*
Workshop: Control Theory of Infinite-dimensional Systems, Hagen

Frank Aurzada

01/03/2018 *Small deviations of fractional Gaussian sums*
German Probability and Statistics Days, Freiburg

Jan Becker

02/10/2018 *Stationarities of Multi-Leader-Single-Follower Games with Convex Lower Level Problems*
Annual Meeting of the SPP 1962, Kremmen

29/10/2018 *Multi-Leader-Single-Follower Games with Unique Lower Level Solution in Function Space*
Graduate School CE Research Colloquium, TU Darmstadt

Johanna Biehl

09/01/2017 *Optimierung von Fluid-Struktur Kopplungen mit Hilfe reduzierter Modelle*
Optimization Seminar, TU Darmstadt

23/01/2017 *Optimization of Fluid-Structure Interaction with Reduced Order Models*
Graduate School CE Research Colloquium, TU Darmstadt

28/09/2017 *Multilevel Optimization of Fluid-Structure Interaction based on Reduced Order Models*
International Conference on Computational Engineering (ICCE), Darmstadt

12/03/2018 *Multilevel Optimization of Fluid-Structure Interaction based on Reduced Order Models*
Graduate School CE Research Colloquium, TU Darmstadt

22/03/2018 *Multilevel Optimization of Fluid-Structure Interaction based on Reduced Order Models*
Annual Meeting of the International Association of Applied Mathematics and Mechanics (GAMM), München

02/07/2018 *Adaptive Multilevel Optimization of Fluid-Structure Interaction based on Reduced Order Models*
International Symposium on Mathematical Programming (ISMP), Bordeaux, France

Alexander Birx

05/07/2018 *An Improved Upper Bound for Online Dial-a-Ride on the Line*
International Symposium on Mathematical Programming (ISMP), Bordeaux, France

20/07/2018 *An Improved Upper Bound for Online Dial-a-Ride on the Line*
Optimization Seminar, TU Darmstadt

13/08/2018 *An Improved Upper Bound for Online Dial-a-Ride on the Line*
Graduate School CE Research Colloquium, TU Darmstadt

Dieter Bothe

29/06/2017 *Flux-correction for fully embedded concentration boundary layers in FV-based solvers*
3rd International Conference Numerical Methods in Multiphase Flows, Tokyo, Japan

Max Bucher

28/08/2017 *Regularization for a Complementarity Formulation of Cardinality Constrained Optimization Programs*
Optimization Seminar, TU Darmstadt

20/09/2017 *Regularization for a Complementarity Formulation of Cardinality Constrained Optimization Programs*
International Conference on Parametric Optimization and Related Topics (ParaoptXI), Prague, Czech Republic

28/09/2017 *Regularization for a Complementarity Formulation of Cardinality Constrained Optimization Programs*
French–German–Italian Conference on Optimization (FGI), Paderborn

27/11/2017 *Regularization for a Complementarity Formulation of Cardinality Constrained Optimization Programs*
Graduate School CE Research Colloquium, TU Darmstadt

Micha Buck

01/03/2018 *Persistence probabilities of fractional Gaussian sequences*
German Probability and Statistics Days, Freiburg

20/03/2018 *Negative excursions of fractional Gaussian sequences*
Spring School "Spin Systems: Discrete and Continuous", Darmstadt

05/07/2018 *Persistence probabilities of two-sided fractional Gaussian sequences*
12th Vilnius Conference on Probability and Statistics and IMS Annual Meeting, Vilnius

Felix Canavoi

23/06/2017 *Common knowledge and multi-scale locality analysis in Cayley structures*
Logic in Computer Science (LICS 2017), Reykjavik, Iceland

07/07/2017 *A modal characterisation theorem for Common Knowledge Logic*
Logic Seminar, TU Darmstadt

11/04/2018 *What is model checking?*
"What is...?" Seminar, TU Darmstadt

Aday Celik

08/03/2018 *Time-periodic Stokes equation in the half space*
Gemeimsame Jahrestagung GDMV 2018, Paderborn

Elisabeth Diehl

23/10/2017 *Simulationsbasierte Optimierung und Optimales Design von Experimenten für Benetzungsvorgänge*
Optimization Seminar, TU Darmstadt

Yann Disser

09/03/2017 *Robust and Adaptive Search*
International Symposium on Theoretical Aspects of Computer Science (STACS), Hannover

19/04/2017 *An Introduction to Exploring Unknown Graphs*
Mathematical Colloquium, TU Darmstadt

24/04/2017 *Robust and Adaptive Search*
Graduate School CE Research Colloquium, TU Darmstadt

Jürgen Dölz

06/10/2018 *On the best approximation of the hierarchical matrix product*
16th Workshop on Fast Boundary Element Methods in Industrial Applications, Hirschegg

12/10/2018 *On the best approximation of the hierarchical matrix product*
2nd Workshop of the Agility Group on Numerical Analysis of the International Association of Applied Mathematics and Mechanics (GAMM), Augsburg

Herbert Egger

25/09/2017 *A mixed finite element approximation for the isentropic compressible Euler equations*
30th Chemnitz FEM Symposium, Strobl

02/11/2017 *A mixed finite element approximation for the isentropic compressible Euler equations*
GAMM Workshop on Numerical Analysis, Aachen

21/05/2018 *Tikhonov regularization under conditional stability*
Inverse Problems: Modeling and Simulation, Malta

12/07/2018 *A hybrid mixed discontinuous Galerkin method for compressible flow on networks*
International Conference on Spectral and High Order Methods, London, UK

05/09/2018 *Structure preserving approximation of evolution problems with dissipation*
Conference on the Numerical Solution of Differential and Differential-Algebraic Equations (NUMDIFF-15) 2018, Halle (Saale)

27/09/2018 *Mass-lumped mixed finite element methods for Maxwell's equations*
12th International Conference on Scientific Computing in Electrical Engineering, Taormina, Italy

11/10/2018 *Structure preserving numerical approximation of dissipative evolution problems*
GAMM Workshop on Numerical Analysis, Augsburg

Kord Eickmeyer

19/09/2017 *Logics with Invariantly Used Relations*
NII-Shōnan Workshop on Logic and Computational Complexity, Shōnan, Japan

Thomas Eiter

08/03/2018 *Falling Drop in an unbounded liquid reservoir: Steady-state solutions*
Gemeimsame Jahrestagung GDMV 2018, Paderborn

Christoph Erath

12/06/2017 *Céa-type quasi-optimality and convergence rates for (adaptive) vertex-centered FVM*
Finite Volumes for Complex Applications VIII (FVCA 8), Lille, France

25/09/2017 *Adaptive vertex-centered finite volume methods (Petrov-Galerkin) with convergence rates for general second-order linear elliptic PDE*
30th Chemnitz FEM Symposium, Strobl

26/09/2017 *Adaptive coupling of finite volume and boundary element methods: non-symmetric and three-field FVM-BEM*
30th Chemnitz FEM Symposium, Strobl

13/10/2017 *A non-symmetric FEM-BEM coupling method for a parabolic-elliptic interface problem*
15. Söllerhaus Workshop on Fast BEM in Industrial Applications, Hirschegg

20/03/2018 *Non symmetric FEM-BEM coupling for solving a time-dependent interface problem*
89th Annual Meeting of the International Association of Applied Mathematics and Mechanics (GAMM), München

26/06/2018 *Non symmetric FEM-BEM coupling for solving a time-dependent interface problem*
Symposium of the International Association for Boundary Element Methods 2018, Paris, France

02/07/2018 *Was sind/waren meine bisherigen Forschungsarbeiten?*
Research Meeting for Cooperation, Graz

Sofia Eriksson

19/01/2017 *Coupling of the cell-centered finite volume method and the boundary element method for time-dependent problems of advection-diffusion type*
Seminar der AG Numerik, TU Darmstadt

02/10/2017 *A dual consistent finite difference method*
University of East Anglia, Norwich, UK

Michael Fischer

22/05/2017 *Fréchet Differentiability of the Boussinesq Flow with Respect to Domain Variations*
SIAM Conference on Optimization (SIOPT), Vancouver, Canada

David Frenzel

30/10/2017 *Optimal control of hyperbolic conservation laws*
CE Research Colloquium, TU Darmstadt

27/06/2018 *WENO schemes in optimal control of hyperbolic conservation laws (Poster)*
XVII International Conference on Hyperbolic Problems Theory, Numerics, Applications (Hyp2018), Pennsylvania State College, USA

30/10/2018 *WENO schemes in optimal control of nonlinear hyperbolic conservation laws*
Seminar der AG Numerik, TU Darmstadt

18/12/2018 *WENO schemes in optimal control of nonlinear hyperbolic conservation laws*
CE Research Colloquium, TU Darmstadt

Anton Freund

03/07/2018 *Bachmann-Howard Fixed Points*
Workshop "Proofs and Computation", Hausdorff Research Institute for Mathematics, Bonn

04/10/2018 *Computing with Bachmann-Howard fixed points*
Seminar of the Logic and Theory Group, Universität Bern

21/11/2018 *From Collapsing Functions to Admissible Sets*
Oberseminar Mathematische Logik, Albert-Ludwigs-Universität Freiburg

Mathis Fricke

23/01/2017 *Das Kontaktlinienproblem für inkompressible Mehrphasenströmungen*
Oberseminar Analysis, HHU Düsseldorf

06/06/2017 *The contact line problem for incompressible two-phase flows*
Oberwolfach Seminar "Compressible and Incompressible Multiphase Flows", Oberwolfach

28/06/2017 *Modeling and VOF based simulation of dynamic contact lines*
3rd International Conference on Numerical Methods in Multiphase Flows, Tokyo, Japan

09/01/2018 *The Moving Contact Line Problem - Analytical and Numerical Aspects, Seminar für Mehrphasenströmungen*
ITLR Stuttgart

21/03/2018 *Kinematics of Contact Line Motion*
GAMM Annual Meeting, Munich

17/05/2018 *A Kinematic Evolution Equation for the Dynamic Contact Angle in the Presence of Phase Change*
Workshop Surface Wettability Effects on Phase Change Phenomena, Brighton, UK

26/07/2018 *A Kinematic Evolution Equation for the Dynamic Contact Angle and some Consequences*
World Congress on Computational Mechanics, New York City, USA

Tristan Gally

28/03/2017 *Gemischt-Ganzzahlige Semidefinite Programmierung zur Robusten Topologieoptimierung von Stabwerken*
Workshop "Operations Research in den Ingenieurwissenschaften" (TOR Workshop), Wenden

08/12/2017 *SCIP-SDP: A Framework for Solving Mixed-Integer Semidefinite Programs*
Alpen-Adria-Workshop on Optimization, Klagenfurt, Austria

07/03/2018 *Warmstarts and other improvements in SCIP-SDP*
SCIP Workshop, Aachen

15/11/2018 *Placement of Active Bars for Buckling Control in Truss Structures under Bar Failures*
International Conference on Uncertainty in Mechanical Engineering (ICUME), Darmstadt

Alf Gerisch

26/07/2018 *Insight into a nonlocal PDE model of cellular adhesion by microscale space-jump process modelling*
European Conference on Mathematical and Theoretical Biology (ECMTB) 2018, Lisbon, Portugal

04/09/2018 *FFT-based evaluation of nonlocal terms in PDE systems*
Conference on the Numerical Solution of Differential and Differential-Algebraic Equations (NUMDIFF-15) 2018, Halle (Saale)

Dirk Gründing

28/06/2017 *Moving contact line treatment using afinite volume ALE interface-trackingmethod*
3rd International Conference on Numerical Methods in Multiphase Flows, Tokyo, Japan

20/03/2018 *Wetting with an ALE interface tracking method*
89th Annual Meeting of the International Association of Applied Mathematics and Mechanics, Munich

26/06/2018 *Wetting phenomena with ALE interface tracking*
13th OpenFOAM Workshop 2018, Shanghai, China

Oliver Habeck

15/08/2017 *Global Optimization of ODE Constrained Network Problems*
Workshop on Future Research in Combinatorial Optimization (FRICO), Trier

06/07/2018 *Global Optimization of ODE Constrained Network Problems*
International Symposium on Mathematical Programming (ISMP), Bordeaux, France

Karl Heinrich Hofmann

05/10/2017 *Locally compact abelian p-groups and some of their challenges*
Algebra Seminar, Tulane University, New Orleans, LA, USA

06/12/2017 *Locally compact periodic groups*
Conference on Topological Groups, University of Cape Town, South Africa

02/03/2018 *Some peculiar locally compact p-groups*
Algebra Seminar, Tulane University, New Orleans, LA, USA

26/07/2018 *Weakly complete group Hopf algebras*
Conference on the Occasion of Joachim Hilgert's 60th Birthday, University of Paderborn

10/09/2018 *Weakly complete real group algebras*
Algebra Seminar, Tulane University, New Orleans, LA, USA

Christopher Hojny

16/08/2017 *On the Size of Integer Programs with Bounded Coefficients or Sparse Constraints*
Workshop on Future Research in Combinatorial Optimization (FRICO), Trier

12/01/2018 *Symmetry Breaking Polytopes: A Framework for Symmetry Handling in Binary Programs*
Combinatorial Optimization Workshop, Aussois, France

Alexander V. Hopp

07/08/2017 *Mightiness of Optimization Algorithms*
Graduate School CE Research Colloquium, TU Darmstadt

22/06/2018 *A Subexponential Lower Bound for Zadeh's Pivot Rule*
Optimization Seminar, TU Darmstadt

06/07/2018 *On Friedmann's Subexponential Lower Bound for Zadeh's Pivot Rule*
International Symposium on Mathematical Programming (ISMP), Bordeaux, France

08/10/2018 *On Friedmann's Subexponential Lower Bound for Zadeh's Pivot Rule*
Graduate School CE Research Colloquium, TU Darmstadt

Benjamin Horn

23/01/2017 *Formoptimierung für Kontaktprobleme auf Basis isogeometrischer Analysis*
Optimization Seminar, TU Darmstadt

22/05/2017 *Geometry and Topology Optimization of Sheet Metal Profiles by Using a Branch-and-Bound Framework*
SIAM Conference on Optimization (SIOPT), Vancouver, Canada

13/09/2017 *Shape Optimization for Isogeometric Contact Problems using Bundle Methods*
Conference on Isogeometric Analysis (IGA), Pavia, Italy

22/03/2018 *Nonsmooth Shape Optimization with Stress Constraints for Contact Problems based on Isogeometric Analysis*
Annual Meeting of the International Association of Applied Mathematics and Mechanics (GAMM), München

26/03/2018 *A Bundle Trust Region Method for Shape Optimization with Stress Constraints for Contact Problems based on Isogeometric Analysis*
Copper Mountain Conference On Iterative Methods (CM), Copper Mountain, USA

02/07/2018 *Shape Optimization with Stress Constraints for Frictional Contact Problems*
International Symposium on Mathematical Programming (ISMP), Bordeaux, France

Amru Hussein

08/05/2017 *Strong L^p well-posedness of the 3D primitive equations*
The 14th Japanese-German International Workshop on Mathematical Fluid Dynamics, Tokio, Japan

08/05/2017 *Primitive equations in L^p spaces and maximal regularity*
Oberwolfach Workshop: Geophysical Fluid Dynamics, Oberwolfach

12/01/2018 *Nematic liquid crystals in Lipschitz domains*
The 15th Japanese-German International Workshop on Mathematical Fluid Dynamics, Tokio, Japan

06/02/2018 *Beyond maximal L^p-regularity - a case study in spaces of bounded functions*
TULKKA, Karlsruhe

07/05/2018 *Primitive equations in the scaling invariant space $L^\infty(\mathbb{R}^2; L^1(-h,0))$*
Japanese-German International Workshop on Mathematical Fluid Dynamics, Bad Boll

26/06/2018 *Non-self-adjoint graphs*
Workshop on Operator Theory, Complex Analysis, and Applications, (WOTCA 2018), Guimarães, Portugal

02/10/2018 *Non-self-adjoint graphs*
Semigroups of Operators: Theory and Applications (SOTA 2018), Kazimierz Dolny, Polen

Kristina Janzen

18/01/2017 *Physical Model of an Energy Network*
Platformseminar ESE, TU Darmstadt

28/01/2017 *Mathematical Model of an Energy Network*
Platform Conference GSC ESE, TU Darmstadt

26/06/2017 *Modeling of Energy Systems for Settlements Involving Renewable Energies*
Optimization Seminar, TU Darmstadt

22/03/2018 *Optimal Design of Energy Networks for Settlements Involving Renewable Energies*
Annual Meeting of the International Association of Applied Mathematics and Mechanics (GAMM), München

03/07/2018 *Optimal Design of a Decentralized Energy Network*
International Symposium on Mathematical Programming (ISMP), Bordeaux, France

Christina Karousatou

02/06/2017 *Comment explorer un arbre inconnu avec des agents à énergie limitée ?*
Rencontres Francophones sur les Aspects Algorithmiques de Télécommunications (AlgoTel), Quiberon, France

08/09/2017 *Collaborative Delivery by Energy-Sharing Low-Power Mobile Robots*
International Symposium on Algorithms and Experiments for Wireless Networks (ALGOSENSORS), Vienna, Austria

Paul Kiefer

22/05/2018 *Boundary components of the orthogonal upper half-plane*
Seminar ABKLS, St. Petersburg

Ulrich Kohlenbach

28/07/2017 *Proof mining in Convex Optimization*
12th International Conference on Fixed Point Theory and its Applications. Newcastle, Australia.

