Biannual Report

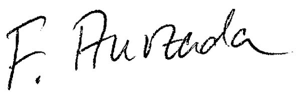
Department of Mathematics
2015 and 2016

TECHNISCHE
UNIVERSITÄT
DARMSTADT

Dear reader,

Thank you for taking interest in the Department of Mathematics at the TU Darmstadt! This biannual report provides a comprehensive overview of the developments at our department in research and teaching.
A signature feature of our deparment is the broad focus on eight diverse mathematics research groups and on inter-disciplinary research. The department is strongly intertwined with other research groups – at the TU Darmstadt, in the Rhein-Main-Neckar area, within Germany, and far beyond – through a number of joint research endeavors like Collaborative Reseach Centres, Graduate Schools, LOEWE centres, and, last but not least, a huge number of personal contacts. These cooperations along with the excellent every-day research work of each and every member have put our department among the top ranks of all mathematics departments of the TU9, the alliance of the leading German Institutes of Technology.
Our teaching activities focus on delivering a challenging mathematics education in our mathematics degree programmes, on the one hand. On the other hand, the department feels a strong dedication to excellent and innovative teaching for other departments in our university, to the effect we offer mathematics courses for virtually every other department of this university. In the near future, a degree Masters programme fully taught in English will be introduced, which shall open up the already well sought-after programmes to students from abroad.
The present report is meant to inform the reader 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 altogether formed our work in the last two years.

With best wishes,



Prof. Dr. Frank Aurzada
(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, Anna von Pippich, Nils Scheithauer, Torsten Wedhorn

Retired professors

Karl-Heinrich Hofmann

Postdocs

Ana Maria Botero, Raffael Dahmen, Stephan Ehlen, Jean-Stefan Koskivirta, Ralf Lehnert, Yingkun Li, Sven Möller, Markus Schwagenscheidt

Research Associates

Johannes Buck, Moritz Dittmann, Timo Henkel, Jens Hesse, Sebastian Opitz, Maximilian Rössler, Fabian Völz

Secretaries

Tanja Douglas, Ute Fahrholz

Project: Harmonic weak Maass forms

In this project the Fourier coefficients and periods of weak Maass Forms are investigated. In particular, we study the coefficients of weight $1/2$ harmonic weak Maass forms. If such a form f maps under the ξ-operator to a newform g of weight $3/2$, then the Fourier coefficients of the holomorphic part of f are given by periods of normalized algebraic differentials of the third kind associated to the Shimura lift of g. For instance, the real periods of differentials of the third kind on rational elliptic curves are related to coefficients of such harmonic Maass forms.
In joint work with Funke and Imamoglu we investigate a regularized theta lift from weak Maass forms of weight 0 to weak Maass forms of weight $1/2$ and show that the coefficients of the lift are given by CM traces and period integrals. In particular we find a definition of the central value of the (non-existent) L-function of Klein's j-invariant. In ongoing work we generalize these results to include lifts of meromorphic modular forms of weight 0 with first order poles.
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.

Partner: K. Ono, Emory University; J. Funke, Durham University; O. Imamoglu, ETH Zürich

Support: DFG

Contact: J. H. Bruinier, M. Schwagenscheidt

References

[1] C. Alfes and M. Schwagenscheidt. On a theta lift related to the Shintani lift. Preprint, 2016.

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

[3] J. H. Bruinier and K. Ono. Heegner divisors, L-functions and harmonic weak Maass forms. *Annals of Mathematics*, 2010.

[4] J. H. Bruinier and M. Schwagenscheidt. Algebraic formulas for the coefficients of mock theta functions and Weyl vectors of Borcherds products. Preprint, 2016.

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 $n-1$. When specialized to the case $n=2$, this result can be viewed as a variant of the Gross-Zagier formula for Shimura curves associated to unitary groups of signature $(1,1)$. These results rely on (among other things) a new method for computing improper arithmetic intersections.

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. Further applications, which we are currently investigating, are new cases of the Colmez conjecture and formulas for arithmetic volumes.

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, 2016.

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

[3] J. H. Bruinier, S. S. Kudla, and T. Yang. Special values of Green functions at big CM points. *International Mathematics Research Notices*, 2012.

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

Project: Modularity of formal Fourier-Jacobi series

A famous theorem of Gross, Kohnen, and Zagier states that the generating series of Heegner divisors on a modular curve is an elliptic modular form of weight $3/2$ with values in the Picard group. This result can be viewed as an elegant description of the relations among Heegner divisors. More generally, Kudla conjectured that the generating series of codimension g special cycles on an orthogonal Shimura variety of dimension n is a Siegel modular form of genus g and weight $1 + n/2$ with coefficients in the Chow group of codimension g cycles. Wei Zhang showed that certain formal Fourier-Jacobi coefficients of Kudla's generating series are modular for genus 1 Jacobi groups. We prove a general convergence result for formal series of Jacobi forms that satisfy a natural symmetry condition. They are formal analogues of Fourier-Jacobi expansions of Siegel modular forms. By combining Zhang's and our result, we deduce Kudla's modularity conjecture for special cycles of arbitrary codimension and for all orthogonal Shimura varieties.

Partner: M. Raum, Chalmers University of Technology, Gothenburg

Support: DFG

Contact: J. H. Bruinier

References

[1] J. H. Bruinier. Vector valued formal Fourier-Jacobi series. *Proceedings of the AMS*, 2015.

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

[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 is devoted to generalize Deligne's isometry to singular metrics. More precisely, jointly with G. Freixas, 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, CNRS Paris

Contact: A.-M. von Pippich

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 which gets to work on the generalization of elliptic and hyperbolic Eisenstein series to more general settings. In a first step, a unifying approach to the construction of parabolic, elliptic, and hyperbolic Eisenstein series on a finite volume hyperbolic Riemann surfaces has been developed. Namely, there is a sequence of integral transforms which begins with the heat kernel, obtains a Poisson and wave kernel, and then yields the corresponding Eisenstein series. In the next step, we aim at carrying over this construction to more general quotients of symmetric spaces. We started by investigating the case of a connected, noncompact semisimple Lie group with finite centre. A second direction of research has been devoted to the study of special values of these Eisenstein series and to establish analogues of Kronecker's limit formula.

Partner: J. Jorgenson (City College, New York); L. Smajlović (University of Sarajevo)

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. We started by proving a Jensen–Rohrlich type formula for the hyperbolic 3-space. As in the classical case, the main step in the proof consists in establishing a Kronecker limit type formula for the corresponding automorphic Green's function.

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

Contact: A.-M. von Pippich

Project: Moonshine for Conway's group

The fake monster algebra is an infinite-dimensional Lie algebra describing the physical states of a bosonic string moving on a 26-dimensional torus. Its denominator identity is given by

$$e^{\rho} \prod_{\alpha \in II_{25,1}^{+}} (1-e^{\alpha})^{[1/\Delta](-\alpha^2/2)} = \sum_{w \in W} \det(w)\, w\Big(e^{\rho} \prod_{n=1}^{\infty} (1-e^{n\rho})^{24}\Big)$$

where

$$\Delta(\tau) = q \prod_{n=1}^{\infty} (1-q^n)^{24} = q - 24q^2 + 252q^3 - 1472q^4 + 4830q^5 - 6048q^6 + \dots$$

is Dedekind's delta function. The real simple roots of the fake monster algebra correspond to the Leech lattice and the automorphism group of the Leech lattice acts by diagram automorphisms on this Lie algebra. Borcherds conjectured that the corresponding twisted denominator identities are automorphic forms of singular weight on orthogonal groups. It is now well-known that this holds for all elements of squarefree level. Some of the remaining cases are proved in [1], [3]. The classification results in [1] and [2] show that these automorphic forms account for most of the automorphic products of singular weight with reflective divisors.

Contact: N. Scheithauer

References

[1] N. Scheithauer. Automorphic products of singular weight. *To appear in Compositio Mathematica*.

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

[3] N. Scheithauer. Some constructions of modular forms for the Weil representation of $SL_2(\mathbb{Z})$. *Nagoya Mathematical Journal*, 220:1–43, 2015.

Project: Classification of automorphic products of singular weight

Borcherds' singular theta correspondence is a map from modular forms for the Weil representation of $SL_2(\mathbb{Z})$ 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 given by $(n-2)/2$. 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. 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] and [2] holomorphic automorphic products of singular weight on lattices of prime 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

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[1] N. Scheithauer. Automorphic products of singular weight. *To appear in Compositio Mathematica*.

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

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 monster vertex operator algebra which Borcherds

used to prove Conway and Norton's moonshine conjecture. This vertex algebra can be constructed as the (-1)-orbifold of the vertex algebra of the Leech lattice.
The construction of the monster vertex operator algebra 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 apply these results to the construction and uniqueness of holomorphic vertex operator algebras. It shall be investigated whether all V_1-structures from Schellekens' list can be realised as orbifolds of the vertex algebra of the Leech lattice. The method of inverse orbifolding shall be used to prove that for non-trivial V_1 the V_1-structure fixes the vertex operator algebra up to isomorphism.

Contact: S. Möller, N. Scheithauer

Partner: J. van Ekeren

References

[1] J. van Ekeren, S. Möller, and N. Scheithauer. Construction and classification of holomorphic vertex operator algebras. arxiv:1507.08142, submitted, TU Darmstadt, 2015.

Project: Reductions of Shimura Varieties

In this project parahoric reductions of Shimura varieties of Hodge type are studied.

Partner: Richard Pink, Jean-Stefan Koskivirta, Paul Ziegler, Eike Lau

Support: DFG

Contact: Torsten Wedhorn

Project: Period domains for moduli spaces of p-divisible groups

In this project we study period maps for perfectoizations of Rapoport-Zink spaces.

Contact: Torsten Wedhorn

Project: Spherical Spaces

In this project the variation of invariants of varieties with reductive action is studied in families.

Contact: Torsten Wedhorn

1.2 Analysis

The research group Analysis consists of five professors, D. Bothe, R. Farwig, M. Hieber, M. Kyed and S. Roch (apl.), R. Haller-Dintelmann as 'Akademischer Rat', 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 group of analysis 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 with 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, Matthias Hieber, Mads Kyed, Steffen Roch

Tenured Positions Robert Haller-Dintelmann, Christian Stinner

Postdocs

Anupam Pal Choudhury, Moritz Egert, Christian Komo, Holger Marschall, Martin Saal, Amru Hussein, Jonas Sauer, Patrick Tolksdorf

Research Associates

Björn Augner, Martin Bolkart, Aday Celik, Xingyuan Chen, Daniel Deising, Thomas Eiter, Manuel Falcone, Matthias Fricke, Mathis Gries, Dirk Gründing, Klaus Kress, Johannes Kromer, Anja Lippert, Muyuan Liu, Tomislav Maric, Jens Möller, Matthias Niethammer, Sonja Odathuparambil, Chiara Pesci, Anton Seyfert, Katharina Schade, Tobias Tolle, Paul Weber, David Wegmann, André Weiner, Marc Wrona

Secretaries

Esther Bauer, Anke Meier-Dörnberg, Verena Schmid, Kerstin Schmitt

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

Coupled transport and transfer processes at interfaces and, in particular, in proximity to contact lines of multi-component fluids are addressed. Simplified scale-reduced sharp interface models will be derived parallel to the extension of existing models based on empirical correlations. The resulting models for momentum, heat and mass transfer at dynamic contact lines are realized using the Volume-of-Fluid (VOF) method. To extend the VOF-method to the contact line problem, one has to pay special attention to the boundary conditions near the contact line. To allow for a moving contact line it is necessary to replace the ordinary no-slip condition. A possible approach is to use the numerical slip, which is related to the grid size. Obviously this method introduces a mesh-dependency, which has to be compensated. This is achieved by applying a mesh-dependent model for the numerical contact angle. A common approach to enforce the contact angle boundary condition is to alter the curvature calculation near the contact line, which is based on the height function method. However this approach leads to an inconsistency in the curvature approximation, which has to be resolved by further research. With our method, based on the VOF-code FS3D, we are able to simulate dynamic contact lines in three dimensions. One example is the thermocapillary migration of a droplet on a solid wall [1]. The further validation will be based on experimental data from generic configurations.

Support: Project B01 within DFG SFB 1194

Contact: M. Fricke, D. 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.

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

When looking out of a window on a rainy day, one can observe droplets sliding down the window glass. A similar phenomenon can be encountered in a wide variety of industrial applications such as e.g. steel casting, printing technologies or flow through microfluidic devices. In these applications - similar to the droplet on the window glass - the intersection of the liquid-gas interface with the solid surface forms the so called contact line. The inclination angle of the interface with the substrate (the so called contact angle) can be observed in experiments and does significantly influence the shape of the interface and consequently the complete hydrodynamics of the considered model. In addition, contaminants usually present in the liquid may act as surface active agents (surfactants), also effecting hydrodynamics of the flow. The aims of the present project are:

1. the consistent derivation and a tested implementation of contact angle models known from literature into a multiphase volume-of-fluid code based on unstructured moving meshes (OpenFOAM) [3]
2. an extension to include the influence of surfactants on the contact angle [2], [1]

3. the comparison to highly resolved experimental results for the hydrodynamics near the contact line from our project partners

Partner: Max-Planck Institut for Polymer Research, Mainz

Support: We gratefully acknowledge financial support from the Deutsche Forschungsgemeinschaft received within the scope of SFB 1194.

Contact: D. Gründing, D. Bothe, H. Marschall

References

[1] D. Gründing, S. Fleckenstein, and D. Bothe. A subgrid-scale model for reactive concentration boundary layers for 3D mass transfer simulations with deformable fluid interfaces. *International Journal of Heat and Mass Transfer*, 101:476–487, 2016.

[2] Y. Sui, H. Ding, and P. D. Spelt. Numerical simulations of flows with moving contact lines. *Annual Review of Fluid Mechanics*, 46(1):97–119, 2014.

[3] v. 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.

Project: Direct Numerical Simulations of Reactive Transport Processes at Single Rising Bubbles

Various industrial applications based on two-fluid systems require a detailed knowledge of the two-phase flow hydrodynamics as well as of the interfacial mass transfer. An understanding of these phenomena can be obtained either experimentally or by means of simulation methods. Even though in the last years new experimental techniques have been developed to investigate mass transfer across interfaces, most of them provide only integral information and cannot provide a detailed insight into these physical processes. Accordingly, it has emerged more and more the need of developing sophisticated numerical methods able to capture the physical information that is not possible to obtain by means of the experimental activities.
In this project the reactive mass transfer at single rising bubbles is investigated by means of an Arbitrary Lagrangian-Eulerian Interface Tracking Method. Different wake patterns (Reynolds number) and chemical reactions strengths (Damköler number) are considered in order to assess quantitatively the complex interplay between two-phase hydrodynamics, local transport processes, and chemical processes. Single reaction and competitive-consecutive prototypes are taken into account together with simple physisorption, in order to estimate the enhancement of the gas dissolution due to the presence of chemical reactions (Enhancement factor). Furthermore, particular attention is paid to the bubble wake, where the mixing patterns influence drastically the conversion and the selectivity of the competitive-consecutive mechanism.

Support: Center of Smart Interfaces, DFG SPP 1740

Contact: M. Falcone, H. Marschall

Project: Numerical Methods for Viscoelastic Fluid Flows at High Weissenberg Number

The objective of the present research is the development of robust numerical methods for viscoelastic fluid flows. Within the project, a general mathematical framework for the derivation of locally decomposed evolution equations of the conformation tensor has been developed and tensorial transformations have been applied to the conformation tensor constitutive equations. Such change-of-variable formulations effectively alleviate the High Weissenberg Number Problem, which refers to the loss of convergence of all numerical methods beyond some limiting value of the fluid elasticity and has been a major challenge in computational rheology for the past three decades. The generic stabilization framework has been implemented into a finite volume method on general unstructured meshes and appropriate solution algorithms for transient single- and two-phase flows of incompressible, viscoelastic fluids have been developed. Evaluations of established benchmark-tests have shown that the numerical methods are both robust and accurate.

Contact: M. Niethammer, H. Marschall, D. Bothe

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 a unified diffuse interface approach based on two-phase Navier-Stokes Cahn-Hilliard and Allen-Cahn type phase-field models, on the basis of which we have developed a consistent numerical solution procedure utilising a second-order finite-volume method with support for dynamic grids of general topology.
Specifically, we put forth the foundation of a non-standard term in the linear momentum equation which arises when insisting on objectivity of the stress tensor. Special emphasis is put on conservative and bounded finite-volume solution methods for phase-field evolution equations. The consistent treatment of boundary conditions complements the developed method.

Contact: H. Marschall

References

[1] X. Cai, H. Marschall, M. Woerner, and O. Deutschmann. Numerical simulation of wetting phenomena with a phase-field method using openfoam. *Chem. Eng. Technol.*, 38:1985–1992, 2015.

[2] X. Cai, H. Marschall, M. Woerner, and O. Deutschmann. Numerical study on the wettability dependent interaction of a rising bubble with a periodic open cellular structure. *Catalysis Today*, 273:151–160, 2016.

Project: A computational framework for direct numerical simulations of two-phase flows using the finite volume method on unstructured meshes

Direct Numerical Simulations of two-phase fluid flows require an accurate numerical approximation for the motion of interfaces that separate the phases. Fluid interfaces in nature undergo severe deformation as well as topological changes: breakup and coalescence. Within this project, two numerical methods have been developed that can accurately approximate the motion of the flud interface: the geometrical Volume-of-Fluid method and the hybrid Level Set / Front Tracking Method.
The geometrical Volume-of-Fluid method shows second order convergence exact volume conservation and conditional numerical stability. The hybrid Level Set / Front Tracking method shows second order convergence, relative volume conservation error below 1e-04

for strongly deformed interfaces and unconditional numerical stability. Both methods support unstructured meshes because they aim at solving problems in geometrically complex solution domains.

Contact: T.Marić, H. Marschall, D. Bothe

References

[1] T. Maric, H. Marschall, and D. Bothe. vofoam-a geometrical volume of fluid algorithm on arbitrary unstructured meshes with local dynamic adaptive mesh refinement using openfoam. *arXiv preprint arXiv:1305.3417*, 2013.

[2] T. Marić, H. Marschall, and D. Bothe. lentfoam–a hybrid level set/front tracking method on unstructured meshes. *Computers & Fluids*, 113:20–31, 2015.

Project: Computed aided linear stability analysis of fluid particles

The present project investigates the global linear stability of two-phase flows around deformable fluid particles. A numerically obtained steady state solution, e.g. a stagnant droplet in zero gravity or a droplet rising with constant velocity without deformation, is subject to a set of small orthonormal perturbations, whose non-linear evolutions are captured over time using the in-house code FS3D, developed by [3]. The number of perturbations is very small compared to the number of degrees of freedom, which allows to use an Arnoldi-type iteration to obtain the decisive eigenvalues and -modes, cf. [2]. The aims of the present project are: 1) extending the method introduced in [1] to flows around fluid particles in three spatial dimensions. Here, special care has to be taken in order to account for the two-phase character of the flow; 2) investigating the linear stability analysis of oil droplets in zero gravity and freely rising ones. The first flow setup inherently features spurious currents, occurring at the interface due to the discrete representation of the interface within the numerical algorithm, which have to be considered appropriately.

Partner: J.Dusek, University of Strassbourgh

Support: Center of Smart Interfaces, Graduate School of Computational Engineering

Contact: D. Bothe, J.Kromer

References

[1] C. Albert, D. Bothe, and A. Tezuka. Global linear stability analysis of falling films with in- and outlet. *Journal of Fluid Mechanics*, 745:444–486, 2014.

[2] W. E. Arnoldi. The principle of minimized iterations in the solution of the matrix eigenvalue problem. *Quarterly of Applied Mathematics*, 9(1):17–29, April 1951.