Philip Kolvenbach

27/09/2017 *Nonlinear Robust Optimization of PDE-Constrained Problems using Second-Order Approximations*
French–German–Italian Conference on Optimization (FGI), Paderborn

23/03/2018 *Nonlinear Robust Optimization of PDE-Constrained Problems using Second-Order Approximations*
Annual Meeting of the International Association of Applied Mathematics and Mechanics (GAMM), München

02/07/2018 *Robust Optimization of PDE-Constrained Problems using Second-Order Methods*
International Symposium on Mathematical Programming (ISMP), Bordeaux, France

15/11/2018 *Robust Design of a Smart Structure under Manufacturing Uncertainty via Nonsmooth PDE-Constrained Optimization*
International Conference on Uncertainty in Mechanical Engineering (ICUME), Darmstadt

Johannes Kromer

29/06/2017 *Numerical quadrature of surface integrals using the surface Laplace-Beltrami operator*
3rd International Conference on Numerical Methods in Multiphase Flows, Tokyo, Japan

Thomas Kugler

21/03/2018 *Optimal control of instationary gas transport*
89th Annual Meeting of the International Association of Applied Mathematics and Mechanics (GAMM), München

05/06/2018 *Structure preserving model reduction for wave propagation with nonlinear damping*
Seminar der AG Numerik, TU Darmstadt

27/06/2018 *Structure preserving model reduction for wave propagation with nonlinear damping*
XVII International Conference on Hyperbolic Problems Theory, Numerics, Applications (Hyp2018), Pennsylvania State College, USA

Jennifer Kupka

06/09/2018 *Mock Modular Forms and Traces of Singular Moduli*
Women in Automorphic Forms, TU Darmstadt

15/11/2018 *Automorphic Forms*
DaFra Seminar, Universität Frankfurt

Anja Kuttich

02/02/2017 *Robust Optimization of Shunted Piezoelectric Transducers for Vibration Attenuation Considering Different Values of Electromechanical Coupling*
Conference & Exposition on Structural Dynamics (IMAC), Garden Grove, USA

24/05/2017 *Simultaneous Truss Topology - and Static Output Feedback Controller Design via Nonlinear Semidefinite Programming*
SIAM Conference on Optimization (SIOPT), Vancouver, Canada

11/10/2017 *Feedback Controller Design and Topology Optimization for Truss Structures Under Uncertain Dynamic Loads*
Colloquium on Computational Mechanics (GACM), Stuttgart

05/07/2018 *Feedback Controller and Topology Design for uncertain mechanical systems*
International Symposium on Mathematical Programming (ISMP), Bordeaux, France

Jens Lang

26/09/2017 *On the stability and conditioning of anisotropic Finite-Element-Runge-Kutta methods*
30th Chemnitz FEM Symposium, Strobl

Yingkun Li

08/06/2017 *Another sum expression for the Appell-Lerch sum*
Workshop on Indefinite Theta Functions, Trinity College Dublin, Ireland

18/07/2018 *Divisibility of Fourier coefficients of meromorphic modular forms*
4th workshop on automorphic forms and related topics, Alfréd Rényi Institute, Budapest

Hendrik Lüthen

21/02/2017 *Geometry and Topology Optimization of Sheet Metal Profiles by Using a Branch-and-Bound Framework*
Manufacturing Integrated Design Final Colloquium CRC 666, Darmstadt

07/09/2017 *On the Size of Integer Programs with Bounded Coefficients or Sparse Constraints*
International Conference on Operations Research (OR), Berlin

Axel Ariaan Lukassen

09/03/2017 *Parameter estimation with reduced basis methods for elliptic differential equations*
88th Annual Meeting of the International Association of Applied Mathematics and Mechanics (GAMM), Weimar

22/03/2018 *Operator splitting for stiff differential equations*
89th Annual Meeting of the International Association of Applied Mathematics and Mechanics (GAMM), München

23/10/2018 *Simulation von chemischen Reaktionssystemen mit unterschiedlichen Zeitskalen*
Doctoral examination, Darmstadt

Holger Marschall

14/03/2017 *Simulationen des Tropfenaufpralls auf strukturierte Oberflächen*
Annual Meeting ProcessNet - Fachgruppe Computational Fluid Dynamics, Bremen

14/03/2017 *Numerical Simulation of Interfacial Heat and Species Transfer in Gas-Liquid Systems - The Continuous Species Transfer (CST) Method*
Annual Meeting ProcessNet-Fachgruppe Computational Fluid Dynamics, Bremen

23/10/2018 *Simulation of Viscoelastic Flows at High Weissenberg Number using a Generic Numerical Stabilization Framework*
6th OpenFOAM User Conference, Hamburg

Marzec Jolanta

07/09/2018 *Maass relations for Saito-Kurokawa lifts of higher levels*
Women in Automorphic Forms, TU Darmstadt

16/10/2018 *Relations between Fourier coefficients of Siegel modular forms*
AG seminar, TU Darmstadt

20/11/2018 *Automorphic representations of* GL_n *- examples*
AG seminar, TU Darmstadt

Alexander Matei

05/03/2018 *Vanishing Viscosity for Gradient-based Optimal Control Problems with Scalar Conservation Laws*
Studierendenkonferenz der Deutschen Mathematiker Vereinigung (DMV), Universität Paderborn

08/06/2018 *Identification of Model Uncertainty in Experiments on Elastic Structural Components – Ideas and Perspectives*
Optimization Seminar, TU Darmstadt

Frederic Matter

07/03/2018 *Solving Complex-Valued* ℓ_0 *Minimization Problems with Constant Modulus Constraints*
SCIP Workshop, Aachen

02/12/2018 *Detection of Ambiguities in Linear Arrays in Signal Processing*
Optimization Seminar, TU Darmstadt

Masoumeh Mohammadi

06/10/2017 *Discretization Error Estimates for Optimal Control of Phase-Field Fracture*
Workshop on Optimization of Infinite Dimensional Non-Smooth Distributed Parameter Systems, Darmstadt

10/10/2017 *Optimizing Fracture Propagation Using a Phase-Field Approach*
Annual Meeting of the SPP 1962, Kremmen

23/03/2018 *Discretization Error Estimates for Optimal Control of Phase-Field Fracture*
Annual Meeting of the International Association of Applied Mathematics and Mechanics (GAMM), München

06/07/2018 *A Priori Error Estimates for a Linearized Fracture Control Problem*
International Symposium on Mathematical Programming (ISMP), Bordeaux, France

07/09/2018 *Discretization Error Estimates for Optimal Control of Phase-Field Fracture*
EWM General Meeting, Graz, Austria

10/09/2018 *A Priori Error Estimates for a Linearized Fracture Control Problem*
European Conference on Computational Optimization (EUCCO), Trier

Christopher Müller

21/03/2017 *Stochastic Galerkin methods for incompressible flows (Poster)*
7th Retreat of the GSC CE 2017, Seeheim

19/07/2017 *Conjugate gradient methods for stochastic Galerkin finite element matrices with saddle point structure (Poster)*
Quantification of Uncertainty: Improving Efficiency and Technology, Trieste, Italy

29/09/2017 *Efficient iterative methods for discrete Stokes equations with random viscosity*
4th International Conference on Computational Engineering (ICCE), Darmstadt

04/12/2017 *Iterative solvers for stochastic Galerkin finite element discretizations of Stokes flow with lognormal random data*
CE Research Colloquium, TU Darmstadt

16/04/2018 *Efficient iterative methods for discrete Stokes equations with random viscosity (Poster)*
SIAM Conference on Uncertainty Quantification 2018, Garden Grove, California, USA

18/06/2018 *Iterative solvers for stochastic Galerkin discretizations of Stokes flow with random data*
Doctoral examination, TU Darmstadt

Michalis Neururer

09/03/2017 *A converse theorem for Maass forms*
Automorphic forms workshop, East Tennessee State University

06/07/2017 *Mahler measures of elliptic surfaces*
Journées arithmétiques, Caen

16/07/2018 *Fourier expansions at cusps*
Building Bridges IV workshop, Budapest

Daniel Nowak

19/09/2017 *A Generalized Nash Game for Computation Offloading with an Extension to an MPEC/EPEC Structure*
International Conference on Parametric Optimization and Related Topics (ParaoptXI), Prague, Czech Republic

06/11/2017 *Generalized Nash Games with Applications in Mobile Edge Computation Offloading*
Graduate School CE Research Colloquium, TU Darmstadt

28/03/2018 *A Generalized Nash Game for Mobile Edge Computation Offloading*
IEEE International Conference on Mobile Cloud Computing, Services, and Engineering (MobileCloud), Bamberg

19/11/2018 *A Multi-Leader-Multi-Follower Game with Application in Gas Markets*
Graduate School CE Research Colloquium, TU Darmstadt

Martin Otto

13/12/2017 *Cayley Structures as Generic Epistemic Models*
Logical Structures in Computation (reunion workshop), Simons Institute, Berkeley

05/03/2018 *Modal logics with questions*
Workshop on Algorithmic Model Theory (AlMoTh 18), Berlin

Andreas Paffenholz

02/05/2017 `polymake`
Workshop on *Low-Level interfaces in mathematical software*, La Cernay, France

Marc Pfetsch

06/07/2018 *On the Size of Integer Programs with Sparse Constraints or Bounded Coefficients*
International Symposium on Mathematical Programming (ISMP), Bordeaux, France

Anna-Maria von Pippich

25/02/2017 *Kongruente Zahlen und elliptische Kurven*
Mathematik-Olympiade, TU Darmstadt

24/05/2017 *Zetawerte in Geometrie und Zahlentheorie*
Mathematisches Kolloquium, TU Darmstadt

Thomas Powell

14/09/2017 *Proof interpretations with imperative features*
Minisymposium on Applied Proof Theory and the Computational Content of Mathematics, Joint ÖMG and DMV Congress, Salzburg

23/06/2018 *Proof interpretations: A modern perspective*
Five day lecture course: North American Summer School on Logic, Language and Information (NASSLLI), Carnegie Mellon University

05/07/2018 *Ideal objects and abstract machines*
Workshop: Proofs and Computation, Hausdorff Institute, Bonn

12/07/2018 *A functional interpretation with state*
ACM-IEEE Symposium on Logic in Computer Science (LICS), University of Oxford

06/08/2018 *Introduction to Proof Theory*
Five day lecture course: European Summer School on Logic, Language and Information (ESSLLI), Sofia University

Bogdan Radu

23/03/2017 *Mixed finite element methods for the acoustic wave equation*
CE Research Colloquium, TU Darmstadt

20/11/2017 *A mixed finite element method for wave propagation with mass lumping*
Seminar der AG Numerik, TU Darmstadt

21/03/2018 *A Mixed FEM with mass lumping for acoustic wave propagation*
89th Annual Meeting of the International Association of Applied Mathematics and Mechanics (GAMM), München

26/06/2018 *A Mixed FEM with mass lumping for acoustic wave propagation*
XVII International Conference on Hyperbolic Problems Theory, Numerics, Applications (Hyp2018), Pennsylvania State College, USA

Anne-Therese Rauls

27/03/2017 *Optimization Methods for Variational Inequalities in Function Spaces*
Optimization Seminar, TU Darmstadt

10/10/2017 *Optimization Methods for MPECs in Function Spaces*
Annual Meeting of the SPP 1962, Kremmen

21/03/2018 *Subgradient Computation for the Solution Operator of the Obstacle Problem*
Annual Meeting of the International Association of Applied Mathematics and Mechanics (GAMM), München

05/07/2018 *Computing a Subgradient for the Solution Operator of the Obstacle Problem*
International Symposium on Mathematical Programming (ISMP), Bordeaux, France

02/10/2018 *Optimization Methods for Mathematical Programs with Equilibrium Constraints in Function Spaces Based on Adaptive Error Control and Reduced Order or Low Rank Tensor Approximations*
Annual Meeting of the SPP 1962, Kremmen

Martin Saal

01/03/2018 *Regularity Structures for the primitive equations*
13th German Probability and Stochastic Days, University of Freiburg

08/05/2018 *Primitive equations with only horizontal viscosity*
Workshop on Mathematical Fluid Dynamics, Evangelische Akademie Bad Boll

Werner Schindler

04/07/2017 *Hardware-Aspekte der IT-Sicherheit*
GI-Workshop Disruptive Technologien, Hünfeld

Andreas Schmidt

08/03/2017 *The Navier-Stokes equations on manifolds with the Coulomb boundary condition*
The 14th Japanese-German International Workshop on Mathematical Fluid Dynamics, Waseda University, Tokyo

08/05/2017 *Strong solutions in time of the Navier-Stokes equations with the Coulomb boundary condition*
The 15th Japanese-German International Workshop on Mathematical Fluid Dynamics, Waseda University, Tokyo

07/05/2018 *Strong solutions in time of the Navier-Stokes equations with the Coulomb boundary condition*
Workshop on Mathematical Fluid Dynamics, Bad Boll

Kersten Schmidt

22/03/2018 *High-oder adaptive mortar finite element discretization for PDE eigenvalue problems in quantum chemistry*
89th Annual Meeting of the International Association of Applied Mathematics and Mechanics (GAMM), München

26/07/2018 *Multiharmonic analysis for nonlinear acoustics with small excitation amplitude*
Conference on Mathematics of Wave Phenomena, Karlsruhe

Andreas Schmitt

07/09/2017 *Symmetry in Mixed Integer Programs: Refined Orbitopes and Extended Formulations*
International Conference on Operations Research (OR), Berlin

04/07/2018 *An Interdiction Approach for the Design of High-Rise Water Supply Systems*
International Symposium on Mathematical Programming (ISMP), Bordeaux, France

16/11/2018 *Algorithmic Design and Resilience Assessment of Energy Efficient High-Rise Water Supply Systems*
International Conference on Uncertainty in Mechanical Engineering (ICUME), Darmstadt

Johann Michael Schmitt

22/03/2018 *Optimal Boundary Control of Hyperbolic Balance Laws with State Constraints*
Annual Meeting of the International Association of Applied Mathematics and Mechanics (GAMM), München

05/06/2018 *Optimal Boundary Control of Hyperbolic Balance Laws with State Constraints*
International Symposium on Mathematical Programming (ISMP), Bordeaux, France

10/10/2018 *Optimal Boundary Control of Hyperbolic Balance Laws with State Constraints*
Conference on Mathematics of Gas Transport (MOG2), Berlin

Moritz Schneider

11/09/2017 *Superconvergent IMEX Peer methods*
International Conference on Scientific Computation and Differential Equations (SciCADE) 2017, Bath, UK

15/05/2018 *Superconvergent IMEX Peer methods*
Seminar der AG Numerik, TU Darmstadt

06/09/2018 *Superconvergent IMEX Peer methods with A-stable implicit part*
Conference on the Numerical Solution of Differential and Differential-Algebraic Equations (NUMDIFF-15) 2018, Halle (Saale)

Lucas Schöbel-Kröhn

13/11/2017 *Analysis and numerical approximation of chemotaxis on networks*
Seminar der AG Numerik, TU Darmstadt

25/01/2018 *Analysis and numerical approximation of chemotaxis on networks*
Seminar of the International Research Training Group 1529, TU Darmstadt

24/07/2018 *Degenerate parabolic equations modelling gas transport on networks*
IFIP TC 7 Conference on System Modelling and Optimization, Essen

Robert Schorr

12/06/2017 *Comparison of adaptive non-symmetric and three-field FVM-BEM coupling*
Finite Volumes for Complex Applications VIII (FVCA 8), Lille, France

25/09/2017 *Non-symmetric coupling of Finite Element Method and Boundary Element Method for parabolic-elliptic interface problems*
European Conference on Numerical Mathematics and Advanced Applications (ENUMATH), Voss, Norway

23/10/2017 *Non-symmetric coupling of Finite Element Method and Boundary Element Method for parabolic-elliptic interface problems*
CE Research Colloquium, TU Darmstadt

20/03/2018 *Stable non-symmetric coupling of the finite volume and the boundary element method for convection-dominated parabolic-elliptic interface problems*
89th Annual Meeting of the International Association of Applied Mathematics and Mechanics (GAMM), München

26/06/2018 *Stable non-symmetric coupling with the boundary element method for convection-dominated parabolic-elliptic interface problems*
Symposium of the International Association for Boundary Element Methods, Paris, France

27/08/2018 *Stable non-symmetric coupling with the boundary element method for convection-dominated parabolic-elliptic interface problems*
CE Research Colloquium, TU Darmstadt

Alexandra Schwartz

17/02/2017 *Convergence of a Relaxation Method for a Complementarity Reformulation of Cardinality Constrained Optimization Problems*
Workshop on Variational Analysis and Optimization, Marianska, Czech Republic

24/05/2017 *Convergence of a Scholtes-type Relaxation Method for Optimization Problems with Cardinality Constraints*
SIAM Conference on Optimization (SIOPT), Vancouver, Canada

12/07/2017 *Convergence of a Scholtes-type Relaxation Method for Optimization Problems with Cardinality Constraints*
EUROPT Workshop on Advances in Continuous Optimization, Montreal, Canada

19/09/2017 *Modeling Truss Structures using Vanishing and Cardinality Constraints*
International Conference on Parametric Optimization and Related Topics, Prague, Czech Republic

10/10/2017 *Multi-Leader-Follower Games in Function Space*
Annual Meeting of the SPP 1962, Kremmen

03/07/2018 *Second-Order Optimality Conditions for Optimization Problems with Cardinality Constraints*
International Symposium on Mathematical Programming (ISMP), Bordeaux, France

11/09/2018 *Second-Order Optimality Conditions for Optimization Problems with Cardinality Constraints*
European Conference on Computational Optimization (EUCCO), Trier

Cedric Sehrt

22/03/2017 *Optimization in the Context of Scalar Transport in Fluid Flow*
Platformseminar ESE, TU Darmstadt

17/01/2018 *Optimization in the Context of Combustion*
Platformseminar ESE, TU Darmstadt

28/06/2018 *Optimization in the Context of Scalar Transport in Fluid Flow*
Platform Conference GSC ESE, TU Darmstadt

Tobias Seitz

21/03/2017 *Identification and optimization of flow and transport phenomena (Poster)*
7th Retreat of the GSC CE, Seeheim

Adrien Semin

09/03/2018 *Asymptotic modeling of the wave-propagation over acoustic liners*
Seminar der AG Numerik, TU Darmstadt

26/08/2018 *Asymptotic modelling of the wave propagation in presence of an array of Helmholtz resonators*
Conference on Mathematics of Wave Phenomena, Karlsruhe

Vsevolod Shashkov

22/11/2018 *Convolution quadrature methods for coupled nonlinear-linear dynamical systems*
Seminar der AG Numerik, TU Darmstadt

Andrei Sipoş

27/07/2018 *Quantitative results on the method of averaged projections*
Logic Colloquium 2018, Udine, Italy

Christopher Spannring

21/03/2017 *Reduced basis methods for PDE problems with random data (Poster)*
7th Retreat of the GSC CE 2017, Seeheim

19/07/2017 *Weighted reduced basis methods for parabolic PDEs with random data (Poster)*
Quantification of Uncertainty: Improving Efficiency and Technology, Trieste, Italy

19/09/2017 *A weighted reduced basis method for parabolic PDEs with random data*
Reduced Basis Summer School 2017, Goslar

29/09/2017 *A weighted reduced basis method for parabolic PDEs with random data*
4th International Conference on Computational Engineering (ICCE), Darmstadt

20/11/2017 *Weighted reduced basis method for parabolic PDEs with random data*
CE Research Colloquium, TU Darmstadt

16/04/2018 *A weighted reduced basis method for parabolic PDEs with random data*
SIAM Conference on Uncertainty Quantification 2018, Garden Grove, California, USA

28/06/2018 *Weighted reduced basis methods for parabolic PDEs with random input data*
Doctoral examination, TU Darmstadt

Philipp Steinbach

10/07/2018 *Adaptive Finite-Elemente-Verfahren für Erdwärmesondenspeicher*
Seminar der AG Numerik, TU Darmstadt

28/11/2018 *Adaptive Finite-Elemente-Verfahren für Erdwärmesondenspeicher (Poster)*
Geothermiekongress 2018, Essen

Elisa Strauch

09/01/2018 *A multi-level Monte Carlo finite element method for stresses along paths*
Seminar der AG Numerik, TU Darmstadt

12/03/2018 *A multi-level Monte Carlo method for stresses along paths (Poster)*
3rd Workshop of the Agility Group on Uncertainty Quantification of the International Association of Applied Mathematics and Mechanics (GAMM), TU Dortmund

Gabriel Teschner

16/01/2018 *Fast iterative solvers for fluid flow problems discretized by finite elements*
Seminar der AG Numerik, TU Darmstadt

27/09/2018 *Estimation of flow geometry and wall shear stress from magnetic resonance imaging*
Chemnitz Symposium on Inverse Problems 2018, TU Chemnitz

Tobias Tolle

29/06/2017 *Extending a hybrid Level Set / Front Tracking method for the simulation of surface tension driven flows*
3rd International Conference Numerical Methods in Multiphase Flows, Tokyo, Japan

Sebastian Ullmann

01/03/2017 *Adaptive reduced-order modeling for flows under uncertainty*
SIAM Conference on Computational Science and Engineering, Atlanta, Georgia, USA

08/09/2017 *CFD under uncertainty: combining model order reduction with spatial adaptivity*
Workshop on Frontiers of Uncertainty Quantification in Engineering, München

28/09/2017 *Model order reduction and spatial adaptivity for incompressible flows with random data*
4th International Conference on Computational Engineering (ICCE), Darmstadt

05/03/2018 *Stochastic Galerkin reduced basis methods for parametrized random elliptic PDEs (Poster)*
UNQW03, Isaac Newton Institute, Cambridge, UK

12/04/2018 *Stochastic Galerkin reduced basis methods for parametrized random elliptic PDEs (Poster)*
Model Reduction of Parametrized Systems, Nantes, France

16/04/2018 *Stochastic Galerkin reduced basis methods for parametrized random elliptic PDEs (Poster)*
SIAM Conference on Uncertainty Quantification 2018, Garden Grove, California, USA

29/05/2018 *Stochastic Galerkin reduced basis methods for parametrized random elliptic PDEs*
Uncertainty quantification for complex systems: theory and methodologies, Isaac Newton Institute, Cambridge, UK

06/09/2018 *Model order reduction for space-adaptive simulations of unsteady incompressible flows*
Conference on the Numerical Solution of Differential and Differential-Algebraic Equations (NUMDIFF-15) 2018, Halle (Saale)

Mirjam Walloth

12/01/2017 *A reliable, efficient and localized error estimator for a discontinuous Galerkin method for the Signorini problem*
Seminar der AG Numerik, TU Darmstadt

09/03/2017 *A reliable, efficient and localized error estimator for a discontinuous Galerkin method for the Signorini problem*
88th Annual Meeting of the International Association of Applied Mathematics and Mechanics (GAMM), Weimar

21/03/2018 *A posteriori error estimation in space and time for contact problems in linear viscoelasticity*
89th Annual Meeting of the International Association of Applied Mathematics and Mechanics (GAMM), München

14/09/2018 *Reliable, efficient and robust a posteriori estimators for the variational inequality in fracture phase-field models*
Jahrestreffen des SPP 1748, Dresden

Anna Walter

26/09/2017 *Optimal Control of Elastoplasticity Problems with Finite Deformations and Application to Deep Drawing Processes*
French–German–Italian Conference on Optimization (FGI), Paderborn

30/10/2017 *Optimale Steuerung elastoplastischer Kontaktprobleme unter Berücksichtigung großer Deformationen*
Optimization Seminar, TU Darmstadt

20/03/2018 *Optimization of Deep Drawing Processes by Optimal Control of Elastoplasticity Problems with Finite Deformations*
Annual Meeting of the International Association of Applied Mathematics and Mechanics (GAMM), München

05/07/2018 *Optimal Control of Elastoplasticity Problems with Finite Deformations*
International Symposium on Mathematical Programming (ISMP), Bordeaux, France

Jonathan Weinberger

08/09/2017 *Interpreting cubical type theory in appropriate presheaf toposes*
Workshop on Homotopy type theory/Univalent foundations as part of Formal Structures in Computation and Deduction (FSCD 2017), Oxford, UK

17/09/2017 *Interpreting cubical type theory in appropriate presheaf toposes*
Peripatetic Seminar on Sheaves and Logic (PSSL 101), Leeds, UK

14/01/2018 *Fibrations in type theory with shapes*
Peripatetic Seminar on Sheaves and Logic (PSSL 102), Santiago de Compostela, Spain

08/04/2018 *Stable ∞-categories in ∞-cosmoses*
Peripatetic Seminar on Sheaves and Logic (PSSL 103), Brno, Czech Republic

31/05/2018 *Proof of model-independence of ∞-category theory in an ∞-cosmos*
MIT Talbot Workshop 2018: Model-independent theory of ∞-categories, Government Camp, OR, USA

08/07/2018 *(Truncated) Simplicial Models of Type Theory*
Workshop on Homotopy type theory/Univalent foundations as part of Federated Logic Conference (FLoC 2018), Oxford, UK

06/10/2018 *Simplicial sets inside cubical sets*
Peripatetic Seminar on Sheaves and Logic (PSSL 104), Amsterdam, Netherlands

08/10/2018 *Universes in a type theory for synthetic ∞-category theory*
EUTYPES 2018, Aarhus, Denmark

21/11/2018 *What is. . . ? A higher category*
What is. . . ? Seminar, Fachbereich Mathematik, TU Darmstadt

11/12/2018 *Universes in a type theory for synthetic ∞-category theory*
Project on Homotopy type theory and Univalent foundations, CAS Oslo, Norway

Cornelia Wichelhaus

26/10/2017 *Nichtparametrische Analyse stochastischer Netzwerke*
Seminar AG Stochastik, Darmstadt

Winnifried Wollner

09/03/2017 *Optimal Control for Fracture Propagation Modeled by a Phase-Field Approach*
Annual Meeting of the International Association of Applied Mathematics and Mechanics (GAMM), Weimar

06/04/2017 *A Priori Error Analysis for Optimization with Elliptic PDE Constraints*
Workshop on Numerical Methods for Optimal Control and Inverse Problems (OCIP), München

13/07/2017 *Optimal Control for Fracture Propagation Modeled by a Phase-Field Approach*
EUROPT 2017 Workshop on Advances in Continuous Optimization, Montreal, Canada

28/09/2017 *A Priori Error Analysis for Optimization with Elliptic PDE Constraints*
European Numerical Mathematics and Advanced Applications Conference (ENUMATH), Bergen, Norway

25/02/2018 *Discretization Error in the Optimization of Damage-Processes*
Chemnitzer Seminar zur Optimalsteuerung, Haus im Ennstal, Austria

06/03/2018 *A Priori Error Analysis for Optimization with Elliptic PDE Constraints*
DMV Jahrestagung, Paderborn

20/03/2018 *Discretization Error for Quadratic-Approximations to Phase-Field Fracture Control*
Annual Meeting of the International Association of Applied Mathematics and Mechanics (GAMM), München

04/07/2018 *Approximation Error for Control Problems Involving Phase-Field Damage Models*
Viennese Conference on Optimal Control and Dynamic Games, Vienna, Austria

10/09/2018 *A Priori Error Analysis for Optimization with Elliptic PDE Constraints*
European Conference on Computational Optimization (EUCCO), Trier

Dimitrios Zacharenakis

01/10/2018 *A posteriori error estimates for a discontinuous Galerkin approximation of the Navier-Stokes-Korteweg model (Poster)*
Fall School on Hyperbolic Conservation Laws and Mathematical Fluid Dynamics, Universität Würzburg

11/12/2018 *A posteriori error estimates for a discontinuous Galerkin approximation of the Navier-Stokes-Korteweg model*
Seminar der AG Numerik, TU Darmstadt

6.1.3 Visits

Frank Aurzada, Columbia University, March 2018

Dieter Bothe, Waseda University, Tokyo, March 2017

Dieter Bothe, ENS, Rennes, November 2018

Aday Celik, TU Wien, October 2018

Yann Disser, ETH Zurich, Switzerland, November 2018

Yann Disser, Maastricht University, Netherlands, February to March 2018

Herbert Egger, University of Twente, TU Eindhoven, The Netherlands, April 2017

Herbert Egger, RWTH Aachen, October 2018

Herbert Egger, Universität Innsbruck, October 2018

Kord Eickmeyer, TU Berlin, March 2018

Thomas Eiter, Waseda University, Tokyo, September 2018

Reinhard Farwig, Universität Kassel, February 2017

Reinhard Farwig, Universität Kiel, June 2017

Reinhard Farwig, University of Vilnius University, August 2017

Reinhard Farwig, Zhejiang Normal University, Jinhua, China, November 2017

Reinhard Farwig, Fudan University, Shanghai, November 2017

Reinhard Farwig, Tongji University, Shanghai, November 2017

Reinhard Farwig, Shanghai University, Shanghai, November 2017

Reinhard Farwig, Institute of Mathematics, Academy of Mathematics and Systems Science, Chinese Academy of Sciences, Beijing, November 2017

Reinhard Farwig, Institute of Applied Physics and Computational Mathematics (IAPCM), Beijing, November 2017

Reinhard Farwig, Universität Jena, December 2017

Reinhard Farwig, Waseda University, Tokyo, January 2018

Reinhard Farwig, Hirosaki University, Hirosaki, January 2018

Reinhard Farwig, Tohoku University Sendai, January 2018

Reinhard Farwig, Universität Paderborn, March 2018

Reinhard Farwig, The Chinese University of Hong Kong, August 2018

Reinhard Farwig, Tokyo Institute of Technology, September 2018

Reinhard Farwig, Waseda University, Tokyo, September 2018

Alf Gerisch, Indian Institute of Technology (IIT) Roorkee, India, November–December 2017

Karsten Grosse-Brauckmann, University of Leicester, November 2018

Matthias Hieber, Banach Center, Bedlewo, Poland, January 2017

Matthias Hieber, Waseda University, Tokyo, Japan, March 2017

Matthias Hieber, University of Tokyo, Japan, March 2017

Matthias Hieber, Uni Düsseldorf, Düsseldorf, July 2015

Matthias Hieber, Banach Center, Bedlewo, Poland, April 2017

Matthias Hieber, Oberwolfach, May 2017

Matthias Hieber, University of Bologna, Italy, May 2017

Matthias Hieber, Wolfgang Pauli Institute, Vienna, Austria, June 2017

Matthias Hieber, CIME, Cetraro, Italy, September 2017

Matthias Hieber, LNCC, Petropolis, Brasil, September 2017

Matthias Hieber, Waseda University, Tokyo, Japan, November 2017

Matthias Hieber, RIMS, Kyoto, Japan, December 2017

Matthias Hieber, Waseda University, Tokyo, Japan, January 2018

Matthias Hieber, University of Tokyo, Tokyo, Japan, Janaury 2018

Matthias Hieber, Universität Ulm, April 2018

Matthias Hieber, Chinese University, Hongkong, July 2018

Matthias Hieber, Euler Institute, St. Petersburg, Russia, August 2018

Matthias Hieber, Tokyo Tech, Japan, September 2018

Matthias Hieber, FU Berlin, October 2018

Matthias Hieber, Waseda University, Tokyo, Japan, November 2018

Matthias Hieber, RIMS, Kyoto, Japan, December 2018

Amru Hussein, Mathematical Institute, Tohoku University, Sendai, Japan, March 2017