[3] M. Rieber. *Numerische Simulation der Dynamik freier Grenzflächen in Zweiphasenströmungen*. PhD thesis, Universität Stuttgart, 2004.

Project: Computational Analysis of Fluidic Interfaces Influenced by Soluble Surfactant

This project, being part of a Tandem project within the DFG-SPP1506, is concerned with continuum physical and numerical modelling of free-surface and two-phase flows under the influence of surfactant. Direct Numerical Simulation (DNS) is 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, [5]. The method supports a moving computational mesh with automatic mesh deformation and eventually re-meshing. Particular attention will be 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. Test cases comprises growing droplets with soluble surfactants for free surface flows, [2, 1], and single rising bubbles in quiescent contaminated water for two-phase flows, [3]. The simulation results are compared to the experimental ones from our project partners, on overview of this comparison is reported in [4]. Future steps involve the study of the influence of surfactant on species transfer, partitioning in oil/water systems and improvement of the model based on the Gauss-Laplace equation in a dynamic scenario.

Support: DFG Priority Program – SPP 1506

Partner: R. Miller, MPI Colloids and Interfaces, Potsdam/Golm

Contact: D. Bothe, C. Pesci

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Project: A hybrid Level Set / Front Tracking method for surface tension driven flows in complex domains

In the present project an existing hybrid Level Set / Front Tracking method is extended for the simulation of surface tension driven flows in complex domains with the focus on moving contact line problems. Existing hybrid Level Set / Front Tracking methods that are able to simulate contact line problems usually rely on structured meshes which are limited to geometrically simple domains. These methods cannot be easily used in geometrically complex flow domains. The method currently in development works on unstructured, polyhedral meshes and is therefore suitable for such problems. Possible applications are wetting problems on geometrically complex substrates that involve heat transfer and phase change. To achieve this goal, some intermediate targets have to be reached: 1) reduction of spurious currents so that the simulation of surface tension driven flows becomes feasible;

2) development of a library for moving contact line problems including appropriate boundary conditions; 3) validation of the software framework with a range of experimental and analytical test cases.

Support: International Research Training Group Mathematical Fluid Dynamics

Contact: T. Tolle, T. Marić, D.Bothe

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Project: Numerical study of binary droplet collisions with the collision outcome splashing and bouncing

Binary droplet collision plays an important role in spray processes. It influences the droplet size distribution of a spray system by means of different collision outcomes. Using Finite Volume/Volume of Fluid method, we study binary droplet collisions with two different collision outcomes, i.e bouncing and splashing, which are rarely studied in previous works. In numerical simulations of splashing for avoiding the artificial rupture of a thin liquid lamella arising in the collision complex, the lamella is stabilized by correcting surface tension computations and surface constructions in the lamella region. By means of properly chosen white noise disturbances, instabilities are triggered and very good agreement between the simulation results and the experiments is achieved. To investigate the rim instability, which results in secondary droplets, we measure the perturbation growth on the rim by conducting several simulations with the same disturbance strength and averaging the spectrum diagram of the rim perturbation. It is shown that the rim perturbation evolution can be predicted by the Plateau-Rayleigh theory in a long time span. Current work on this topic is focused on the viscous effect on the spectrum of detached secondary droplets. In the bouncing phenomenon, an extremely thin gas layer is entrapped between the colliding droplets. This gas layer cannot be resolved by numerical grids with feasible computational resource. A sub-grid-scale model based on the lubrication theory is developed for taking into account the flow in the gas layer. In addition, the rarefied flow effect is also included in this sub-grid-scale model, since the characteristic length in the flow in the gas layer is comparable with the mean free path of gas molecules. Current work on this topic is numerical simulation of bouncing phenomenon by means of the developed sub-grid-scale model.

Support: DFG - project TRR 75

Contact: D. Bothe, M. Liu

Project: 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), see results by W. Varnhorn, H. Sohr and R. Farwig (2009). In this project we admit 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 ess $\sup_{t\in(0,\infty)} t^\alpha \|e^{-tA}u_0\|_q$ when $s = \infty$, is finite. Such initial values can be described 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., $s_q < s \leq \infty$. The problem is to prove existence of weak solutions in the weighted space $L^s_{t^\alpha}(0, T; L^q(\Omega))$ and their continuity with respect to the above Besov norm, i.e., $u \in C^0([0, T); B^{-1+3/q}_{q,s})$. Weak-strong uniqueness in the sense of Serrin seems to be valid only for "well-chosen" weak solutions for which the approximation procedure is "admissible" in a certain sense.

Partner: Prof. Dr. Y. Giga and Dr. Pen-Yuan Hsu,Tokyo University

Contact: R. Farwig.

Project: Nonzero Dirichlet Boundary Data of Navier-Stokes Flow

The nonstationary Navier-Stokes equations pose new problems when nonhomogeneous boundary data are considered. The main reason is the energy estimate due to a possible energy transfer through the boundary into the fluid domain. One possibility to find solutions is to solve first of all a linear Stokes system with the nonhomogeneous boundary data and to reduce the problem to a modified Navier-Stokes system containing several perturbation terms. This strategy has been successfully applied by H. Kozono, H. Sohr and R. Farwig for bounded and exterior domains during the last years. Even weak solutions satisfying the strong energy inequality can be obtained for exterior domains. Then the perturbation terms will influence the analysis of the rate of decay of weak solutions as $t \to \infty$. However, it is expected that even for an exterior domain the rate of decay is the same as in the classical case with vanishing Dirichlet boundary data.

Partner: D. Wegmann, TU Darmstadt, and Prof. Dr. H. Kozono, Waseda University, Tokyo

Contact: R. Farwig.

Project: Asymptotic Decay and Concentration-Diffusion Phenomena for the Fractional Navier-Stokes Equations

The fractional Navier-Stokes system is a model for fluid flow where in contrast to the classical Navier-Stokes system on the whole space $\mathbb{R}^3$ the friction term $-\Delta u$ is replaced by the nonlocal fractional Laplacian $(-\Delta)^{\alpha/2}u$, $0 < \alpha < 2$. Using the Fourier transform we have to consider the term $|\xi|^\alpha$ rather than $|\xi|^2$ leading to a fundamental solution $E_\alpha(x, t) = t^{-3/\alpha}E^0_\alpha(xt^{1/\alpha})$ with Fourier transform $e^{-t|\xi|^\alpha}$ of the fractional heat equation. Here E^0_α is positive and bounded by $c(1+|x|)^{-\alpha-3}$ and hence not exponentially decaying. The first aim of the project is to determine the asymptotic structure of solutions of the corresponding fractional Navier-Stokes equations where the Helmholtz projection must be taken into account as well. A second aim is to prove the possibility of a concentration-diffusion phenomenon under suitable symmetry assumptions on the initial value. Such a result requires that the solutions of the nonlinear problem depend in an analytic way on initial data and leading terms of the asymptotic structure are known.

Partner: Prof. Dr. H.-O. Bae, Ajou University, Suwon, South Korea, and Prof. Dr. Chenyin Qian, Zhejiang Normal University Jinhua, China

Contact: R. Farwig.

Project: The Global Attractor of Quasi-Geostrophic Equations with Fractional Dissipation in $\mathbb{R}^2$

The quasi-geostrophic equations (QSE) are a model in oceanography and atmospheric sciences modeling the flow of water or gas under the influence of forces due to a rotating impact under small Rossby and Ekman numbers. Adding a fractional dissipation of the form $(-\Delta)^\alpha$, $0 < \alpha < 1$, the QSE on the whole space $\mathbb{R}^2$ is a scalar nonlinear and nonlocal equation in the unknown potential temperature, θ. For certain values of α the QSE has properties (scaling invariance, embedding of function spaces) as the 2D or 3D Navier-Stokes or Euler system, respectively. The aim of the project is to prove the existence of the global attractor in the autonomous case with a prescribed force term $f(\theta, x)$ and in the nonautonomous case with given force $f(t, x)$. Such results are known in the periodic setting $\Omega = (-\pi, \pi)^2$ when compact Sobolev embeddings and the Poincaré inequality can be used. Moreover, since the problem is feasible when the force term admits a damping of the form $-\lambda\theta$ with positive λ the challenge is to use damping as little as possible.

Partner: Prof. Dr. Chenyin Qian, Zhejiang Normal University Jinhua, China

Contact: R. Farwig.

Project: Fundamental Solutions of Fluid Flow around Moving Bodies

The fundamental solution of linear problems play a crucial role in finding adequate function spaces to solve related nonlinear problems and to determine asymptotic properties in space and/or time of solutions. In this project we are looking for fundamental solutions arising from problems of fluid flow past a rigid body with prescribed angular and translational velocity and prescribed change of the shape of the body. The corresponding linearized equations are obtained by a global coordinate transform so that the position of the obstacle is fixed in space, combined with a coordinate transfom mapping the time-depending shape to a constant reference shape; after these transforms the domain filled by the fluid is independent of time. In a next step these equations are considered in the whole space yielding a fundamental solution of non-convolution type due to x- and t-depending coefficients in the resulting equations. In the case of a rotating body with constant translational velocity parallel or non-parallel to the axis of revolution this kind of problem was solved in cooperation with E.A. Thomann and R.B. Guenther (Oregon State University). A key step is the solution of an intermediate ODE system the solution of which simplifies the original problem considerably. Of course, only in very specific cases of prescribed motions a more or less explicit fundamental solution can be expected.

Partner: Prof. Dr. Š. Nečasová, Academy of Sciences of the Czech Republic, Prague, and S. Kračmar, TU Prague, Prague

Contact: R. Farwig.

Project: Maximal Regularity of the Stokes System in Unbounded Domains with Navier Slip Boundary Condition

Based on an analysis in function spaces $\tilde{L}^q := L^q \cap L^2$ when $2 < q < \infty$ and $\tilde{L}^q := L^q + L^2$ when $1 < q \leq 2$ the (Navier-)Stokes equations in general unbounded smooth domains with boundary conditions of Navier slip or Robin type $\alpha(T(u) \cdot n)_\tau + \beta u_\tau = 0$ ($\alpha > 0$, $\beta \geq 0$) are analyzed; here $T(u) = T(u, p)$ denotes the Cauchy stress tensor, n the exterior normal vector on the boundary, and τ denotes the tangential component along the boundary.