Ulrich Kohlenbach, University of Seville, March 2017

Burkhard Kümmerer, University of Nijmegen, June 2017

Burkhard Kümmerer, ZiF Bielefeld, November 2017

Jens Lang, University of Bath, UK, April–May 2017

Jens Lang, University of Southern Denmark, Odense, Denmark, June 2017

Jens Lang, Isaac Newton Institute, University of Cambridge, UK, March–April 2018

Oliver Lass, WIAS Berlin, May 2017

Alexander Matei, Fraunhofer Institut für Techno- und Wirtschaftsmathematik (ITWM), Kaiserslautern, September 2018

Hannes Meinlschmidt, Karl-Franzens Universität Graz, Austria, April 2017

Michalis Neururer, University of Oxford, March 2018

Marc Pfetsch, Georgia Tech, Atlanta, USA, May 2017

Marc Pfetsch, IASI, Rome, Italy, June 2017

Marc Pfetsch, L'Aquila, Italy, June 2017

Anna-Maria von Pippich, Mathematisches Institut, Universität zu Köln, January 2017

Anna-Maria von Pippich, Centre National de la Recherche Scientifique (C.N.R.S.), Paris, February–March 2017

Anna-Maria von Pippich, Institute for Mathematical Research (FIM), ETH Zurich, April 2017

Anna-Maria von Pippich, Institut Fourier, Grenoble, June 2018

Anna-Maria von Pippich, Fachbereich Mathematik, Eberhard Karls Universität Tübingen, October 2018–March 2019

Thomas Powell, LMU München, July 2017

Thomas Powell, University of Copenhagen, April 2018

Anne-Therese Rauls, TU Chemnitz, January 2018

Martin Saal, Hausdorff Center Bonn, February 2017

Martin Saal, University of Konstanz, March 2017

Martin Saal, MFO Oberwolfach, May 2017

Martin Saal, UFRJ, September 2017

Martin Saal, Tōhoku University, February 2018

Martin Saal, Scuola Normale Superiore di Pisa, June 2018

Martin Saal, International Mathematical Summer Center Cetraro, September 2018

Martin Saal, Londrina State University, September 2018

Martin Saal, University of Konstanz, November 2018

Alexandra Schwartz, McGill University, Montreal, Canada, July 2017

Thomas Streicher, Paris Diderot University (Paris VII), September 2018

Stefan Ulbrich, INP ENSEEIHT, Toulouse, France, February 2017

Stefan Ulbrich, INP ENSEEIHT, Toulouse, France, September 2017

Stefan Ulbrich, TU München, October 2018

Sebastian Ullmann, Isaac Newton Institute, University of Cambridge, UK, May–June 2018

Torsten Wedhorn, University Stockholm, September 2018

Jonathan Weinberger, University of Nottingham, September 2017

Jonathan Weinberger, University of Nottingham, March 2018

Jonathan Weinberger, University of Nottingham, September 2018

Jonathan Weinberger, CAS Oslo, December 2018

Winnifried Wollner, Universität Kassel, January 2017

Winnifried Wollner, Universität Erlangen-Nürnberg, April 2017

Winnifried Wollner, CMAP, Ecolé Polytechnique, France, May 2017

Winnifried Wollner, INRIA Paris, France, May 2017

Winnifried Wollner, Universität Augsburg, May 2017

Winnifried Wollner, TU Berlin, May 2017

Winnifried Wollner, Universität Magdeburg, May 2017

Winnifried Wollner, Universität Bonn, June 2017

Winnifried Wollner, WIAS Berlin, June 2017

Winnifried Wollner, TU München, July 2017

Winnifried Wollner, Universität Erlangen-Nürnberg, August 2017

Winnifried Wollner, HU Berlin, September 2017

Winnifried Wollner, Universität Magdeburg, November 2017

Winnifried Wollner, Universität Hannover, December 2017

Winnifried Wollner, TU Kaiserslautern, March 2018

Winnifried Wollner, TU Dortmund, April 2018

Winnifried Wollner, Universität Augsburg, April 2018

Winnifried Wollner, Universität Bonn, May 2018

Winnifried Wollner, Universität Hannover, May 2018

Winnifried Wollner, HU Berlin, July 2018

Winnifried Wollner, Universität Klagenfurt, Austria, September 2018

Winnifried Wollner, DeustoTech, Universidad de Deusto, Bilbao, Spain, September 2018

Winnifried Wollner, Universität Hannover, October 2018

Winnifried Wollner, Universität Braunschweig, November 2018

6.2 Organization and Program Commitees of Conferences and Workshops

Frank Aurzada

- AIM SQuaRE “Persistence probabilities”, American Institute of Mathematics (joint with Amir Dembo, Ohad Feldheim, Naomi Feldheim, Fuchang Gao, Sumit Mukherjee, Thomas Simon), March 2017
- Session organizer “12th Vilnius Conference on Probability and Statistics and IMS Annual Meeting”, Vilnius, July 2018

Volker Betz

- Spring school on Probability in Mathematics and Physics, Darmstadt, March 2017 (jointly with Matthias Meiners, Frank Aurzada)
- Interplay of Analysis and Probability in Applied Mathematics, Oberwolfach, February 2018
- Spin Systems: Discrete and Continuous, Darmstadt, March 2018 (jointly with Frank Aurzada and Matthias Meiners)

Dieter Bothe

- Short Course on Atomization & Sprays, Darmstadt, February 20 to 23, 2017
- 3rd International Conference on Numerical Methods in Multiphase Flow (ICNMMF-III, Scientific Committee), Tokyo, June 26 to 29, 2017
- Annual Colloquium of the priority program SPP 1740 “Reactive Bubbly Flows”, Darmstadt, September 27 to 29, 2018 (jointly with Holger Marschall)
- Short Course on Atomization & Sprays, Darmstadt, February 19 to 22, 2018
- Section “Interfacial Flows” at the GAMM Annual Conference, Munich, March 19 to 23, 2018

Regina Bruder

- 4. Conference of the working group ‘problem solving’ of the society for didactics of mathematics, 13.10. and 14.10.2017, Darmstadt
- Autumn conference of the working group ‘empiric educational research’ of the society for didactics of mathematics, 30.11. and 01.12.2018, Darmstadt

Jan H. Bruinier

- ABKLS-Seminar on *Automorphic Forms* (jointly with K. Bringmann, V. Gritsenko, A. Krieg, G. Nebe, N.-P. Skoruppa, D. Zagier), 15.02.17 Siegen, 03.05.17 Lille, 04.10.17 Köln, 22.11.17 Bonn, 14.02.18 Aachen, 22.05.18 St. Petersburg, 23.11.18 Utrecht
- Conference *Automorphic Forms and Algebraic Geometry* (jointly with G. van der Geer and V. Gritsenko), Steklov Mathematical Institute, St. Petersburg, 14.05.18–18.05.18

- Special session *Automorphic forms and L-functions* (jointly with A. Popa), Joint Meeting of the German and the Romanian Mathematical Societies, 16.09.17–19.09.17

Yann Disser

- Member of Program Committee, International Colloquium on Structural Information and Communication Complexity (SIROCCO), 2017, Porquerolles
- Chair of Program Committee (jointly with Vassilios Verykios), 4th International Symposium on Algorithmic Aspects of Cloud Computing (ALGOCLOUD), 2018, Helsinki

Reinhard Farwig

- International Conference ”Vorticity, Rotation and Symmetry (IV) - Complex Fluids and the Issue of Regularity”, CIRM Luminy (Marseille, France), 08.-12.05.17, jointly with J. Neustupa (Prague), P. Penel (Toulon), R. Danchin (Paris)
- ”15th Japanese–German International Workshop on Mathematical Fluid Dynamics”, Waseda University, Tokyo, 09.-12.01.18, jointly with M. Hieber (Darmstadt), H. Kozono (Waseda University, Tokyo), Y. Shibata (Waseda University, Tokyo)
- Session ”Nonlinear Partial Differential Equations: Hyperbolic and mixed problems”, joint conference of the Korean Mathematical Society and DMV, Seoul, 04.10.-05.10.18, jointly with Robert Denk (Universität Konstanz)
- Satellite Conference ”Nonlinear Partial Differential Equations: Modelling, Analysis and Perspectives in Mathematical Fluid Mechanics”, Seoul, 02.-03.10.2018, jointly with Robert Denk (Universität Konstanz), and J. Wolf (Chung-Ang University, Seoul)

Christopher Hojny

- Session “Symmetry Handling in Integer Programs” at the International Symposium on Mathematical Programming (ISMP), 2018, Bordeaux

Christina Karousatou

- Local Organizer and member of Organizing Committee, International Colloquium on Structural Information and Communication Complexity (SIROCCO), 2017, Porquerolles

Ulrich Kohlenbach

- Oberwolfach Workshop on ‘Mathematical Logic’, Nov. 5-11, 2017 (jointly with Sam Buss, Rosalie Iemhoff, Michael Rathjen)
- Member of Scientific Committee of ‘12th International Conference on Fixed Point Theory and its Applications’, July 24-28, 2017, Newcastle, Australia
- PC Member, Foundations of Mathematics, March 21-27, 2019, Wuhan, China
- Organizer (with Sam Buss), Special Session on Proof Theory, ASL Logic Collquium 2019, August 11-16, 2019, Prague

Burkhard Kümmerer

– Exhibition: Geheimnis – Herrschaft – Wissen, Universitäts- und Landesbibliothek Darmstadt, jointly with Björn Gebert (ULB), Prof. V. Huth (Institut für Personengeschichte Bensheim), Prof. Dr. Gerrit Schenk (Institut für Geschichte, TU Darmstadt)

Masoumeh Mohammadi

– Minisymposium "Nonsmooth PDE-constrained optimization: problems and methods" at the European Women in Mathematics (EWM) General Meeting, 2018, Graz

Martin Otto

– Logical Aspects of Quantum Information (jointly with S. Abramsky, Ph. Kolaitis and I. Ciardelli), Lorentz Center Leiden, 2018

Marc Pfetsch

– Stream "Networks" at the International Conference on Operations Research (OR), 2017, Berlin

– A Frankfurt-Darmstadt Afternoon on Optimization (jointly with Stefan Ulbrich and Thorsten Theobald), June 22, 2018, Frankfurt

– Stream "IP Practice" at the International Symposium on Mathematical Programming (ISMP), 2018, Bordeaux

– Stream "Networks" at the International Conference on Operations Research (OR), 2018, Brussels

Anna-Maria von Pippich

– Winter-Workshop of the Darmstadt Algebra Group (jointly with J. Bruinier, S. Möller, N. Scheithauer), La Plagne, France, 11.03.17–18.03.17

– Summer school "Faszination Mathematik" for mathematically talented pupils, Jugendherberge Heidelberg, 20.06.17–23.06.17

– Winter-Workshop of the Darmstadt Algebra Group" (jointly with J. Bruinier, M. Rössler, N. Scheithauer, T. Wedhorn), Chalet Giersch, Manigod, France, 18.02.18–25.02.18

– Summer school "Faszination Mathematik" for mathematically talented pupils, Jugendherberge Darmstadt, 15.06.18–19.06.18

Thomas Powell

– Minisymposium on Applied Proof Theory and the Computational Content of Mathematics, Joint ÖMG and DMV Congress, Salzburg (jointly with Sam Sanders)

Ulrich Reif

– Geometry and Computation for Interactive Simulation (jointly with Jorg Peters), BIRS workshop 2017 in Oaxaca, Mexico

- Symposium on Approximation of Curves and Surfaces (jointly with Abdellah Rhababah), Section at ICNAAM 2018 in Rhodes, Greece

Nils Scheithauer

- 10th Seminar on Conformal Field Theory, April 23 - 27, 2018, RIMS, Kyoto (organized by T. Arakawa, P. Fiebig, K. Wendland, N. Scheithauer, K. Wendland, H. Yamauchi)

Alexandra Schwartz

- Sessions "Generalized Nash Equilibrium Problems" and "Disjunctive and Complementarity-type structures" at the International Conference on Parametric Optimization and Related Topics (ParaoptXI), 2017, Prague

Stefan Ulbrich

- Stream "Control Theory and Continuous Optimization" (with Mirjam Dür) at the International Conference on Operations Research (OR), 2017, Berlin
- Stream "Optimal Control, PDE Constrained Optimization, and Multi-level Methods" (jointly with Jean-Bernard Lasserre, Emmanuel Trélat) at the International Symposium on Mathematical Programming (ISMP), 2018, Bordeaux

Mirjam Walloth

- Current Trends and Open Problems in Computational Solid Mechanics (jointly with Fadi Aldakheel, Thomas Wick, Winnifried Wollner, Peter Wriggers), Oct 8–9, 2018, Universität Hannover

Winnifried Wollner

- Workshop "Current trends and open problems in computational solid mechanics" at Universität Hannover, 2018

7 Workshops and Visitors at the Department

7.1 The Colloquium

Winter term 2016

19/10/2016 Prof. Dr. Christoph Ortner (University of Warwick), *Atomistische und mehrskalige Materialmodellierung*

26/10/2016 Prof. Dr. Gregor Nickel (Universität Siegen), *Die Sprache der Modelle – Mathematik und die Mathematisierung der Wissenschaften*

02/11/2016 Prof. Dr. Ralph Neininger (Universität Frankfurt), *Pólya-Urnen*

09/11/2016 Prof. Dr. Vincent Geiger (Australian Catholic University, Brisbane), *Seeking out and taking advantage of opportunities for mathematical literacy across the curriculum*

16/11/2016 Prof. Dr. Heiko von der Mosel (RWTH Aachen), *Elastische Knoten und der Satz von Fary-Milnor*

23/11/2016 Prof. Dr. Mark A. J. Chaplain (University of St. Andrews), *Micro, Meso and Macro: Mathematical Modelling of Cancer at Multiple Scales or Multiscale Cancer Modelling?*

30/11/2016 Prof. Dr. Christian Liedtke (TU München), *(Over-)parametrizing solutions of algebraic equations – (uni-)rationality questions*

07/12/2016 Prof. Dr. Jan Dusek (University of Strasbourg), *On the dynamics of freely falling objects*

14/12/2016 Prof. Dr. Armin Iske (Universität Hamburg), *Ten good reasons for using kernel reconstructions in adaptive finite volume particle methods*

21/12/2016 Prof. Dr. Felix Ali Mehmeti (University of Valenciennes), *Wie zerfließen Wellenpakete in Abhängigkeit vom Frequenzband?*

11/01/2017 Prof. Dr. Andreas Thom (TU Dresden), *Topological methods to solve equations over groups*

18/01/2017 Prof. Dr. Franz Merkl (LMU München), *Verstärkte Irrfahrten und das supersymmetrische hyperbolische sigma-Modell*

25/01/2017 Prof. Dr. Henri Lombardi (University of Franche-Comté, Besançon), *An elementary recursive bound for effective Positivstellensatz and Hilbert 17-th problem*

01/02/2017 Prof. Dr. Nicolas R. Gauger (TU Kaiserslautern), *Simultaneous Aerodynamic Design Optimization in the Presence of Chaos*

08/02/2017 Dr. habil. Christian Stinner (TU Darmstadt), *Mathematische Modelle für Anhäufungen von Zellen durch Chemotaxis*

Summer term 2017

19/04/2017 Prof. Dr. Yann Disser (TU Darmstadt), *Eine Einführung in die Exploration unbekannter Graphen*

26/04/2017 Prof. Dr. Gitta Kutyniok (TU Berlin), *Approximation Theory meets Deep Learning*

03/05/2017 Prof. Dr. Tim Hoheisel (McGill University, Montreal), *Convex Analysis on a Class of Matrix Support Functionals*

10/05/2017 Prof. Dr. Daniel Huybrechts (Universität Bonn), *K3 Flächen*

17/05/2017 Prof. Dr. Stanislaw Schukajlow (Universität Münster), *Emotionen und Motivation von Lehramtsstudierenden*

24/05/2017 Prof. Dr. Anna von Pippich (TU Darmstadt), *Zetawerte in Geometrie und Zahlentheorie*

02/06/2017 Graduation Ceremony for summer term 2016 and winter term 2016/2017: Prof. Dr. Tomas Sauer (Universität Passau), *Katzenvideo, Webcam und das Rechnen mit großen Matrizen*

07/06/2017 Prof. Dr. Anja Sturm (Universität Göttingen), *Interacting particle systems: From local stochastic interactions to global phenomena*

14/06/2017 Prof. Dr. Reinhold Schneider (TU Berlin), *Hierarchical tensor representation for Langevin dynamics*

21/06/2017 Prof. Dr. Anja Fischer (Universität Göttingen), *Neue Varianten des Problems des Handlungsreisenden*

28/06/2017 Prof. Dr. Peter Eichelsbacher (Ruhr-Universität Bochum), *Die Steinsche Methode nach Charles Stein*

05/07/2017 Prof. Dr. Helmut Harbrecht (Universität Basel), *Fast boundary element methods on parametric surfaces*

12/07/2017 Prof. Dr. Eberhard Bänsch (Universität Erlangen-Nürnberg), *A finite element method for particulate flow*

19/07/2017 Prof. Dr. Michael Plum (KIT, Karlsruhe), *Kann der Computer helfen, Existenz- und Vielfachheitsbeweise für nichtlineare elliptische Randwertprobleme zu führen?*

Winter term 2017

18/10/2017 Prof. Dr. Robert Haller-Dintelmann (TU Darmstadt), *Warum es sich lohnt halbe Sachen zu machen: Die Kato Square Root Property*

25/10/2017 Prof. Dr. Alexander Drewitz (Universität Köln), *Zufall über Zufall: Verzweigende Irrfahrten in homogener und zufälliger Umgebung*

03/11/2017 Celebration colloquium on the occasion of 85th Birthday of Prof. Dr. Karl H. Hofmann: Prof. Dr. Karl Hermann Neeb (Universität Erlangen-Nürnberg), *Operator algebras, order, and semigroups*

03/11/2017 Celebration colloquium on the occasion of 85th Birthday of Prof. Dr. Karl H. Hofmann: Prof. Dr. Joachim Hilgert (Universität Paderborn), *Symmetric spaces – classical and quantum perspectives*

08/11/2017 Prof. Dr. Maryna Viazovska (Swiss Federal Institute of Technology in Lausanne), *The sphere packing problem in dimensions 8 and 24*

15/11/2017 Prof. Dr. Christoph Buchheim (TU Dortmund), *Oracle-based Algorithms for Robust Optimization*

22/11/2017 Prof. Dr. Markus Seidel (Westsächsische Hochschule Zwickau), *Kirigami für Operatorgleichungen*

29/11/2017 Prof. Dr. Rolf Biehler (Universität Paderborn), *Das Umgehen mit der Diskontinuität am Übergang Schule-Hochschule als Herausforderung für die Hochschullehre in Mathematik*

06/12/2017 Prof. Dr. Gerd Steinebach (Hochschule Bonn-Rhein-Sieg), *Numerische Simulation von Wassernetzwerken*

13/12/2017 Prof. Dr. Thomas Schuster (Universität des Saarlandes), *Parameter identification for elastic wave equations*

20/12/2017 Prof. Dr. Bernd Sturmfels (MPIM Leipzig), *Changing Views on Curves and Surfaces*

10/01/2018 Prof. Dr. Norbert Hungerbühler (ETH Zürich), *Vom Fragen und vom Staunen in der Mathematik*

17/01/2018 Prof. Dr. Georg Stadler (Courant Institute & New York University), *Bayesian inverse problems governed by PDEs*

24/01/2018 Prof. Dr. Stefan Teufel (Universität Tübingen), *Geometrie periodischer Quantensysteme*

31/01/2018 Prof. Dr. Philipp Grohs (Universität Wien), *Stable Phase Retrieval and Spectral Clustering*

07/02/2018 Prof. Dr. Peter Wittwer (University of Geneva), *Do the Navier-Stokes equations correctly describe stationary fluid flows in two dimensions?*

Summer term 2018

11/04/2018 Dr. Kord Eickmeyer (TU Darmstadt), *Logic, Graphs and Algorithms*

18/04/2018 Prof. Dr. Andreas Weinmann (Hochschule Darmstadt), *Variational methods for processing manifold-valued images*

25/04/2018 Prof. Dr. Dorothee Knees (Universität Kassel), *Rate-independent systems in the context of damage and fracture*

02/05/2018 Prof. Dr. Alexander Lindner (Universität Ulm), *On quasi-infinitely divisible distributions*

09/05/2018 Prof. Dr. Maike Vollstedt (Universität Bremen), *Eine Reise zum Sinn der Mathematik: Studien zu Sinnkonstruktionen von Schülerinnen und Schülern in Deutschland, Hongkong, Thailand und Finnland*

16/05/2018 Prof. Dr. Winfried Sickel (Universität Jena), *Besov-Räume*

25/05/2018 Graduation Ceremony for summer term 2017 and winter term 2017/2018: Prof. Dr. Anton Wakolbinger (Universit"at Frankfurt), *Mathematische Populationsgenetik und experimentelle Evolution*

30/05/2018 Prof. Dr. Angelika Steger (ETH Zürich), *Resilience of Random Graphs*

06/06/2018 Prof. Dr. Alexander Mielke (WIAS and HU Berlin), *Entropy-induced geometry for classical and quantum Markov semigroups*

13/06/2018 Prof. Dr. Gerhard Starke (Universität Duisburg-Essen), *Spannungsbasierte Formulierungen für Variationsungleichungen in der Festkörpermechanik*

27/06/2018 Prof. Dr. Rod Downey (Victoria University, Wellington, Neusealand), *Algorithmic Randomness*

04/07/2018 Prof. Dr. Michael Kohler (TU Darmstadt), *Statistical theory for deep neural networks*

11/07/2018 Dr. Kersten Schmidt (TU Darmstadt), *Einfach Randbedingungen – asymptotische und numerische Analysis von absorbierenden und Impedanzrandbedingungen*

Winter term 2018

17/10/2018 Celebration colloquium on the occasion of 60th Birthday of Prof. Dr. Steffen Roch: Prof. Dr. Albrecht Böttcher (TU Chemnitz), *Die Duduchava-Roch-Formel*

24/10/2018 Prof. Dr. Patrick Joly (ENSTA ParisTech), *Artificial boundary conditions for wave propagation in complex media*

31/10/2018 Prof. Dr. Guido Sweers (Universität Köln), *Laundry lines, curtain rods, membranes and thin plates*

07/11/2018 Prof. Dr. Johannes Schmidt-Hieber (Universiteit Leiden), *Statistical theory for deep neural networks*

14/11/2018 Prof. Dr. Peter Fiebig (Universität Erlangen-Nürnberg), *Darstellungstheorie in positiver Charakteristik*

21/11/2018 Prof. Dr. Denis-Charles Cisinski (Universität Regensburg), *Higher categories as a basic language for mathematics*

28/11/2018 Prof. Dr. Gianluigi Rozza (International School for Advanced Studies (Sissa), Trieste), *State of the art and perspectives for reduced order methods in computational fluid dynamics*

05/12/2018 Prof. Dr. Roland Herzog (TU Chemnitz), *An Introduction to Optimal Experimental Design with PDEs*

12/12/2018 Prof. Dr. Stefan Krauss (Universität Regensburg), *Die diagnostische Kompetenz von Lehrkräften in der COACTIV-Studie*

19/12/2018 Prof. Dr. Christoph Buchheim (TU Dortmund), *Oracle-based Algorithms for Robust Optimization*

16/01/2019 Prof. Dr. Amin Coja-Oghlan (Universität Frankfurt), *Spin systems on Bethe lattices*

23/01/2019 Prof. Dr. Esther Brunner (PH Thurgau, Kreuzlingen), *Welche Beweistypen setzen Lehrpersonen ein und womit hängt das zusammen?*

30/01/2019 Prof. Dr. Yingkun Li (TU Darmstadt), *Green's function and arithmetic*

06/02/2019 Prof. Dr. Jochen Heinloth (Universität Duisburg-Essen), *Hitchin's fibration: From integrable systems to number theory*

13/02/2019 Celebration colloquium on the occasion of the retirement of Prof. Dr. Burkhard Kümmerer: Prof. Dr. Burkhard Kümmerer (TU Darmstadt), *Mathematik berührt – Keine Abschiedsvorlesung*

7.2 Guest Talks at the Department

17/01/2017 Prof. Dr. Ulrich Görtz (Universität Duisburg-Essen), *Fully Hodge-Newton Decomposable Shimura Varieties* (Torsten Wedhorn)

19/01/2017 Manon Baudel (University of Orleans), *Spectral theory for random Poincare maps* (Volker Betz)

26/01/2017 Dr. Sebastian Riedel (TU Berlin), *Rough differential equations with unbounded drift* (Frank Aurzada)

01/02/2017 Prof. Dr. Nicolas Gauger (TU Kaiserslautern), *Simultaneous Aerodynamic Design Optimization in the Presence of Chaos* (Stefan Ulbrich)

02/02/2017 Dr. Petr Siegl (Universität Bern), *The damped wave equation with unbounded damping* (Amru Hussein)

03/02/2017 Prof. Dr. Gerald Höhn (University of Kansas, USA), *On the Genus of the Moonshine Module* (Nils Scheithauer)

03/02/2017 Prof. Dr. Tomoyuki Arakawa (RIMS Kyoto, Japan), *Moore-Tachikawa conjecture and chiral algebras of class S* (Nils Scheithauer)

03/02/2017 Prof. Dr. Wolfgang Soergel (Universität Freiburg), *Special Bimodules and Motives* (Nils Scheithauer)

07/02/2017 Dr. Jens Funke (University of Durham, UK), *Indefinite theta functions* (Jan H. Bruinier)

09/02/2017 Arbi Moses Badlyan (TU Berlin), *Port-Hamiltonian structure of Navier-Stokes equations for reactive flows* (Herbert Egger)

10/02/2017 Flavia Cavalcanti Miranda (Fachgebiet Energie- und Kraftwerktechnik, TU Darmstadt), *Radiation modeling for oxy-fuel combustion* (Herbert Egger)

21/02/2017 Prof. Dr. Michael Stingl (Universität Erlangen-Nürnberg), *On the Life Cycle Oriented Design of High Pressure Steam Pipes Based on Timoschenko Beam Network Models* (Stefan Ulbrich)

21/02/2017 Prof. Dr. Michal Kocvara (University of Birmingham), *New Numerical Tools for Very Large Scale Topology Optimization* (Stefan Ulbrich)

23/02/2017 Prof. Dr. Hans Maassen (University of Nijmegen), *Ergodische Zerlegung von Messreihen* (Burkhard Kümmerer)

15/03/2017 Prof. Alexander Lorz (Pierre and Marie Curie University, France), *On mathematical models of mutation selection* (Christoph Erath)

11/04/2017 Michal Konecny (Aston University, Birmingham), *Representations for feasibly approximable functions* (Florian Steinberg)

25/04/2017 Dr. Robin de Jong (University of Leiden, NL), *Chern-Weil theory for line bundles with the family Arakelov metric* (Anna von Pippich)

03/05/2017 Prof. Dr. Tim Hoheisel (McGill University Montreal), *Convex Analysis on a Class of Matrix Support Functionals* (Alexandra Schwartz)

09/05/2017 Prof. Dr. Hartmut Monien (Universität Bonn), *Belyi-maps of non-congruence subgroups of the modular group associated to sporadic groups* (Jan H. Bruinier)

10/05/2017 Daniel Huybrechts (Universität Bonn), *K3 surfaces* (Torsten Wedhorn)

11/05/2017 Dr. Samuele Anni (Universität Heidelberg), *The inverse Galois problem, Jacobians and the Goldbach's conjecture* (Torsten Wedhorn)

11/05/2017 Dr. Timo Richarz (Universität Duisburg-Essen), *Lokale Modelle von Shimuravarietäten und benachbarte Zykel* (Torsten Wedhorn)

16/05/2017 Dr. Cecilia Mondaini (Brown University), *A general approach to rudging-based data assimiliaton algorithms: analysis results* (Matthias Hieber)

16/05/2017 Prof. Dr. Daoyuan Fang (Hangzhou University), *3D axiymmetric Navier-Stokes equations* (Matthias Hieber)

16/05/2017 Prof. Dr. Edriss Titi (FU Berlin), *Some remarks on a generalization of the Bardos-Tartar conjecture for nonlinear dissipative PDEs* (Matthias Hieber)

16/05/2017 Prof. Dr. Huy Nguyen (University of Science and Technology, Hanoi), *Boundedness, Periodicity and Stability of Solutions to Fluid Flow Problems* (Matthias Hieber)

16/05/2017 Prof. Dr. Jinkai Li (Chinese University of Hongkong), *Primitive equations with horizontal viscosity and diffusivity around H^1 initial data* (Matthias Hieber)

16/05/2017 Prof. Dr. Vu Hoang (University of Texas), *Singularity formation for a one-dimensional active scalar equation* (Matthias Hieber)

16/05/2017 Prof. Dr. Yoshihoro Shibata (Waseda University), *Two phase problem for the Navier-Stokes equations in unbounded domains* (Matthias Hieber)

06/06/2017 Dr. Robert Wilms (Gutenberg-Universität Mainz), *On Falting's delta invariant* (Anna von Pippich)

07/06/2017 Dr. Lennart Gehrmann (Universität Duisburg-Essen), *Automorphe L-Invarianten* (Torsten Wedhorn)

07/06/2017 Prof. Dr. Britta Dorn (Universität Tübingen), *Kollektive Entscheidungsfindung - Existenz, Komplexität und Struktur von fairen Aufteilungen* (Jan H. Bruinier)

07/06/2017 Prof. Dr. Walther Paravicini (Universität Göttingen), *Bivariante Äquivariante Invarianten für Operatoralgebren* (Jan H. Bruinier)

08/06/2017 Carmen Gräßle (Universität Hamburg), *The inclusion of adaptivity concepts in the context of POD model order reduction* (Sebastian Ullmann)

08/06/2017 Prof. Dr. Thomas Bauer (Universität Marburg), *Kammerzerlegungen auf algebraischen Flächen* (Jan H. Bruinier)

12/06/2017 Stephane Le Roux (Free University of Brussels), *Stable Nash Equilibria* (Volker Betz)

15/06/2017 Prof. Dr. Thomas Creutzig (University of Alberta, Canada), *Modular aspects of logarithmic conformal field theory* (Nils Scheithauer)

16/06/2017 Prof. Rod Downey (Victoria University Wellington, New Zealand), *Notes on Computability in Mathematics* (Ulrich Kohlenbach)

21/06/2017 Prof. Dr. Anja Fischer (Universität Göttingen), *Neue Varianten des Problems des Handlungsreisenden* (Alexandra Schwartz)

21/06/2017 Prof. Dr. Gregor Nickel (Universität Siegen), *Eine historisch-philosophische Spurensuche* (Jan H. Bruinier)

22/06/2017 Prof. Dr. Carla Cederbaum (Universität Tübingen), *Geometrische Strukturen in der Mathematischen Relativitätstheorie* (Jan H. Bruinier)

27/06/2017 Dr. Mathias Wilke (Universität Regensburg), *Quasilinear parabolic evolution equations in time-weighted function spaces* (Amru Hussein)

01/07/2017 Prof. Andrey Morozov (Sobolev Institute of Mathematics, Novosibirsk), *Infinite time Blum-Shub-Smale machines for computability in analysis* (Ulrich Kohlenbach)