By results of Y. Shibata and R. Shimada (Waseda University, Tokyo) it is known that the corresponding Stokes operator generates an analytic semigroup on bounded domains on every L^q-space, $1 < q < \infty$, and has maximal regularity. These results were extended and lead to the existence and analyticity of the corresponding Stokes semigroup in general smooth unbounded domains. The aim of this project is to prove that the Stokes operator even has maximal regularity. Since the Stokes semigroup is not shown to be bounded as $t \to \infty$ the maximal regularity estimate will be proved only for bounded time intervals.

Partner: Dr. V. Rosteck, Springer Verlag Heidelberg

Contact: R. Farwig.

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 (Université de Valenciennes)

Contact: Robert Haller-Dintelmann

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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

Contact: Robert Haller-Dintelmann, Patrick Tolksdorf

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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 assumtion on the initial conditions, and also to achive additional information on the regularity of global solutions.

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

Contact: A. Hussein.

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[1] Y. Giga, M. Griesa, 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*, to appear.

[2] M. Hieber, A. Hussein, and T. Kashiwabarar. Global strong l^p well-posedness of the 3d primitive equations with heat and salinity diffusion. *Journal of Differential Equations*, 216:6950–6981, 2016.

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 anlytic 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) and Martin Saal

Contact: A. Hussein.

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 how Kelvin-Voigt damping is sufficient to avoid resonance in the nonlinear (hyperbolic) wave equution.

Contact: Mads Kyed, Aday Celik

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Project: A priori estimates for time-periodic solutions to parabolic boundary value problems

A celebrated and famous result of Agmon, Douglis and Nirenberg states that a solution to an elliptic boundary value problem satisfies an a priori L^p estimate if and only if the boundary operators satisfy a so-called complementing condition with respect to the elliptic differential operator. A similar result was established by the same authors for systems of elliptic boundary value problems. The theorems of Agmon, Douglis and Nirenberg are fundamental to the modern approach to partial differential equations of elliptic type. Our aim is to extend their results to time-periodic solutions to parabolic boundary value problems. In [1] we developed a generic method to establish time-periodic L^p estimates based on time-periodic Fourier multipliers.

Partner: Jonas Sauer (MPI Leipzig)

Contact: Mads Kyed

References

[1] M. Kyed and J. Sauer. A method for obtaining time-periodic L^p estimates. *Journal of Differential Equations*, To appear (2016).

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 [5]. 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 [3] and [4]. One of our goals is to further develop an approach based on time-periodic Fourier multipliers introduced by Mads Kyed; see [2]. An important outcome hereof has been the identification in [6, 1] 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)

Contact: Mads Kyed, Thomas Eiter

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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

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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 two 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

Support: CONACYT, DFG

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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, N. Sfakianakis (Universität Mainz).

Contact: C. Stinner.

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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.

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[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), R.G. Iagar (ICMAT Madrid)

Contact: C. Stinner.

References

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Project: L^p-theory of the Stokes operator on bounded convex domains

It is a well-known result of Dahlberg that solutions to the Poisson problem with right-hand side in L^2 fail to admit H^2-regularity if the boundary of the underlying domain is merely Lipschitz. However, Grisvard proved that H^2-regularity can be attained if the domain is convex. The same question arises if the Laplace operator is replaced by the Stokes operator and is one question that shall be investigated in this project. Moreover, due to the good properties of the Laplacian, it can be shown that the Helmholtz projection gives rise to a bounded operator on L^p for all $1 < p < \infty$ which is a property that fails on arbitrary bounded Lipschitz domains. The boundedness of the Helmholtz projection is a strong indicator that also the Stokes operator should admit a fruitful L^p-theory for all $1 < p < \infty$. This is another question that is investigated in this project.

Contact: P. Tolksdorf.

Project: The simplified Ericksen–Lesley model on bounded Lipschitz domains

The simplified Ericksen–Lesley model is a simplified model to describe the flow of an incompressible nematic liquid crystal material. The usual local in time and global for small data existence theory has been performed on bounded C^2-domains in [1]. However, a short glimpse on a smartphone display shows that it is more natural if the container of the liquid crystal material has only a Lipschitz boundary. As new results for the Stokes operator on Lipschitz domains are available, see [2], the local in time and global for small data existence theory for this model on three-dimensional bounded Lipschitz domains is the aim of this project.

Partner: Amru Hussein; Anupam Pal Choudhury.

Contact: A. Hussein, A. Pal Choudhury, P. Tolksdorf.

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[1] M. Hieber, M. Nesensohn, J. Prüss, and K. Schade. Dynamics of nematic liquid crystal flows: the quasilinear approach. *Ann. Inst. H. Poincaré Anal. Non Linéaire*, 33(2):397–408, 2016.

[2] P. Tolksdorf. *On the L^p-theory of the Navier-Stokes equations on Lipschitz domains*. TU Prints, 2017.

Project: Strong periodic solutions to the bidomain model

The bidomain model is a system related to intra- and extra-cellular electric potentials and some ionic variables. For this model Giga and Kajiwara proved in [1] resolvent estimates of the corresponding bidomain operator which is the linear and stationary part of the system of equations. The aim of this project is to prove the existence of strong and periodic solutions to this model if the acting external forces are periodic. One way to achieve this aim is to prove maximal regularity of the bidomain operator on L^p or certain subspaces of L^p.

Partner: N. Kajiwara

Contact: M. Hieber, K. Kress, P. Tolksdorf.

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[1] Y. Giga and N. Kajiwara. On a resolvent estimate for bidomain operators and its applications. *SIAM Journal on Optimization*, 2016.

1.3 Applied Geometry

The research group “Geometry and Approximation” investigates geometric objects, typically surfaces, as well as approximations thereof.
Classical Differential Geometry deals with curves and surfaces. Surfaces arising in the sciences are frequently minimizers to certain functionals. In the simplest case, say for a biological cell, they might bound a given volume in such a way that the area of the surface is minimal. Other interfaces minimize functionals involving curvatures. Critical points satisfy Euler equations, namely non-linear partial differential equations. Our goal is to establish new solutions and properties of solutions, in Euclidean 3-space but also in other Riemannian spaces, by employing analysis and Riemannian Geometry.
In Geometric Modeling, mathematical tools for the explicit description of geometric objects are developed and analyzed. Unlike in elementary geometry, the focus is not on simple objects like circles or spheres, but on more 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 further 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, Ulrich Reif

Research Associates

Jerome Alex, Tristan Alex, Tobias Ewald, Susanne Kürsten, Lars-Benjamin Maier, Claudia Möller, Sonja Odathuparambil, Miroslav Vrzina

Secretary

Karolin Berghaus

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: Periodic Minimal Surfaces in Homogeneous Manifolds

Schwarz reflection is a well-known procedure to generate triply periodic minimal surfaces in Euclidean 3-space. In Riemannian fibrations $\pi\colon E(\kappa,\tau) \to \Sigma(\kappa)$ with constant bundle curvature $\tau \neq 0$ over a simply connected base surface $\Sigma(\kappa)$ of constant curvature κ, the same techniques apply to obtain periodic minimal surfaces; vertical planes and horizontal

sections used as barriers guarantee the embeddedness of a Plateau solution with respect to a polygon consisting entirely of horizontal geodesic arcs.
This solution is reflected across its boundary geodesics to obtain a periodic minimal surface. The construction relies on tessellations of the base manifold Σ with additional symmetry and in particular generates new minimal surfaces in the 3-sphere.

Contact: T. Alex.

Project: Analysis of Geometric Subdivision Schemes for Curves

The development of a universal convergence and smoothness theory for non-linear curve subdivision is an open question. This project introduces in [2] a broad class of geometric (refinement rules commute with similarities), local, uniform, equilinear (linear polyons are reproduced) schemes and establishes a $C^{1,\alpha}$-theory for these so called GLUE-schemes while improving the results to $C^{2,\alpha}$-regularity for an important subset including all real-valued schemes. The key is the decay of a newly introduced quantity, whose decay rate can be verified automatically and rigorously by a computer when using affine arithmetics. We implemented this non-trivial algorithm and proved open conjectures on regularity of some concrete schemes. When dropping equilinearity, we still have necessary and sufficient convergence conditions, see [1], while C^1-continuity is work in progress.

Partner:

Contact: T. Ewald, U. Reif

References

[1] T. Ewald. Convergence of geometric subdivision schemes. *Applied Mathematics and Computation*, 272:41 – 52, 2016.

[2] T. Ewald, U. Reif, and M. Sabin. Hölder regularity of geometric subdivision schemes. *Constructive Approximation*, 42:425 – 458, 2015.

Project: Geometric Subdivision Surfaces

We investigate two new approaches for subdivision schemes where points are generated in a geometric way. The first one introduces a discrete curvature estimator and places the points by solving a non-linear optimization problem of minimizing the fluctuation of this quantity. The second idea is fitting with rotated paraboloids which leads to a problem of finding the roots of a polynomial and solving a linear sytem simultaneously.

Contact: T. Ewald, U. Reif

Project: Surfaces in homogeneous 3-manifolds

Minimal and constant mean curvature surfaces are a traditional subject for Euclidean ambient space, or more generally in space forms such as hyperbolic space or 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. Besides [1] various publications that evolved from PhD theses are in preparation for appearence in the next period 2017/18 of the Jahresbericht, the first being [2].

Partner: Rob Kusner (Amherst, MA)

Contact: K. Große-Brauckmann

References

[1] T. Alex. On the half-space theorem for minimal surfaces in Heisenberg space. *Pacific Journal of Mathematics*, 282:1–7, 2016.

[2] M. Vrzina. On the existence problem for tilted unduloids in $H^2 \times R$. Technical report, arXiv:1702.02761 [math.DG].