04/07/2017 Dr. Paul Ziegler (University of Oxford, UK), *Mirror Symmetry for Moduli Spaces of Higgs Bundles* (Torsten Wedhorn)

07/07/2017 Dr. Sapna Pandit (Indian Institute of Technology Roorkee, India), *Haar wavelet quasilinearization approach for numerical simulation of parabolic equations* (Herbert Egger)

07/07/2017 Prof. Dr. Mikhail Lifshits (St. Petersburg), *Energy saving approximation of random processes* (Frank Aurzada)

07/07/2017 Prof. Dr. Vitali Wachtel (Universität Augsburg), *First-passage times over moving boundaries for random walks with non-identically distributed increments* (Frank Aurzada)

11/07/2017 Ana Caraiani (Imperial College London), *Generic part of the cohomology of some Shimura varieties* (Torsten Wedhorn)

11/07/2017 Prof. Dr. Ana Caraiani (Harvard University, USA), *On the vanishing of cohomology for certain unitary Shimura varieties* (Torsten Wedhorn)

17/07/2017 Dr. Jan Hackfeld (HU Berlin), *Tight Bounds for Online TSP on the Line* (Yann Disser)

19/07/2017 Prof. Dr. Michael Plum (KIT, Karlsruhe), *Kann der Computer helfen, Existenz- und Vielfachheitsbeweise für nichtlineare elliptische Randwertprobleme zu führen?* (Reinhard Farwig)

19/07/2017 Prof. Dr. Ram Jiwari (Indian Institute of Technology Roorkee, India), *Numerical simulation of parabolic problems using differential quadrature methods* (Alf Gerisch)

20/07/2017 Dr. Alexander Linke (WIAS, Berlin), *Towards Pressure-Robust Mixed Methods for the Incompressible Navier-Stokes Equations* (Winnifried Wollner)

13/09/2017 Eike Neumann (Aston University, UK), *Continuous enclosures of discontinuous problems* (Florian Steinberg)

05/10/2017 Christian Hirsch (LMU München), *From heavy-tailed Boolean models to scale-free Gilbert graphs* (Volker Betz)

06/10/2017 Prof. Martin Ziegler (KAIST School of Computing), *Formal Verification in Imperative Multivalued Programming over Continuous Data Types* (Thomas Streicher)

17/10/2017 Prof. Dr. Bülent Karasözen (Middle-East Technical University Ankara, Turkey), *Energy preserving model order reduction of the nonlinear Schrödinger equations* (Jens Lang)

19/10/2017 Dr. Gudrun Täter (KIT), *Convection in the horizontal annulus:energy bounds from below as interesting tools* (Matthias Hieber, Karoline Disser)

24/10/2017 M.Sc. Thomas Spittler (Universität Freiburg), *A compactification of a moduli space of lattice polarized K3 surfaces* (Nils Scheithauer)

24/10/2017 Vsevolod Shashkov (TU Berlin), *On model order reduction for transient electromagnetic field-circuit coupled systems based on convolution quadrature* (Herbert Egger, Kersten Schmidt)

26/10/2017 Dr. Hiroyuki Tsurumi (Kyshu University), *Ill-posedness of the stationary Navier-Stokes equations in Besov space* (Matthias Hieber)

26/10/2017 Dr. Keiichi Watanabe (Waseda University), *Compressible-incompressible two-phase flows with phase transition:model problems* (Matthias Hieber)

26/10/2017 Dr. Yuka Teramoto (Kyushu University), *On the spectrum of linear artificial compressible system* (Matthias Hieber)

26/10/2017 Prof. Dr. Yuka Teramoto (Kyshu University), *On the spectrum of linear artificial compressible system* (Matthias Hieber)

03/11/2017 Anton Freund (University of Leeds), *From Cut Elimination to* Π^1_1*-Comprehension* (Ulrich Kohlenbach)

07/11/2017 Dr. Jaclyn Lang (Max-Planck-Institut für Mathematik), *Chow motives associated to certain algebraic Hecke characters* (Yingkun Li)

07/11/2017 Dr. Jaclyn Lang (MPIM Bonn), *Chow motives associated to certain algebraic Hecke characters* (Jan H. Bruinier)

09/11/2017 Dr. Joachim Rehberg (WIAS Berlin), *Explicit and uniform resolvent estimates for second order divergence operators on* L^p *spaces* (Matthias Hieber)

13/11/2017 Matko Ljuli (University of Zagreb, Croatia), *Mesh-reinforced shells* (Herbert Egger, Kersten Schmidt)

14/11/2017 Dr. Mira Schedensack (Universität Augsburg), *Fehleranalysis für eine numerische Mehrskalenmethode für konvektionsdominierte Diffusion in 2D* (AG Numerik)

16/11/2017 Kay Hamacher (TU Darmstadt, Department of biology), *Permutation Tests, Resampling and the like in Biostatistics* (Volker Betz)

17/11/2017 Dr. Benjamin Küster (Universität Paderborn), *Klassische Resonanzen auf lokalsymmetrischen Räumen* (Jan H. Bruinier)

17/11/2017 Dr. Dietmar Gallistl (KIT), *Numerische Berechnung der inf-sup-Konstanten der Divergenz* (AG Numerik)

17/11/2017 Dr. Michael H. Mertens (Universität Köln), *Mock-Modulformen und ihre Anwendungen - Von Klassenzahlen zu Moonshine* (Jan H. Bruinier)

17/11/2017 Dr. Samuele Anni (MPIM Bonn), *Congruences, graphs and modular forms* (Jan H. Bruinier)

21/11/2017 Prof. Dr. Christian Engwer (Universität Münster), *Flexible und effiziente numerische Verfahren für komplexe Anwendungen* (AG Numerik)

22/11/2017 Priv. Doz. Dr. Jan Giesselmann (Universität Stuttgart), *Relative Entropie für Gleichungen der Strömungsmechanik* (AG Numerik)

22/11/2017 Prof. Dr. Markus Seidel (Westsächsische Hochschule Zwickau), *Kirigami für Operatorgleichungen* (Steffen Roch)

23/11/2017 Dr. Hannes Meinlschmidt (RICAM Linz), *A gentle introduction to optimal control for analysts* (Matthias Hieber, Karoline Disser)

23/11/2017 Dr. Melina Freitag (University of Bath, UK), *Model order reduction for stochastically controlled linear systems* (AG Numerik)

23/11/2017 Dr. Raul Borsche (TU Kaiserslautern), *Numerische Verfahren für gekoppelte hyperbolische partielle Differentialgleichungen* (AG Numerik)

23/11/2017 Prof. Dr. Arnulf Jentzen (ETH Zürich), *On deep learning, the curse of dimensionality, and stochastic approximation algorithms for PDEs* (AG Numerik)

30/11/2017 Chuangjie Xu (LMU München), *The computer as referee in mathematics* (Thomas Powell)

30/11/2017 David Dereudre (University of Lille 1), *Path-dependent infinite-dimensional SDE with non-regular drift: an existence result* (Volker Betz)

03/12/2017 Prof. Dr. Markus Bachmayr (Universität Bonn), *Nichtlineare Approximationen für hochdimensionale Probleme* (AG Numerik)

12/12/2017 Prof. Dr. Günther Of (TU Graz), *Schnelle Randelementmethode und Anwendungen* (AG Numerik)

14/12/2017 Dr. Takéo Takahashi (INRIA Nancy), *Analysis of a Bingham-rigid body system* (Matthias Hieber, Karoline Disser)

09/01/2018 Prof. Dr. Claudia Alfes-Neumann (Universität Paderborn), *Shintani lifts of harmonic Maass forms* (Jan H. Bruinier)

16/01/2018 Dr. Behnam Soleimani (Universität Halle-Wittenberg), *Implicit-Explicit Peer Methods* (Jens Lang)

16/01/2018 Prof. Dr. Georg Stadler (New York University), *Sparse Optimal Control of PDEs with Uncertain Coefficients* (Winnifried Wollner)

18/01/2018 Dr. Anupam Pal Choudhury (RICAM Linz), *Liquid crystals on Lipschitz domains* (Matthias Hieber)

18/01/2018 Prof. Dr. Michael Winkler (Universität Paderborn), *Kann Fluid-Interaktion in primitiven Chemotaxissystemen räumliche Strukturen erzeugen?* (Christian Stinner)

18/01/2018 Prof. Dr. Michael Winkler (Universität Paderborn), *Kann Fluid-Interaktion in primitiven Chemotaxissystemen räumliche Strukturen erzeugen?* (Matthias Hieber, Ch. Stinner)

22/01/2018 Prof. Dr. Yulii Shikmurzaev (University of Birmingham, School of Mathematics, Birmingham), *Wetting in porous media: Modelling results and emerging issues* (Prof. Dr. Dieter Bothe)

23/01/2018 Prof. Dr. Yulii Shikmurzaev (University of Birmingham, School of Mathematics, Birmingham), *Mathematics of curved liquid jets and how not to do it* (Prof. Dr. Dieter Bothe)

25/01/2018 Dr. Orif Ibrogimov (University College London), *Essential spectrum due to singularity* (Matthias Hieber, A. Hussein)

25/01/2018 Prof. Dr. Mikhail Lifshits (St. Petersburg), *A hierarchical renormalisation model* (Frank Aurzada)

01/02/2018 Dr. Hind Al Baba (University of Pau and Pays de l'Adour), *L^p-L^q estimates and maximal regularity to the Stokes problem with Navier-type boundary conditions* (Matthias Hieber, Patrick Tolksdorf)

02/02/2018 Dr. Adriana Nicolae (University of Seville), *"Lion-Man" and the Fixed Point Property* (Ulrich Kohlenbach)

02/02/2018 Prof. Dr. Don Zagier (MPIM Bonn), *Modular forms and mock modular forms in physics* (Jan H. Bruinier)

02/02/2018 Prof. Dr. Stephen Kudla (University of Toronto, Canada), *Arithmetic theta series* (Jan H. Bruinier)

05/02/2018 Dr. Damir Jurić (CNRS, LIMSI, Paris), *Code BLUE: A front-tracking/immersed boundary approach to complex multiphase flows* (Prof. Dr. Dieter Bothe)

06/02/2018 Dr. Henrik Bachmann (Max-Planck-Institut für Mathematik), *Multiple harmonic q-series at roots of unity and their connection to finite and symmetrized multiple zeta values* (Yingkun Li)

06/02/2018 Prof. Dr. Henrik Bachmann (Nagoya University, Japan), *Multiple harmonic q-series at roots of unity and their connection to finite symmetrized multiple zeta values* (Jan H. Bruinier)

06/02/2018 Prof. Dr. Rüdiger Weiner (Universität Halle-Wittenberg), *Zweischritt-W-Methoden* (Jens Lang)

08/02/2018 Dr. Yulia Petrova (St. Petersburg), *Exact L_2-small ball probabilities for finite-dimensional perturbations of Gaussian processes: spectral method* (Frank Aurzada)

09/02/2018 Dr. Florian Steinberg (Institut Nationale de Recherche en Informatique et en Automatique), *Type-two poly-time and length revisions* (Ulrich Kohlenbach)

13/03/2018 Dr. Matthias Köhne (Universität Düsseldorf, Düsseldorf), *Towards a Rigorous Analysis of Basic Contact Line Models* (Prof. Dr. Dieter Bothe)

15/03/2018 Dr. Holger Heumann (CASTOR, Inria Sophia Antipolis, France), *A high order method for the approximation of integrals over implicity defined hypersurfaces* (Herbert Egger)

15/05/2018 Prof. Dr. Simon Lentner (Universität Hamburg), *Non-semisimple modular tensor categories* (Nils Scheithauer)

16/05/2018 Prof. Dr. Winfried Sickel (Universität Jena), *Besov-Räume* (Reinhard Farwig)

18/05/2018 Prof. Dr. Friedrich Götze (Universität Bielefeld), *Asymptotic Expansions in Entropic Limit Theorems* (Frank Aurzada)

18/05/2018 Prof. Dr. Michael Scheutzow (TU Berlin), *Generalized couplings and ergodicity* (Frank Aurzada)

04/06/2018 Prof. Dr. Milovan Peric (Universität Düsseldorf, Düsseldorf), *Strömungssimulation in zeitlich veränderlichen Lösungsgebieten* (Prof. Dr. Dieter Bothe)

12/06/2018 Dr. Raimondo Penta (University of Glasgow, UK), *Effective balance equations for elastic composites subject to inhomogeneous potentials* (Alf Gerisch)

14/06/2018 Dr. Marcel Braukhoff (TU Wien), *Energy-transport Systems for Optical Lattices: Derivation, Analysis, Simulation* (Aday Celik)

14/06/2018 Dr. Yuji Shinano (Zuse Institut Berlin), *Massively Parallel Mixed Integer Programs (MIP) Solving: Towards Harnessing over a Million CPU Cores to Solve a Single MIP on Supercomputers* (Marc Pfetsch)

14/06/2018 Laura Bittner (Universität Wuppertal), *How Regularity Theory Benefits Shape Calculus: Probabilistic Lifespan Optimization for Devices under Load* (Winnifried Wollner)

18/06/2018 Dr. Vo Ahnh Khoa (Universität Göttingen), *Approximations for semi-linear re-action-diffusion equations forward and backward cases* (Herbert Egger)

19/06/2018 M.Sc. Linda Frey (Universität Basel, Switzerland), *Explicit small height bound for* $\mathbb{Q}(E_{tor})$ (Jan H. Bruinier)

28/06/2018 Dr. Alessandra Cipriani (TU Delft), *The scaling limit of the membrane model* (Volker Betz)

03/07/2018 Dr. Thomas Oliver (University of Oxford), *Order and cancellation of zeros of automorphic L-functions* (Michalis Neururer)

03/07/2018 Dr. Tom Oliver (University of Oxford, UK), *Order and cancellation of zeros for automorphic L-functions* (Jan H. Bruinier)

27/08/2018 Rasa Giniunaite (University of Oxford, UK), *Modelling the collective migration of neural crest cells* (Alf Gerisch)

13/09/2018 Prof. Dr. Wolfgang Dreyer (WIAS, Berlin), *Thermodynamics and Kinetic Theory of Non-Newtonian Fluids* (Prof. Dr. Dieter Bothe)

20/09/2018 Dr. Benedikt Jahnel (WIAS Berlin), *Dynamical Gibbs-non-Gibbs transitions for the continuum Widom-Rowlinson model* (Frank Aurzada)

17/10/2018 Prof. Dr. Albrecht Böttcher (TU Chemnitz), *Die Duduchava-Roch-Formel* (Reinhard Farwig, Steffen Roch)

18/10/2018 Dr. Kazuyuki Tsuda (Osaka University, Japan), *I. Time periodic problem for the compressible Navier-Stokes equation on the whole space; II. Time decay estimate for solutions to the compressible Navier-Stokes-Korteweg system* (Reinhard Farwig)

18/10/2018 Prof. Dr. Octavio Vera Villagran (University of Bio-Bio, Chile), *Nonlinear Schrödinger equations* (Matthias Hieber, Martin Saal)

23/10/2018 Mr. Toshiki Matsusaka (Universität zu Köln/Kyushu University), *CM values, cycle integrals, and polyharmonic Maass forms* (Yingkun Li)

25/10/2018 Dr. Toshiki Matsusaka (Kyushu University, Japan), *CM values, cycle integrals, and polyharmonic Maass forms* (Yingkun Li)

30/10/2018 Prof. Dr. Christian Elsholtz (TU Graz, Austria), *Applications of sieve methods* (Jan H. Bruinier)

31/10/2018 Prof. Dr. Guido Sweers (Universität Köln), *Laundry lines, curtain rods, membranes and thin plates* (Reinhard Farwig)

01/11/2018 Dr. Dirk Zeindler (Lancaster University), *Random permutations with logarithmic cycle weights* (Volker Betz)

13/11/2018 Dr. Mania Sabouri (Guest Researcher), *Mortar spectral element method for the p-Laplacian equation* (Herbert Egger)

15/11/2018 Dr. Liron Ravner (University of Amsterdam), *Estimating the input of a Lévy-driven queue by Poisson sampling of the workload process* (Cornelia Wichelhaus)

15/11/2018 Kira Bangert (TU Dortmund), *Homogenisierung und das Bloch-Theorem* (Matthias Hieber)

15/11/2018 Prof. Dr. Georg Stadler (Courant Institute, New York University), *Optimal Control of Systems Governed by PDEs with Uncertain Parameters* (Stefan Ulbrich)

20/11/2018 Fabian Meyer (Universität Stuttgart), *A posteriori error analysis for random conservation laws* (Jan Giesselmann)

22/11/2018 Caroline Geiersbach (Universität Wien), *A Stochastic Gradient Algorithm for PDE Constrained Optimization under Uncertainty* (Winnifried Wollner)

23/11/2018 Prof. Anuj Dawar (University of Cambridge), *Definable Inapproximability: New Challenges for Duplicator* (Martin Otto)

27/11/2018 Dr. Andreea Mocanu (University of Nottingham, UK), *Newform theory for Jacobi forms of lattice index* (Jan H. Bruinier)

27/11/2018 MSc. Andreea Mocanu (University of Nottingham), *Newform theory from Jacobi forms of lattice index* (Michalis Neururer)

16/02/2017 Dr. Sam Sanders (LMU München), *The crazy Reverse Mathematics of Nonstandard Analysis and Computability Theory* (Thomas Powell)

29/11/2018 Prof. Dr. Leif Döring (Universität Mannheim), *Boundary behaviour for stable jump diffusions* (Frank Aurzada)

04/12/2018 Marcel Klinge (Universität Halle-Wittenberg), *A comparison of one-step and two-step AMF methods* (Alf Gerisch)

05/12/2018 Prof. Dr. Roland Herzog (TU Chemnitz), *An Introduction to Optimal Experimental Design with PDEs* (Winnifried Wollner)

07/12/2018 Prof. Dr. James Sprittles (University of Warwick, Warwick), *Modelling nanoscale effects in drop impact and spreading* (Prof. Dr. Dieter Bothe)

18/12/2018 Dr. Haowu Wang (University of Lille, France), *Non-existence of reflective modular forms* (Yingkun Li)

18/12/2018 Mr. Haowu Wang (University of Lille), *Non-existence of reflective modular forms* (Yingkun Li)

7.3 Visitors at the Department

Prof. Dr. Mikhail Lifshits (St. Petersburg State University), January 2018.