Project: Periodic surfaces and interfaces

Periodic surfaces play an important role for the modelling of various naturally occuring interfaces. Among various energies to be considered, the Willmore case under a volume constraint is interesting. Limits of such surface families establish a way to construct a Schoen skeletal graph rigorously. An optimality problem for these periodic graphs is studied.

Contact: K. Große-Brauckmann

Partner: G.E. Schröder-Turk (Perth)

Project: AutoDiff

AutoDiff is a Matlab Toolbox which admits to compute ordinary and partial derivatives of arbitrary order my means of operator overloading.

Partner: MathWorks

Contact: U. Reif

Project: NURBS Enhancements

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.

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.

Contact: U. Reif

Project: Constant mean curvature surfaces in homogeneous 3-manifolds

In the recent years constant mean curvature surfaces have been studied in simply connected homogeneous 3-manifolds. In ambient spaces like $\mathbb{H}^2 \times \mathbb{R}$, $\widetilde{\mathrm{PSL}}_2(\mathbb{R})$, Nil_3 and Sol_3 we construct new constant mean curvature annuli with methods from geometric analysis, i.e., they are obtained as solutions of ordinary and partial differential equations. In Sol_3

we also construct triply-periodic minimal surfaces. In order to visualise these surfaces we compute solutions of differential equations with Mathematica and the Surface Evolver.

Contact: M. Vrzina

References

[1] M. Vrzina. Cylinders as invariant CMC surfaces in homogeneous 3-manifolds. *Submitted*, 2016.

[2] M. Vrzina. On the existence problem for tilted unduloids in $\mathbb{H}^2 \times \mathbb{R}$. *Submitted*, 2017.

[3] M. Vrzina. Triply-periodic minimal surfaces in Sol_3. *In preparation*, 2017.

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: A. 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. This includes discussions on curricular issues regarding content selection and substantiation for general-education mathematics classes. 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 I 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 – expertise in research methodology has also been built, for instance, in how to enter developmental progress in learning processes.
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) at the commencement of the engineering degree courses in four departments (VEMINT project in cooperation with Kassel, Paderborn and Lüneburg) and university-wide e-portfolio project dikopost demonstrate the broad networking and anchoring of the working group on subject didactics at Darmstadt Technical University.

Research Group in Operator Algebras and Mathematical Physics

Quantum probability is an extension of classical probability theory that allows one 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.). Our investigations of the long time behaviour of Markov processes have also opened the door to research on quantum 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, entanglement of Fermionic states, and criteria for entanglement by methods from convex algebraic geometry.

Members of the research group

Professors

Regina Bruder, Burkhard Kümmerer

Research Associates

Julia Berlin-Bonn, Axel Böhnke, Nora Feldt-Caesar, Felix Johlke, Thomas Klein, Albrun Knof, Barbara Krauth, Renate Nitsch, Sandra Lang, Ulrike Roder, Oliver Schmitt, Marcel Schaub, Insa Schreiber, Florian Sokoli

Secretaries

Sigrid Hartmann, Heike Müller, Elisabeth Müller-Klingenburg

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 Technische Universität 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

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 varieties within the results of different counties.

Support: Ministry of education and cultural affairs of Lower Saxony

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

Project: MAKOS 2014-2016

The project MAKOS (technology supported mathematics classes with a competence 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: Deutsches Zentrum für Lehrerbildung Mathematik (DZLM), Hessisches Kultusministerium, Landesschulamt, Studienseminare für berufliche Schulen und Gymnasien in Darmstadt und Kassel, Universität Kassel

Contact: R. Bruder, U. Roder

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[1] U. Roder and R. Bruder. Das hessische Projekt MAKOS zu Implementierung des neuen Kerncurriculums (KC) Oberstufe. In F. Caluori, H. Linneweber-Lammerskitten, and C. Streit, editors, *Beiträge zum Mathematikunterricht*, pages 1097–1100. WTM-Verlag Münster, 2015.

[2] U. roder and R. Bruder. Das hessische Projekt MAKOS zu Implementierung des neuen Kerncurriculums (KC) Oberstufe. In *Beiträge zum Mathematikunterricht*. WTM-Verlag Münster, 2015.

[3] U. Roder and R. Bruder. *MAKOS – Ein Projekt zur Umsetzung der Abiturstandards*. Springer Fachmedien Wiesbaden, 2015.

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 universitiy 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 contents of mathematics can be very different at university compared to mathematics at school.
In Darmstadt the learning materials are used as an e-learning course which takes place shortly before the first semester. To increase the participation in the course and the interaction among the students, we use the plugin 'Moodle Peers' from the project with the same name, with which we cooperate. With the help of the plugin we can match the students in learn groups after personality traits.
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] R. Bruder and M. Schaub. Qualitätskriterien für diagnostische Tests im Übergang Schule - Hochschule . In F. Caluori, H. Linneweber-Lammerskitten, and C. Streit, editors, *Beiträge zum Mathematikunterricht*, pages 1105–1108. WTM-Verlag Münster, 2015.

Project: DTA- 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 fault detection. The base is an analysis of the answers in live-time, which is 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 elementarized loop, that can identify missing elementary building blocks and typical faults 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

Contact: R.Bruder, N. Feldt-Caesar, M. Schaub

References

[1] R. Bruder and K. Winter. Diagnostische Testaufgaben - DTA . In *Beiträge zum Mathematikunterricht*, pages 1149–1152. WTM-Verlag Münster, 2016.

[2] N. Feldt-Caesar. Konzeptualisierung und Operationalisierung von Mindeststandards - von der Zielformulierung zum digitalen Diagnoseverfahren. In *Beiträge zum Mathematikunterricht*, pages 1149–1152. WTM-Verlag Münster, 2016.

[3] M. Schaub. Die DTA unter einem tätigkeitstheoretischen Blickwinkeln. In *Beiträge zum Mathematikunterricht*, pages 1161–1164. WTM-Verlag Münster, 2016.

Project: Conceptualization and Operationalization of Mathematical Basic Knowledge

In this project mathematical basic knowledge has been conceptualized and operationalized in order to develop a suitable method of diagnosing mathematical basic knowledge at the end of secondary school (Abitur).
Defining the concept of basic knowledge, social historical activity theory provides an adequate framework for describing required contents and actions. Against this theoretical background demands on a diagnostic tool have been outlined. Based on these demands a method for digital assessment of basic knowledge (called 'elementarizing testing') has been developed. This method uses adaptive elements for a stepwise break down of the demanded cognitive actions. Thus testing time can be used more effectively and possible sources of errors deriving from elementary deficits might be detected. Since construction and usage raise many research questions, an elementarizing testing tool was tested with

high-school students and first-year students (n=623) within the field of differential calculus. Additionally, diagnostic interviews were conducted. On the basis of the collected quantitative and qualitative data prospects and constraints of this diagnostic method could have been carved out and guidelines for constructing adaptive elements could have been derived. The tool is intended to support mathematics teachers with the diagnosis of basic knowledge by locating potential deficits precisely. An automatically generated feedback enables teachers to counteract those deficits. In the long term suitable learning material will be provided within the feedback to facilitate learners to work on their basic knowledge single-handedly.

Contact: N. Feldt-Caesar, R. Bruder

References

[1] R. Bruder, N. Feldt-Caesar, A. Pallack, G. Pinkernell, and A. Wynands. Mathematisches Grundwissen und Grundkönnen in der Sekundarstufe II. In W. B. et al., editor, *Bildungsstandards aktuell: Mathematik in der Sekundarstufe II*, pages 105–120. Schroedel, 2015.

[2] N. Feldt-Caesar. Möglichkeiten der Diagnose von Grundwissen und Grundkönnen durch ein adaptiv gestaltetes Testverfahren. In *Beiträge zum Mathematikunterricht*, pages 276–279. WTM-Verlag Münster, 2015.

[3] N. Feldt-Caesar. Konzeptualisierung und Operationalisierung von Mindeststandards - von der Zielformulierung zum digitalen Diagnoseverfahren. In *Beiträge zum Mathematikunterricht*, pages 1149–1152. WTM-Verlag Münster, 2016.

Project: COnceptual DIfficulties in the field of functional relationships

In the project CODI we analysed students' learning difficulties in the field of functional relationships. We developed a diagnostic tool in which multiple translations are considered to identify students' learning difficulties at an early stage. For this purpose, we focused on the identification of stable phenomena as misconceptions and developed an online tool which can be evaluated with an automatic feedback. The study is limited to linear and quadratic functions, as these are the two types with which the examined age group (class 9 and 10) is familiar in the German curriculum.

As the aim of this study was to develop a flexible diagnostic tool which can be converted into an online version with automatic feedback, most items were designed in a multiple choice format. All multiple choice items have four response possibilities and only one correct answer. As many distractors as possible represent a specific systematic error. Typical systematic errors were chosen from literature and by analysing students' answers to the written test in the project HEUREKO. We assumed that misconceptions can be identified by analysing consistent error patterns. Therefore, we considered at least two items of each translation and function type.

N=569 students of classes 9, 10 and 11 took part in the main study. Overall, we identified nine error patterns which occurred among more than 10% of the students. In general, it was possible to ascribe these error patterns to underlying misconceptions, not least with the help of the fruitful diagnostic interviews.

Additionally, we conducted a cluster and a variance analysis in order to find group structures. We found several factors which influence the occurrence of error patterns, such as the educational treatment.

In order to examine the stability of these error patterns, a posttest was conducted after six months. The results reveal that students have a significant learning gain in most translation types. However, there are some particular persistent error patterns which indicate robust misconceptions.

With the help of the developed diagnostic tool, teachers are supported in the identification of typical learning difficulties. The (German) tool is accessible online at `http://www.codi-test.de/`

Contact: R. Nitsch, R. Bruder

References

[1] R. Nitsch. *Diagnose von Lernschwierigkeiten im Bereich funktionaler Zusammenhänge*. Wiesbaden: Springer Spektrum, 2015.

[2] R. Nitsch, R. Bruder, and A. Kelava. Schülerhandlungen als Elemente fachdidaktisch motivierter Kompetenzmodellierungen. *Journal für Mathematik-Didaktik*, 37:289–317, 2016.