Prof. Dr. Mikhail Lifshits (St. Petersburg State University), August 2018.

Dr. Benjamin Lees (Humboldt Fellow), May 2017 to December 2018.

Prof. Dr. Wolfgang Dreyer (WIAS, Berlin), May 2017.

Prof. Dr. Akio Tomiyama (Kobe University, Kobe), October 2017.

Prof. Dr. Yulii Shikmurzaev (University of Birmingham, School of Mathematics, Birmingham), January 2018.

Dr. Damir Jurić (CNRS, LIMSI, Paris), February 2018.

Dr. Matthias Köhne (Universität Düsseldorf, Düsseldorf), March 2018.

Prof. Dr. Wolfgang Dreyer (WIAS, Berlin), April 2018.

Prof. Dr. Kohei Soga (University of Science, Tokyo), May 2018.

Dr. Matthias Köhne (Universität Düsseldorf, Düsseldorf), June 2018.

Prof. Dr. Milovan Peric (Universität Düsseldorf, Düsseldorf), June 2018.

Prof. Dr. Wolfgang Dreyer (WIAS, Berlin), June 2018.

Prof. Dr. Hrvoje Jasak (University of Zagreb, Zagreb), July 2018.

Prof. Dr. Jürger Saal (Universität Düsseldorf), August 2018.

Prof. Dr. Wolfgang Dreyer (WIAS, Berlin), August 2018.

Dr. Hafida Laasri (Bergische Universität Wuppertal), August 2018.

Dr. Pierre-Etienne Druet (WIAS, Berlin), September 2018.

Prof. Dr. Wolfgang Dreyer (WIAS, Berlin), November 2018.

Prof. Dr. James Sprittles (University of Warwick, Warwick), December 2018.

Prof. Dr. Vince Geiger (Catholic University of Brisbane, Queensland, Australia), September and October 2018.

Dr. Marcel Braukhoff (TU Wien), June 2018.

Alexander Mielke (WIAS Berlin und HU Berlin), June 2018.

Hannes Meinlschmidt (RICAM Linz), November 2017, December 2018.

Takéo Takahashi (University of Nancy), December 2017.

Prof. Dr. Andreas Feldmann (Charles University, Prague), August 2018.

Dr. Anna Zych-Pawlewicz (University of Warsaw), August 2018.

Dr. Jan Hackfeld (HU Berlin), July 2017.

Dr. Kevin Schewior (ENS Paris), July 2017.

Dr. Miriam Schlöter (ETH Zurich), July 2017.

Prof. Dr. Hideo Kozono (Waseda University, Tokyo, Japan), January 2017.

Dr. Chenyin Qian (Zhejiang Normal University, Jinhua, China), January to August 2017.

Dr. Kohei Nakao (Shinshu University, Matsumoto, Japan), April to June 2017.

Dr. Naoto Kajiwara (University of Tokyo, Tokyo, Japan), June to July 2017.

Prof. Dr. Michael Plum (KIT, Karlsruhe), July 2017.

Prof. Dr. Hideo Kozono (Waseda University, Tokyo, Japan), March 2018.

Prof. Dr. Winfried Sickel (Universität Jena), May 2018.

Dr. Chenyin Qian (Zhejiang Normal University, Jinhua, China), July 2018.

Prof. Dr. Guido Sweers (Universität zu Köln), October 2018.

Dr. Kazuyuki Tsuda (Osaka University, Japan), October to December 2018.

Dr. Yuji Shinano (Zuse Institut Berlin), June 2018.

Dr. Raimondo Penta (University of Glasgow, UK), June 2018.

Rasa Giniunaite (University of Oxford, UK), August 2018.

Prof. Dr. Ram Jiwari (Indian Institute of Technology Roorkee, India), June-July 2017.

Prof. Dr. Daoyuan Fang (Hangzhou University), May 2017.

Prof. Dr. Vu Hoang (University of Texas), May 2017.

Prof. Dr. Jinkai Li (Chinese Unversity of Hongkong), May 2017.

Prof. Dr. Cecilia Mondaini (Brown University), May 2017.

Prof. Dr. Huy Nguyen (University of Science and Technology Hanoi), May 2017.

Prof. Dr. Yoshihoro Shibata (Waseda University Tokyo), May 2017.

Prof. Dr. Edriss Titi (FU Berlin), May 2017.

Prof. Dr. Suma Inna Muzenah (Waseda University Tokyo), May 2017.

Prof. Dr. Gudrun Täter (KIT, Karlsruhe), October 2017.

Dr. Yuka Teramoto (Kyushi University), October 2017.

Dr. Hiroyuku Tsurumi (Kyushi Univerity), October 2017.

Dr. Keiichi Watanabe (Waseda University, Tokyo), October 2017.

Dr. Anupam Pal Choudhury (Ricam Linz), January 2018.

Prof. Dr. Michael Winkler (Universität Paderborn), January 2018.

Prof. Dr. Hind Al Baba (University of Pau and Pays de l'Adour), January 2018.

Prof. Dr. Hideo Kozono (Waseda University Tokyo), February 2018.

Prof. Dr. Kohei Soga (Keio University), March 2018.

Prof. Dr. Hideo Kozono (Waseda University Tokyo), March 2018.

Prof. Dr. Helmut Abels (Universität Regensburg), May 2018.

Prof. Dr. Herbert Amann (Universiät Zürich), May 2018.

Prof. Dr. Peter Constantin (Princeton University), May 2018.

Prof. Dr. Raphael Danchin (University of Paris), May 2018.

Prof. Dr. Robert Denk (Universität Konstanz), May 2018.

Prof. Dr. Eduard Feireisl (University Prague), May 2018.

Prof. Dr. Franco Flandoli (University of Pisa), May 2018.

Prof. Dr. Yoshikazu Giga (University of Tokyo), May 2018.

Prof. Dr. Olivier Glass (Paris Dauphine University), May 2018.

Prof. Dr. Takahito Kashiwabara (University of Tokyo), May 2018.

Prof. Dr. Herbert Koch (Universiät Bonn), May 2018.

Prof. Dr. Peter Korn (MPI Hamburg), May 2018.

Prof. Dr. Anna Mazzucato (Penn State University New York), May 2018.

Prof. Dr. Sylvie Monniaux (Aix-Marseille University), May 2018.

Prof. Dr. Piotr Mucha (University Warsaw), May 2018.

Prof. Dr. Felix Otto (Universiät Leipzig), May 2018.

Prof. Dr. Jan Prüss (Universiät Halle), May 2018.

Prof. Dr. Michel Renardy (University Blacksburg), May 2018.

Prof. Dr. Elisabetta Rocca (University of Pavia), May 2018.

Prof. Dr. Jürgen Saal (Universiät Düsseldorf), May 2018.

Prof. Dr. Okihiro Sawada (University of Gifu), May 2018.

Prof. Dr. Gregory Seregin (University of Oxford), May 2018.

Prof. Dr. Gieri Simonett (Vanderbilt University Nashville), May 2018.

Prof. Dr. Ryo Takada (University Kyushu), May 2018.

Prof. Dr. Edriss Titi (FU Berlin), May 2018.

Prof. Dr. Matthias Wilke (Universiät Regensburg), May 2018.

Prof. Dr. Zhouping Xin (University Hongkong), May 2018.

Prof. Dr. Ruizhao Zi (University Wuhan), May 2018.

Dr. Imke Joormann (TU Braunschweig), March 2017.

Prof. Dr. Martin Schmidt (Universität Erlangen-Nürnberg), March 2017.

Prof. Dr. Adam Krzyżyk (Concordia University, Montreal), May 2018.

Prof. Dr. Hans Maassen (University of Nijmegen), January 2017.

Prof. Dr. Hans Maassen (University of Nijmegen), February 2017.

Prof. Dr. Hans Maassen (University of Nijmegen), April 2018.

Prof. Dr. Hans Maassen (University of Nijmegen), May 2018.

Prof. Dr. Hans Maassen (University of Nijmegen), July 2018.

Prof. Dr. Christian Meyer (TU Dortmund), March 2017.

Dr. Joachim Rehberg (WIAS Berlin), March 2017.

Dr. Thomas Oliver (University of Oxford), June 2018.

Prof. Dr. Matthew de Brecht (Kyoto University, Japan), March 2017.

Rémy Cerda (Claude Bernard University Lyon 1), May to August 2017.

Prof. Dr. Genaro López Acedo (University of Seville), February 2018.

Dr. Adriana Nicolae (University of Seville), February 2018.

Dr. Sam Sanders (LMU München, Center for Advanced Studies), August 2018 to February 2019.

Dr. Florian Steinberg (INRIA), February 2018.

Prof. Dr. Keita Yokoyama (Japan Advanced Institute for Science and Technology), August 2018.

Dr. Ahmad Ramli (Universiti Sains Malaysia), January to September 2018.

Dr. Jens Funke (University of Durham, UK), January to March 2017.

Prof. Dr. Gerald Höhn (University of Kansas, USA), February 2017.

Prof. Dr. Tomoyuki Arakawa (RIMS Kyoto, Japan), February 2017.

Prof. Dr. Özlem Imamoglu (ETH Zürich, Switzerland), March 2017.

Dr. Stephan Ehlen (Universität Köln), April 2017.

Prof. Dr. Stephen Kudla (University of Toronto, Canada), May 2017.

Prof. Dr. Tonghai Yang (University of Wisconsin, USA), May 2017.

Prof. Dr. Jürg Kramer (HU Berlin), June 2017.

Prof. Dr. Thomas Creutzig (University Alberta, Canada), June 2017.

Dr. Jens Funke (University of Durham, UK), September 2017.

Dr. Jens Funke (University of Durham, UK), January 2018.

Dr. Stephan Ehlen (Universität Köln), January 2018.

Dr. Jens Funke (University of Durham, UK), February 2018.

Dr. Shaul Zemel (University of Jerusalem, Israel), March 2018.

Dr. Stephan Ehlen (Universität Köln), March 2018.

Dr. Paul Ziegler (University of Oxford, UK), March 2018.

Dr. Stephan Ehlen (Universität Köln), April 2018.

Dr. Markus Schwagenscheidt (Universität Köln), May 2018.

Prof. Dr. Tonghai Yang (University of Wisconsin, USA), May 2018.

Dr. Stephan Ehlen (Universität Köln), May 2018.

Dr. Sven Möller (Rutgers University, USA), June 2018.

Prof. Dr. Salvati Manni (University of Rome, Italy), September 2018.

Prof. Dr. Martin Möller (Universität Frankfurt), September 2018.

Dr. Jens Funke (University of Durham, UK), November 2018.

Fabian Rüffler (Universität Erlangen-Nürnberg), April 2017.

Prof. Dr. Tim Hoheisel (McGill University Montreal), May 2017.

RNDr. Michal Červinka Ph.D. (Charles University Prague), November 2017.

Remy Cerda (ENS Lyon), July 2017 to August 2017.

Prof. Dr. Michal Kocvara (University of Birmingham), February 2017.

Prof. Dr. Michael Stingl (Universität Erlangen-Nürnberg), February 2017.

Jianjie Lu (Universität Konstanz), November 2018.

Prof. Dr. Roland Herzog (TU Chemnitz), December 2018.

Prof. Dr. Georg Stadler (Courant Institute, New York University), November 2018.

Carmen Gräßle (Universität Hamburg), June 2017, January-February 2018, April 2018.

Paul Ziegler (University of Oxford), March 2018.

Dr. Liron Ravner (University of Amsterdam), November 2018.

Prof. Dr. Thomas Surowiec (Universität Marburg), January 2017.

Prof. Dr. Thomas Wick (CMAP, Ecolé Polytechnique), April 2017.

Prof. Dr. Ira Neitzel (Universität Bonn), April 2017.

Prof. Dr. Ulrich Langer (Universität Linz), April 2017.

Dr. Alexander Linke (WIAS Berlin), July 2017.

Prof. Dr. Malte Peter (Universität Augsburg), September 2017.

Prof. Dr. Juan Carlos de los Reyes (Escuela Politécnica Nacional), October 2017.

Prof. Dr. Georg Stadler (Courant Institute, New York University), January 2018.

Prof. Dr. Thomas Wick (Universität Hannover), June 2018.

Prof. Dr. Ira Neitzel (Universität Bonn), June 2018.

Prof. Dr. Ulrich Langer (Universität Linz), June 2018.

Bernhard Endtmayer (Universität Linz), July 2018.

Professor Dr. Adrial Hirn (Hochschule Esslingen), July 2018.

Caroline Geiersbach (Universität Wien), November 2018.

Dr. Marita Thomas (WIAS Berlin), November 2018.

Katrin Mang (Universität Hannover), December 2018.