[3] R. Nitsch, A. Fredebohm, R. Bruder, D. Naccarella, T. Leuders, and M. Wirtz. Students' competencies in working with functions in secondary mathematics education – empirical examination of a competence structure model. In *International Journal of Science and Mathematics Education*, volume 13, pages 657–682. Springer, URL: http://link.springer.com/article/10.1007%2Fs10763-013-9496-7#, 2015.

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 comprise 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

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[1] O. Schmitt. Reflexionswissen aus tätigkeitstheoretischer Perspektive am Beispiel des mathematischen Argumentierens. In F. Caluori, H. Linneweber-Lammerskitten, and C. Streit, editors, *Beiträge zum Mathematikunterricht*, pages 816–819. WTM-Verlag Münster, 2015.

[2] O. Schmitt. Konzept zur Vermittlung von Reflexionswissen aus tätigkeitstheoretischer Perspektive. In I. für Mathematik und Informatik Heidelberg, editor, *Beiträge zum Mathematikunterricht*, pages 871–874. WTM-Verlag Münster, 2016.

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 draft 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 on 8/1/2013 and ran for a duration of 3.5 years. A total of 15 schools took part, 14 other schools had 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

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[3] R. Bruder, D. Meyer, and L. Bergmann. Ein Kompetenzentwicklungsmodell zur langfristigen Förderung mathematischer Problemlösekompetenz im Projekt LEMAMOP. In *Problemlösen - gestalten und beforschen*, pages 33–58. Münster: WTM-Verlag, 2015. In Ana Kuzle and Benjamin Rott: Tagungsband der Herbsttagung des GDM-Arbeitskreises Problemlösen in Münster 2014.

Project: EOM 2016

The goal of the project EOM (E-Feedback to Overcome Misconceptions) is the development of learning environments to overcomce misconceptions in the field of functional relations by the use of a computerbased feedback.
A basic feature of the diagnostic-test-exercise (DTA "Diagnostische Testaufgabe") is the usage of an individual feedback with options for further learning. This expands the field of usage of such exercises by the learning part. There are already theoretical conceptions of the occurence of error patterns. The Conceptual-Change Theory assumes that especially in the field of mathematics and scientific topics perceptions of everyday life play an important part in influencing further learning. These not satisfying preconceptions can be shown in text-excercises because of their systematic nature.
Equally those theories offer the possibilities to overcome these error patterns and the misconceptions behind. Specific, different feedback-possibilities on the basis of the Conceptual-Change-Theory will be elaborated and implemented by varying methods. Besides text-based feedback, there are realisations by video, (animated) picture or interactive plugins.

Contact: F. Johlke

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 term 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.

Partner: R. Gohm (Aberystwyth)

Contact: B. Kümmerer, A. Gärtner

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: Representations of Finitely Correlated States

A stationary Markov Chain on a finite set in probability theory permits two basically equivalent descriptions: Given a stochastic matrix with invariant probability distribution one can consider the induced stationary Markov measure on the path space or one can consider the induced stationary Markov process.
In noncommutative probability theory this equivalence breaks: There is no canonical correspondence between noncommutative stationary Markov processes – Markov Dilations

– and noncommutative stationary Markov measures – certain states on an infinite tensor product C*-algebra. This lack is due to non-existence of needed conditional expectations which is a purely noncommutative phenomenon.

In this project, we succeed in constructing representations of a certain class of noncommutative Markov measures known as finitely correlated states using inductive limits of Hilbert spaces, C*-algebras and representations.
This technique allows us to analyse entanglement properties of the one side restriction of a pure finitely correlated state and, especially, determining its von Neumann entropy, which would be impossible using only restrictions on finite dimensional subalgebras. We clarify the connection between aperiodic irreducibility of a pure transition operator, irreducibility of certain representations and thus purity of certain finitely correlated states.

Contact: B. Kümmerer, W. Reußwig

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[1] W. Reußwig. Ein darstellungstheoretischer zugang zu verschänkungseigenschaften endlich korrelierter zustände. Phd-thesis, TU Darmstadt, 2013.

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 that 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, C. Köstler, 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*, to appear, electronic version: http://link.springer.com/article/10.1007/s00220-017-2851-8:36, 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 term 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 was 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 a long time.

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: 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. Non-seperable states are called *entangled*. Experiments show that only entangled states behave truly quantum-mechanically, as they 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.

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

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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 bith 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 diverse ergodic properties.

Contact: B. Kümmerer, A. Gärtner, K. Schwieger

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

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.

Contact: R. Gohm, B. Kümmerer, A. Knof

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[1] R. Gohm, F. Haag, and B. Kümmerer. Universal preparability of states and asymptotic completeness. *Communications in Mathematical Physics*, to appear, electronic version: http://link.springer.com/article/10.1007/s00220-017-2851-8:36, 2017.

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Project: Mathematics: The Common Language of Natural Sciences

In this project we develop an innovative multidisciplinary lecture course to be attended by all student teachers who study at least one of the subjects mathematics, physics, chemistry, biology, or informatics. It is a building block of the interlinking area, which is established as part of the MINTplus-initiative of the TU Darmstadt to profile the teachers education at our university.

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 a common language of the natural sciences, and in particular, of the possibilities and limitations of mathematical modelling in the 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 the natural sciences.

Contact: B. Kümmerer, S. Lang

Project: A concept for diagnosis and support of basic mathematical knowledge at the transition to upper secondary school (BASICS-Mathematics)

Basic mathematical knowledge (BMK) is a necessary foundation for further learning due to the deductive structure of mathematics. Learning difficulties relating to the lack of basic mathematical knowledge and skills often become highly noticeable at the transition between different school levels. Therefore, special supportive measures and appropriate diagnostic methods for basic knowledge at transition periods are required. The aim of the project is to suggest initial theoretical approaches towards a diagnosis and supportive concept for BMK.

As an exemplification, a digital testing instrument in combination with learning materials regarding the topic of functions and elementary algebra has been developed. This is about an assessment of mathematical basics of functions and elementary algebra at the beginning of upper secondary school covering knowledge and skills of several school years.

Subsequent to the digital test, the students receive individual, topic-specific and elaborated feedback that contains indications for possible supportive measures regarding basic skills and knowledge in the field of functions and elementary algebra. As a consequence, learning materials for support are combined with the test instrument. The designed materials are essentially self-learning environments and refer to one another. The structure of

the different materials is virtually identical. Every worksheet contains an explanation of a specific topic (e.g. roots of linear functions) and tries to suggest typical representations and the relevance of the topic. In addition, a prime example is included and followed by exercises on this topic. Work is focused on the interaction of the learners with these supportive materials. The materials were tested in class, and in interviews it was examined which kind of tasks may specifically help to reactivate prior knowledge. To analyse the effectiveness of the developed material the students had to solve a post-test. Currently, the results of the pre- and post-test are examined regarding possible learning effects due to the use of the supportive materials.
Details: www.basics-mathematik.de

Contact: U. Roder

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Project: The development of a digital adaptive diagnostic test at the beginning of studies (since 2014)

This doctorate project is about the development of adaptive test method "elementarizing testing" to new kinds of exercises. It will be analyzed which kind of exercises can be elementarized and how the elementarization of the new kind of exercises can be constructed. Especially two kinds of exercises are in the focus of this development: Exercises that test operations of reasoning, and exercises where the students must give an example for something with certain characteristics. The second kind is possible in digital testing with STACK, that uses a CAS in the background. The aim of this project is to give students a learning-supporting feedback for learning at the end of a digital diagnostic test what will be realized through this adaptive test method that can identify missing elementary blocks and typical faults in elementary blocks.
The new theoretical results will be transferred to the VEMINT-test, so it will be possible to evaluate the results in 2017.
This project is based by results of the dissertation of Nora Feldt-Caesar and the project DTA.

Contact: M. Schaub

References

[1] M. Schaub. Die DTA unter einem tätigkeitstheoretischen Blickwinkeln. In *Beiträge zum Mathematikunterricht*, pages 1161–1164. WTM-Verlag Münster, 2016.

Project: Development of mathematical reasoning competence at the transition school-university (EMASU)

The Project EMASU deals with the development of mathematical reasoning competence at the transition school-university. The long-term goal is the development of a concept for the improvement of reasoning competence in the period between school and the start of math-studies at university.

In the first phase of the project a digital questionnaire was developed with common and new scales about facets of reasoning and problem-solving competence, past mathematical experience, working behavior and study expectations. In a second questionnaire at the middle of the first semester, difficulties in mathematics studies and requests for the preparation by school are also asked. In autumn 2016 the questionnaires were piloted using a small number of participants.

Contact: I. Schreiber

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[2] I. Schreiber. Beweisen lernen. 2016.

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, Ziegler). Model theoretic investigations make intra-mathematical links with algebra and discrete mathematics, e.g. graphs and hypergraphs (Blumensath, 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 (Ziegler), 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 2 PI's (Kohlenbach, Ziegler) 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, Martin Ziegler (until 2015)

Retired professors

Peter Burmeister, Christian Herrmann, Klaus Keimel, Rudolf Wille

Postdocs

Achim Blumensath, Ulrik Buchholtz, Kord Eickmeyer, Vassilios Gregoriades, Stéphane Le Roux, Davorin Lešnik, Thomas Powell, Carsten Rösnick, Matthias Schröder

Research Associates

Julian Bitterlich, Felix Canavoi, Daniel Günzel, Robin Hesse, Daniel Körnlein, Angeliki Koutsoukou-Argyraki, Florian Steinberg, Jonathan Weinberger

Secretaries

Barbara Bergsträßer, Betina Schubotz

Project: Quantitative results on abstract Cauchy problems and strongly continuous semigroups

In this project we extract explicit rates of convergence and metastability for abstract Cauchy problems generated by accretive operators ([2]). These rates are extracted by applying proof-theoretic techniques to proofs in [1]. The results crucially make use of the novel concept of a 'uniformly accretive (at zero) set-valued operator'. A second part is concerned with explicit bounds on the asymptotic behavior of an algorithm due to Suzuki [5] for the computation of a common fixed point of a one-parameter strongly continuous semigroup of nonexpansive mappings. Suzuki's theorem assigns to a nonexpansive semigroup $(T(t))_{t\geq 0}$ the single nonexpansive mapping

$$S := \lambda T(\alpha) + (1-\lambda)T(\beta)$$

(with $\lambda \in (0,1)$ and $0 < \alpha < \beta$ such that α/β is irrational) and shows that any fixed point of S is a common fixed point for the whole semigroup. We extract an explicit bound $\Phi(\varepsilon, M) > 0$ such that any $\Phi(\varepsilon, M)$-fixed point of S is a common ε-approximate fixed point of $T(t)$ for all $t \in [0, M]$. The bound crucially depends on an effective irrationality measure for α/β.

Support: DFG International Research Training Group 1529: Mathematics Fluid Dynamics

Contact: A. Koutsoukou-Argyraki, U. Kohlenbach.

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[5] T. Suzuki. Common fixed points of one-parameter nonexpansive semigroups. *Bull. London Math. Soc.*, 38:1009–1018, 2006.

Project: Metastability for iterations of nonexpansive and pseudocontractive operators

This project is concerned with the extraction of a rate of metastability (in the sense of Tao) for a celebrated iteration scheme due to [1] for pseudocontractive operators in Hilbert space. In [5], such a rate is extracted from a proof due to [2] for Lipschitzian pseudocontractions. Based on Bruck's original proof, a rate of metastability that only uses demicontinuity is extracted in [3] by-passing the use of Zorn's lemma (to construct maximally monotone extensions of monotone operators) in [1] based on ideas from [5]. Another topic is the extraction of rates of metastability for ergodic averages of nonexpansive mappings in uniformly smooth spaces ([6]) from a proof by [7]. See also [4].

Support: DFG project KO 1737/5-2

Contact: D. Körnlein, U. Kohlenbach.

References

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[2] C. Chidume and H. Zegeye. Approximate fixed point sequences and convergence theorems for Lipschitz pseudocontractive maps. *Proceedings of the American Mathematical Society*, 132:831–840, 2004.
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[6] D. Körnlein. Quantitative results for Halpern iterations of nonexpansive mappings. *Journal of Mathematical Analysis and Applications*, 428:161–1172, 2015.
[7] H.-K. Xu. Iterative algorithms for nonlinear operators. *J. Lond. Math. Soc.*, 66:240–256, 2002.

Project: Logical metatheorems for abstract spaces axiomatized in positive bounded logic

In this project we show that normed structures which can be axiomatized in positive bounded logic (in the sense of Henson and Iovino [2]) admit proof-theoretic metatheorems (as developed by Kohlenbach since 2005) on the extractability of explicit uniform bounds from proofs in the respective theories. This can be applied to design such metatheorems for abstract Banach lattices, L^p- and $C(K)$-spaces as well as bands in $L^p(L^q)$-Bochner spaces. It turns out that a proof-theoretic uniform boundedness principle can serve in many cases as a substitute for the model-theoretic use of ultrapowers of Banach spaces.

Support: DFG project KO 1737/5-2

Contact: D. Günzel, U. Kohlenbach.

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[1] D. Günzel and U. Kohlenbach. Logical metatheorems for abstract spaces axiomatized in positive bounded logic. *Advances in Mathematics*, 290:503–551, 2016.

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Project: Quantitative results on Fejér monotone sequences

Fejér monotonicity (and – in the presence of error terms – quasi Fejér monotonicity) is a key notion employed in the study of many problems in convex optimization and programming, fixed point theory and the study of (ill-posed) inverse problems (see e.g. [3, 1]). Together with the bounded compactness of the underlying space this property guarantees (using sequential compactness) under very general conditions the strong convergence of iterative sequences towards a fixed point of the operator in question.

In [2], we provide in a unified way quantitative forms of strong convergence results for numerous iterative procedures that satisfy a general type of Fejér monotonicity where the convergence uses the compactness of the underlying space.

These quantitative versions are in the form of explicit rates of so-called metastability in the sense of T. Tao.

Our approach covers examples ranging from the proximal point algorithm for maximal monotone operators to various fixed point iterations (x_n) for firmly nonexpansive, asymptotically nonexpansive, strictly pseudo-contractive and other types of mappings. Many of the results hold in a general metric setting with some convexity structure added (so-called W-hyperbolic spaces). Sometimes uniform convexity is assumed, still covering the important class of CAT(0)-spaces due to Gromov.

Support: DFG project KO 1737/5-2

Contact: U. Kohlenbach, L. Leuştean, A. Nicolae

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[3] V. Vasin and I. Eremin. *Operators and Iterative Processes of Fejér Type. Theory and Applications*. Walter de Gruyter, Berlin-New York, 2009.

Project: Proof Mining in Convex Optimization

(a) Asymptotic regularity and metastability for Yamada's hybrid steepest descent method: Let X be real Hilbert space and consider a mapping $\Theta : X \to \mathbb{R}$. The goal is to minimize

$\min \Theta$ over a closed convex subset $C \subseteq X$.

Let the gradient $\mathscr{F} := \Theta'$ of Θ be κ-Lipschitzian and η-strongly monotone and $C = Fix(T)$ for some nonexpansive $T : X \to X$. Then the above goal is equivalent to solving the following variational inequality problem:

$$\text{VIP: Find } u^* \in C \text{ s.t. } \langle v - u^*, \mathscr{F}(u^*) \rangle \geq 0 \text{ for all } v \in C.$$

In 2001, I. Yamada showed that under suitable conditions on (λ_n) the scheme (with $\mu := \eta/\kappa^2$)

$$(*)\ u_{n+1} := Tu_n - \lambda_{n+1}\mu\mathscr{F}Tu_n$$

converges strongly to a solution of VIP. Putting $\mathscr{G} := I - \mu\mathscr{F}$ the iteration becomes

$$(**)\ u_{n+1} = (1-\lambda_{n+1})Tu_n + \lambda_{n+1}\mathscr{G}Tu_n$$

and $\mathscr{G}$ is a strict contraction with $\tau = 1 - \sqrt{1-\mu(2\eta - \mu\kappa)}$.

In [3], Körnlein extracts an explicit and highly uniform effective rate of metastability for (u_n) as given in $(**)$ where $\mathscr{G}$ is a general τ-contraction $C \to C$ (with $\tau \in (0,1)$) and not necessarily has to be of the form $I - \mu\mathscr{F}$ with μ and $\mathscr{F}$. Also a generalization to finite families of mappings $T_1, \ldots, T_N$ is treated.

(b) Convex feasibility problems:

We obtain quantitative forms of convex feasibility problems in the context of CAT(κ) spaces ($\kappa > 0$) (see [1]). Here the essential insight is that metric projections in CAT(κ)-spaces, while never being nonexpansive unless $\kappa = 0$, are strongly quasi-nonexpansive, which is a class of operators for which quantitative convergence results have been obtained via the logical approach in [1].

In [2], explicit rates of asymptotic regularity and metastability are extracted (in the context of CAT(0)-spaces) using our logical tools for a convex minimization problem studied by Bauschke, Combettes and Reich in Hilbert space and by Banert in CAT(0)-spaces for

$$\Phi(x,y) := f(x) + g(y) + \frac{1}{2\lambda}d(x,y)^2$$

where f, g are two convex and lower semi-continuous functions. In fact, we study this problem in the much more general context of firmly nonexpansive mappings.

Support: DFG project KO 1737/5-2

Contact: D. Körnlein, U. Kohlenbach

References

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[3] D. Körnlein. *Quantitative Analysis of Iterative Algorithms in Fixed Point Theory and Convex Optimization*. PhD thesis, TU Darmstadt, 2016.

Project: Seperating weak forms of the law-of-excluded-middle principle

In this project we show that over a strong (semi-)intuitionistic base theory, the recursive comprehension principle Δ^0_1-CA does not imply the disjunctive Markov principle $MP^\vee$ ([2]).

Together with Makoto Fujiwara, we give a comprehensive analysis of restricted forms of the double-negation-shift principle DNS, which plays an important role in the consistency proof of classical analysis due to C. Spector, and double negated forms of all the other fragments of the LEM-principle considered in the literature ([1]).

Support: DFG project KO 1737/5-2

Contact: U. Kohlenbach

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[2] U. Kohlenbach. On the disjunctive Markov principle. *Studia Logica*, 103:1313–1317, 2015.

Project: Construction and Analysis in Hypergraphs of Controlled Acyclicity

This is a DFG project, approved in 2012, which is based on results and new directions provided by the successful completion (in 2011) of its forerunner "Model Constructions and Model-Theoretic Games in Special Classes of Structures", see in particular [2, 3, 1].
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. For such applications, especially in the realm of finite model theory, the focus must therefore be on

- suitable relaxations of full acyclicity that can be realised in finitary coverings (partial unfoldings), and
- methods that can use these relaxed notions of acyclicity to similar algorithmic and model-theoretic benefit as full acyclicity.

The new project puts the development of constructions and methods at the center, 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, the combinatorics of graphs and hypergraphs, discrete geometry, combinatorial and algebraic methods). Substantial results are being presented in [4].

Support: DFG

Contact: M. Otto

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[1] V. Barany, G. Gottlob, and M. Otto. Querying the guarded fragment. *Logical Methods in Computer Science*, 10(2), 2014. Journal version of LICS'10 paper.

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

[3] M. Otto. Expressive completeness through logically tractable models. *Annals of Pure and Applied Logic*, 164:1418–1453, 2013.

[4] M. Otto. Finite groupoids, finite coverings and symmetries in finite structures. technical report, 52 pages, arXiv:1404.4599, 2016.