7.4 Workshops and Conferences at the Department

- Spring School “Probability in mathematics and physics”, March 27-31, 2017 (organized by Frank Aurzada, Volker Betz, Matthias Meiners (Innsbruck))
- Spring School “Spin Systems: Discrete and continuous”, March 19-23, 2018 (organized by Frank Aurzada, Volker Betz, Matthias Meiners (Innsbruck))
- IRTG-Workshop, Tokyo, Japan, March 6-10, 2017 (organized by International Research Training Group 1529)

- Geophysical Fluid Flows, Oberwolfach, May 8-12, 2017 (organized by Matthias Hieber)
- Analysis Day, Darmstadt, May 16, 2017 (organized by Matthias Hieber)
- Fluid Dynamics, Cetraro Summer School, September 4-8, 2017 (organized by Matthias Hieber)
- Int. Conference on Mathematical Fluid Dynamics, Tokyo, Japan, November 1-3, 2017 (organized by Matthias Hieber)
- Mathematical Fluid Dynamics, Waseda University, January 8-12, 2018 (organized by International Research Training Group 1529)
- International Conference on Mathematical Fluid Dynamics, Bad Boll, IRTG 1529, May 7-11, 2018 (organized by Matthias Hieber)
- Int. Conference on Mathematical Fluid Dynamics, Tokyo, Japan, November 27-30, 2018 (organized by Matthias Hieber)
- Mathematische Modellierungswoche, October 15–20, 2017, Fuldatal (organized by Martin Kiehl, TU Darmstadt and Tobias Braumann, Zentrum für Mathematik, Bensheim)
- Mathematische Modellierungswoche, October 7–12, 2018, Fuldatal (organized by Martin Kiehl, TU Darmstadt and Tobias Braumann, Zentrum für Mathematik, Bensheim)
- 96th Workshop on General Algebra (AAA 96), June 1-3, 2018 (organized by Manuel Bodirsky, Bernhard Ganter, Ulrich Kohlenbach)
- 3rd International Conference on Uncertainty in Mechanical Engineering at the TU Darmstadt, Session on Uncertainty Quantification, November 15 to 16, 2018 (organized by Michael Kohler)
- Workshop "π-Tensor Norms and Multipartite Entanglement", September 11 - 14, 2017 (organized by Burkhard Kümmerer)
- Workshop "Mathematik verbindet – Die gemeinsame Sprache der Naturwissenschaften", October 5, 2017 (organized by Burkhard Kümmerer)
- Workshop "Synchronizing Words in Directed Graphs and Non-Commutative Generalizations", September 10 - 13, 2018 (organized by Burkhard Kümmerer)
- LOEWE-Conference "Women in automorphic forms", September 5 to 7, 2018 (organized by Claudia Alfes-Neumann and Anna-Maria von Pippich)
- 7th Seminar on Conformal Field Theory, February 3, 2017 (organized by Peter Fiebig, Nils Scheithauer and Katrin Wendland)
- Annual Women's Meeting of the SPP 1962, July 31 to August 1, 2017 (organized by Alexandra Schwartz, TU Darmstadt)

- Annual Women's Meeting of the SPP 1962, July 16–17, 2018 (organized by Alexandra Schwartz, TU Darmstadt and Veronika Karl, Universität Würzburg)
- Minisymposium "Mathematical models for cell migration" at the joint annual meeting of DMV and GDM, Universität Paderborn, 05.03.-09.03.2018 (organized by Christian Stinner jointly with C. Surulescu and A. Zhigun)
- Workshop on p-adic Hodge Theory, April 10 to 12, 2017 (organized by Andreas Langer, Eike Lau, Torsten Wedhorn, Thomas Zink)
- Workshop on Perfectoid Shimura Varieties (after Caraiani-Scholze), September 2017 (organized by Jens Hesse, Torsten Wedhorn)
- Workshop on p-adic Riemann Hilbert correspondence, June 06 to 08 (organized by Eike Lau, Torsten Wedhorn, Annette Werner)
- Optimization of Infinite Dimensional Non-Smooth Distributed Parameter Systems, October 4–6, 2017 (organized by Alexandra Schwartz, Stefan Ulbrich, Winnifried Wollner, TU Darmstadt)

8 Other scientific and organisational activities

8.1 Memberships in Scientific Boards and Committees

Volker Betz

- Fellow in the EPSRC Peer Review College

Dieter Bothe

- Member of the German Mathematical Society (DMV)
- Member of DECHEMA (Society for Chemical Technology and Biotechnology)
- Advisory Board of ProcessNet technical committee on Computational Fluid Dynamics
- Advisory Board of ProcessNet technical committee on Multiphase Flows
- Member of GAMM section Partial Differential Equations

Regina Bruder

- Member of the international group for PME (Psychology of Mathematics Education)
- Member of the group 'Arbeitskreis Empirische Bildungsforschung' of the GDM (Organization for Didactics of Mathematics)
- Member of the ISTRON – group in Germany
- Member of the group 'Arbeitskreis Problemlösen' of the GDM
- Director of the Center of Teacher Education (ZfL) TU Darmstadt until June 2018

Jan H. Bruinier

- Associate Member of the Pohang Mathematics Institute (PMI), Postech, Pohang, Korea

Karl Heinrich Hofmann

- Fellow of the American Mathematical Society
- Honorary Editor of Semigroup Forum

Martin Kiehl

- Vorsitzender des Aufsichtsrats, Zentrum für Mathematik, Bensheim

Ulrich Kohlenbach

- President of the Association for Symbolic Logic (ASL)
- Member of FWO (Research Foundation Flanders) expert panel: Mathematical Sciences
- Advisory Board Member of Springer book series 'Theory and Applications of Computability Theory'

– Member of WoLLIC Steering Committee

– Member of LCC (Logic and Computational Complexity) Steering Committee

– Member of 'Wissenschaftliche Gesellschaft an der J.W.Goethe Universität Frankfurt'

Jens Lang

– Member of Board of Deans of the DFG Graduate School of Excellence Computational Engineering, TU Darmstadt, since 2008

– Member of Scientific Steering Committee of Profile Area Thermo-Fluids & Interfaces, TU Darmstadt, since 2017

– Member of Scientific Committee of the Conference on the Numerical Solution of Differential and Differential-Algebraic Equations to be held at the Martin-Luther University Halle-Wittenberg every three years

Holger Marschall

– Assigned Member of the DECHEMA ProcessNet Committee Computational Fluid Dynamics

– Chair of the Multiphase Technical Committee within the ESI OpenFOAM Governance structure

– Member of the OpenFOAM Workshop Committee

Marc Pfetsch

– Forschungsrat der Rhein-Main Universitäten

– Applied Mathematics Committee of the European Mathematical Society

Steffen Roch

– Auswahlausschuss Bundeswettbewerb Mathematik

Stefan Ulbrich

– Member of the IFIP Technical Committee TC 7, WG 7.2 "Computational Techniques in Distributed Systems", 2003 –

– Universitätsversammlung TU Darmstadt

– Senat TU Darmstadt

Winnifried Wollner

– Speaker of GAMM Activity Group on "Optimization with Partial Differential Equations"

8.2 Awards and Offers

Awards

Jan H. Bruinier: Distinguished paper award of the ICCM (International Consortium of Chinese Mathematics) 2017 for *Heights of Kudla-Rapoport divisors and derivatives of L-functions* (with B. Howard and T. Yang), Invent. Math. (2015)

Dirk Gründing: Best Poster award OpenFOAM Workshop 2017 in Exeter

Ulrich Kohlenbach: Invited Speaker ICM2018, Rio de Janeiro

Tomislav Maric: Lenovo High Performance Computing / Artificial Intelligence Award 2017

Hannes Meinlschmidt: Preis für hervorragende wissenschaftliche Leistungen (Vereinigung von Freunden der Technischen Universität zu Darmstadt e.V.), May 3, 2018

Andrei Sipoş: 2018 Prize for Excellence in Doctoral Research (Category: Mathematics and Computer Science) of the “Ad-Astra” Association of Romanian Researchers (awarded every two years)

Mirjam Walloth: Ruth Moufang-Postdoktorandinnen-Förderpreis (Fachbereich Mathematik, TU Darmstadt), June 02, 2017

Offers of Appointments

Yingkun Li: Junior Professorship (W1) in arithmetic and global analysis, TU Darmstadt

8.3 Secondary Schools and Public Relations

The department of mathematics is involved in various activities for schools, secondary school students, and public relations. In addition to printed information material, the department of mathematics presents itself to the public on its web pages. These were fundamentally revised in 2017 and provide useful information about all aspects of the study as well as an attractive insight into the department. The information is available in German and in English.

Math on Demand In April 2015, the mathematics department of TU Darmstadt launched the programme *Math on Demand* for mathematically interested secondary school students and mathematics teachers. The purpose of this programme is to stimulate their interest in mathematics beyond the traditional classroom. On demand, scientists from the mathematics department offer lectures or workshops, which are intended to illustrate the variety and importance of mathematics in everyday life, and to give a first insight in some recent developments in the tremendous opportunities for careers in mathematics and about the mathematics programme at TU Darmstadt.

By now ten scientists (F. Aurzada, P. Domschke, R. Haller-Dintelmann, A. Knof, B. Kümmerer, M. Otto, A.-M. von Pippich, U. Reif, A. Schwartz, B. Seyfferth) offer lectures covering a wide range of topics. In 2017 and 2018, 17 lectures or workshops were held for a variety of audiences from the Rhine-Main metropolitan area and its surroundings. Further information is available on the webpage `https://www.mathematik.tu-darmstadt.de/studium/orientierung_und_beratung/veranstaltungen_fuer_studieninteressierte/math_on_demand.en.jsp`

Summer school "Faszination Mathematik" for secondary school students

The following is a list of further public relations activities.

Activities for secondary school students and prospective students

- Presentation of the department with a booth and several talks at the job and study information fair HoBIT, Hochschul- und Berufsinformationstage, three days every January: about 20.000 participants; with a booth staffed by professors, academic staff and students and scientific talks from the fields of Analysis, Logic, and Stochastics in 2017 and from the fields of Algebra, Logic and Geometry in 2018.

- Presentation of the department and its study programmes at the university information day, TUDay, every May: with talks by the student advisor, sample lectures and tutorial classes, meetings with students of the department; about 80 participants over the course of the day (lectures from the fields of Algebra and Analysis in 2017 and two lectures from the field of Optimization in 2018).

- Annual organization of an afternoon with several talks about mathematics for secondary school students, "Darmstädter Schülerinnen- und Schülernachmittag zur Mathematik" (organization: Prof. Kohler; in 2017 with talks from the fields of Algebra, Geometry, Didactics and Stochastics and in 2018 from the fields of Analysis, Numerical Analysis and Scientific Computing and Stochastics).

- Annual participation at the information days for female students, "Schnuppertage für Schülerinnen", with participation at the central event for female students with interest in STEM/MINT programmes and an on-site presentation of the department including a talk by the student advisor, a sample lecture and talks with female mathematicians, about 30 participants in each year (organized by the department's gender equaltity officers; lectures from the field of Stochastics in 2017 and from the field of Optimization in 2018)

- Support of the annual organization of the Mathematikolympiade Hessen (third level) in cooperation with the Center for Mathematics Bensheim for all grades (about 20 participants per grade each year) (Prof. Kiehl, academic staff and students).
  In the recent years, the department had the opportunity to host the finals.
  Mathematical afternoon lectures were delivered by Prof. Kiehl and Prof. von Pippich (2017) and Prof. Reif and Prof. Bokowski (2018).

- Organization of the Mathematical Modeling Week for secondary school students in grade 12 in cooperation with Center for Mathematics Bensheim each October (40 participants each year) (Prof. Kiehl).

- Involvement in the annual German Maths Contest (Bundeswettbewerb Mathematik) (Prof. (em.) Alber, Prof. Roch)
- In connection with the project course "Teaching in Mathematics: Problem Solving" (Prof. Bruder, StR Krauth, OStR Klein and participating students, winter semester 2016/17), diverse mathematical "Knobelstraßen" for secondary schools were developed and conducted at several schools in Darmstadt and Frankfurt.

Other activities

- In cooperation with the "Hochschuldidaktische Arbeitsstelle (HDA)" (Center of University Didactics) at the TU Darmstadt Prof. Kümmerer and Sandra Lang produced an image film (in German) to report on the innovative multidisciplinary lecture course "Mathematik als gemeinsame Sprache der Naturwissenschaften" (Mathematics: The Common Language of Natural Sciences). This lecture course addresses all teacher students who study at least one of the subjects mathematics, physics, chemistry, biology, or informatics. It is a building block of the recently founded "Vernetzungsbereich" (interlinking area), which is established as a part of the MINTplus initiative of the TU Darmstadt to profile the teachers education at our university. It is financially supported by the German Bundesministerium für Bildung und Forschung as part of the "Qualititätsoffensive Lehrerbildung". The common mathematical language provides a link between different natural sciences and fosters crossover cooperations in school teaching.
- A short film (in German) was produced by Prof. Kümmerer in cooperation with the "Hochschuldidaktische Arbeitsstelle (HDA)" (Center of University Didactics) at the TU Darmstadt, which gives didactic hints on the use of blackboards in lecture courses (`https://www.einfachlehren.tu-darmstadt.de/themensammlung/details_12352.de.jsp`
- On the occasion of the 450th anniversary of the former Court and present University and State Library of Darmstadt, an exhibition "Geheimnis – Herrschaft – Wissen" (Mystery – Dominion – Knowledge) with particularly valuable treasures from the library's holdings was arranged. In cooperation with B. Gebert (University Library Darmstadt), Prof. V. Huth (Institut für Personengeschichte, Bensheim), Prof. Kümmerer (TU Darmstadt, Department of Mathematics), Prof. Schenk (TU Darmstadt, Department of History) handwritings and prints from the collection of the Hessian landgraves on astronomy, astrology, and medicine, but also on secret sciences such as alchemy were presented at the University Library from from 18 July to 22 October 2017.
- Talk titled "Unendliche Weiten; und wie man darin ein Optimum sucht. Numerische Methoden für unendlichdimensionale Optimierungsprobleme", Lecture in the series "Was steckt dahinter?" (June 6, 2018, Prof. Wollner)
- Talk titled "Stille Post - Wie wir Nachrichten zuverlässig übertragen können", lecture for children organized by the Bürgerstiftung Darmstadt (November 11, 2018, Prof. Wollner)

- Talk titled ”Das Rucksackproblem: Wie Mathematiker Koffer packen”, lecture for secondary school students at the “Tags der Mathematik 2018”, Merck KGaA, Darmstadt (March 3, 2018, Christopher Hojny)
- Talk titled ”Lineare und ganzzahlige Optimierung”, at Goethe Gymnasium, Bensheim (June 6, 2018, Prof. Pfetsch)
- Talk titled ”Unendliche Summe”, visit from the Bertolt Brecht Gymnasium Darmstadt (October 24, 2018, Prof. Haller-Dintelmann)
- Talk titled ”Wie gewinnt man eine Goldmedaille im Skifliegen? Parameteroptimierung in dynamischen Systemen”, visit from the Georg-August-Zinn-Schule Reichelsheim (September 26, 2018, Prof. Kiehl)
- Annual Graduation Event: celebration with friends and family of the graduated students (organisation: Prof. Aurzada and staff).

8.4 Student Body (Fachschaft)

Officially, the students at the Department of Mathematics are represented by the five people forming the “Fachschaftsrat”. This board is elected once a year during the university elections. However, since there usually is more work to be done than five people can handle, there are many more students participating actively in the Students’ Union. Moreover, some of them are members of university-wide committees such as the Senate or the University Assembly.

We, the Students’ Union, regard ourselves as representatives inside and outside the mathematics department for all math students. As such, all students are invited to talk to us in order to tell us about problems or suggestions they might have. Furthermore, we organise a lot of orientation events for students and secondary school students throughout the year. Finally, a student’s life does not only consist of attending lectures and exercises, so we additionally offer some extra-curricular activities.

As part of our activities we appoint the student representatives in the committees of the department. Some of us are members of the “Fachbereichsrat” (another important board consisting of professors, assistants and students, elected during the university elections) and its committees, like the committee for learning and studying, the library committee and many more. The evaluation and quality control of teaching done at the department are two of our main objectives. We think that it is essential to hear and consider students’ opinions regarding these areas because they are the ones directly affected. We also support the improvement and development of courses and studying in general, a point which every student should be concerned about naturally. We are working on those subjects together with Students’ Unions from other departments and with the university administration.

Concerning orientation events, we organise the orientation week for the first semester students, which takes place at the beginning of each semester. During the semester, there is an orientation colloquium for the students in their first two years, which is meant to give them an impression of what the work in the research groups usually is about (meant to support the decision on a thesis subject). After finishing their first two years, students attend another orientation event, the “Introduction to Advanced Studies” (*Einführung ins*

Hauptstudium), giving them more information about the research groups, the relevant regulations and much more.
Not all of these events take place in the mathematics department. University-wide orientation events for secondary school students are also part of our work. There we cooperate with the student counsellors.
However, not all our activities concern purely study-related topics. The organisation of games evenings, music evenings, as well as the traditional Christmas party of the department are examples of what we do to help students socialize among themselves.
We hope that this rather brief introduction helps to give an impression of our work.

9 Contact

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