Project: Quantitative uniforme Komplexitätstheorie mehrwertiger reeller Funktionen und Operatoren in Analysis

Computable Analysis, initiated by Alan Turing in 1937, provides a rigorous algorithmic foundation to approximate computations over real numbers, vectors, sequences, functions, operators, and Euclidean subsets — qualitatively. We refine this theory quantitatively from the perspective of computational complexity: both non-uniformly relative to common hypotheses like $P \subsetneq NP \subsetneq \#P \subsetneq CH \subsetneq PSPACE \subsetneq EXP$ (cf. Millennium Prize Problems); and uniformly by adapting adversary arguments from Information-Based Complexity to the bit cost model. More precisely, we devise provably correct algorithms with axiomatized semantics over (possibly multivalued and enriched) continuous data types. Our research yields canonical interface declarations in contemporary object-oriented imperative programming languages, accompanied by rigorous parameterized running-time bounds and complemented by optimality proofs. Implementations confirm the predictions of these investigations in practice.

Partner: A. Karamura (University of Tokyo), N. Müller (Universität Trier)

Support: DFG Zi 1009/4

Contact: M. Schröder, T. Streicher

References

[1] A. Kawamura, N. Müller, C. Rösnick, and M. Ziegler. Computational benefit of smoothness: Parameterized bit-complexity of numerical operators on analytic functions and Gevrey's hierarchy. *Journal of Complexity*, 31(5), 2015.

[2] A. Kawamura, F. Steinberg, and M. Ziegler. On the computational complexity of the Dirichlet problem for Poisson's equation. *Mathematical Structures in COmputer Science*, 2016.

[3] M. Schröder and M. Ziegler. Average-case bit-complexity theory of real functions. In *6th International Conference on Mathematical Aspects of Computer and Information Sciences (MACIS)*, Lecture Notes in Computer Science, pages 505–519. Springer, 2016.

Project: COMPUTAL

Located within the EU FB7 *Marie Curie-Actions* (MCA) scheme, the *International Research Staff Exchange Schemes* (IRSES) connect, and foster collaboration between, scientists at selected European and non-European institutes. Specifically COMPUTAL evolves around the foundations of computing on continuous data, covering aspects and perspectives on the interface between Theoretical Computer Science, Logic, and Analysis; including, but not limited to, Domain Theory, Type-2 Theory of Effectivity, and Constructive Topology.

Partner: D. Spreen (Universität Siegen), A. Pauly (University of Cambridge), A. Bauer (University of Ljubljana), V. Brattka (Universität der Bundeswehr München), U. Berger (Swansea University), N. Müller (Universität Trier), H.-P. Künzi (University of Cape Town), H. Ishihara (Japan Advanced Institute of Science and Technology), V. Selivanov (Ershov

Institute of Informatics System), W. Fouché (University of South Africa), K. Weihrauch (FernUniversität in Hagen), H. Tsuiki (Kyoto University)

Support: EU FP7 MCA IRSES

Contact: M. Ziegler

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[1] H. Férée and M. Ziegler. On the computational complexity of positive linear functionals on $C[0;1]$. In *6th International Conference on Mathematical Aspects of Computer and Information Sciences (MACIS)*, Lecture Notes in Computer Science, pages 489–504. Springer, 2016.

[2] V. Gregoriades, T. Kihara, and K. M. Ng. Turing degrees in Polish Spaces and decomposability of Borel Functions. Technical report, 2016.

[3] M. Schröder and V. Selivanov. Some hierarchies of qcb0-spaces. *Mathematical Structures in Computer Science*, 25(8):1799–1823, 2015.

[4] S. Sun, N. Zhong, and M. Ziegler. On computability of Navier-Stokes' Equation. In *11th Conference on Computability in Europe (CiE)*, Lecture Notes in Computer Science, pages 334–342. Springer, 2015.

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 the 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 the modeling and simulation in energy science.

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, or the structure preserving model reduction.

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 Programs SPP 1253 Optimisation with Partial Differential Equations, SPP 1276 Multiple Scales in Fluid Mechanics and Meteorology (MetStröm), and SPP 1420 Biomimetic Materials Research: Functionality by Hierarchical Structuring of Materials, 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, Martin Kiehl, Jens Lang

Retired professors

Peter Spellucci

Postdocs

Pia Domschke, Sofia Eriksson, Alf Gerisch, Michelle Lass, Raimondo Penta, Jan-Frederik Pietschmann, Sebastian Ullmann, Mirjam Walloth

Research Associates

Anke Böttcher, David Frenzel, Thomas Kugler, Axel Ariaan Lukassen, Pascal Mindt, Christopher Müller, Bogdan Radu, Alexander Rath, Moritz Schneider, Lucas Schöbel-Kröhn, Robert Schorr, Dirk Schröder, Tobias Seitz, Christopher Spannring, Zhen Sun, Gabriel Teschner, Sara Tiburtius, Lisa Wagner

Secretaries

Elke Dehnert, Sigrid Hartmann

Project: Numerical approximation of phase field models in elastic bodies

Phase field transformations occur in different natural 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. The model is implemented in Matlab with a finite element formulation. Convergence and asymptotic stability of numerical schemes are investigated.

Contact: A. Böttcher, H. 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.

[2] R. Müller, A. Böttcher, B. Xu, J. Aurich, and D. Gross. Driving forces on interfaces in elastic-plastic two phase materials. *ZAMM. Angew. Math. Mech.*, 90:812–820, 2010.

Project: Mixed finite element methods for the acoustic wave equation

The study of wave propagation is an important topic in the field of engineering and it finds application 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. Successful numerical methods have to take into account various problem specific aspects: discrete problems are typically of large scale and efficient time stepping schemes are required; computational domains have to be truncated and artificial boundaries have to be introduced; a systematic derivative and adjoint calculus are required in order to tackle optimization, control, and inverse problems; the approximation of solutions at high wave number requires very fine grids; special treatment of material interfaces may be needed.

Our goal is to model the APE (acoustic perturbed equation) and to analyze its discrete system in the context of mixed finite element methods. Further, we will then extend the obtained results to the elastodynamics and Maxwell's equations.

Support: Graduate School Computational Engineering, DFG

Contact: H. Egger, B. Radu

References

[1] H. Egger and B. Radu. Super-convergence and post-processing for mixed finite element approximations of the wave equation. *arXiv:1608.03818*, 2016.

Project: Tikhonov stability in Hilbert scales under Hölder stability

We consider the stable solution of nonlinear ill-posed problems by Tikhonov regularization in Hilbert scales. Order-optimal convergence rates are established for a priori and a posteriori parameter choice strategies under a conditional stability assumption for the inverse problem. The role of a hidden source condition is investigated and the relation to previous results for regularization in Hilbert scales is elaborated. The applicability of the results is discussed for some model problems, and the theoretical results are illustrated by numerical tests.

Partner: B. Hofmann (TU Chemnitz)

Contact: H. Egger

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: K. Fellner, T. Q. Tang (TU Graz); J.-F. Pietschmann (WWU Münster)

Contact: H. Egger

References

[1] H. Egger, K. Fellner, J.-F. Pietschmann, and B. Q. Tang. A finite element method for volume-surface reaction-diffusion systems. *arXiv:1511.00846*, 2015.

Project: Boundary treatment and accelerated reconstruction in Fluorescence optical tomography

Flourescence optical tomography is a non-invasive imaging modality that allows one to obtain space- and time-resolved information about biological processes in-vitro and in-vivo. Two of the main challenges in the practical use of this method are: (i) the automatic detection and handling of unknown geometry, and (ii) the computational handling and inversion of huge data sets. The goal of this project is to enhance existing computational methods in order to address these challenges.

Partner: M. Schlottbom (UT Twente)

Contact: H. Egger

References

[1] H. Egger and M. Schlottbom. A class of Galerkin schemes for time-dependent radiative transfer. *SIAM Journal on Numerical Analysis*, 54:3577–3599, 2015.

[2] H. Egger and M. Schlottbom. Numerical methods for parameter identification in stationary radiative transfer. *Computational Optimization and Applications*, 62:67–83, 2015.

Project: Asymptotic preserving schemes 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 analyse new numerical schemes that preserve these properties during the discretization process.

Partner: M. Lukačova (JGU Mainz)

Contact: H. Egger

References

[1] H. Egger. A mixed variational discretization for non-isothermal compressible flow in pipelines. *arXiv:1611.03368*, 2016.

[2] H. Egger. A robust conservative mixed finite element method for compressible flow on pipe networks. *arXiv:1609.04988*, 2016.

[3] H. Egger and T. Kugler. Damped wave systems on networks: Exponential stability and uniform approximations. *arXiv:1605.03066*, 2016.

Project: Spinodal decomposition of polymer-solvent systems

Mathematical models for the dynamics of polymer systems on the mesoscopic scale are based on a bead-spring description of polymer chains and the Navier-Stokes solver for the surrounding solvent. Despite their structural simplicity, a simulation of these models on relevant scales is still computationally infeasible. Theoretical models are better suited for numerical simulations on macroscopic scales but they often yield unrealistic results due to insufficient information about the underlying constitutive equations. This project intends to close the gap between the mesoscopic and the macroscopic world for a particular model system with highly complex non-equilibrium dynamics, namely a phase-separating polymer solution. A particular focus lies on the development of new concepts of multiscale methods and coarse-graining. The main goal of the project is to develop efficient and robust parameter identification strategies that allow us to estimate the required constitutive laws in the macroscopic model via calibration to simulation results for the underlying mesoscale models obtained by a coupled Lattice-Boltzmann–Molecular-Dynamics algorithm.

Partner: B. Dünweg (MPIP Mainz); M. Lukačova (JGU Mainz)

Contact: H. Egger

References

[1] H. Egger, T. Kugler, and N. Strogies. Parameter identification in a semilinear hyperbolic system. *arXiv:1606.03580*, 2016.

[2] H. Egger, J.-F. Pietschmann, and M. Schlottbom. Identification of chemotaxis models with volume-filling. *SIAM J. Appl. Math.*, 75(2):275–288, 2015.

Project: Identification of nonlinear diffusion laws in quasi-linear parabolic and elliptic equations

We consider the inverse problem of identifying a nonlinear diffusion coefficient in second order quasi-linear parabolic and elliptic equations with principal part in divergence form, given knowledge of a partial Dirichlet-to-Neumann map. The proofs are based on a localization procedure at the boundary. Since this is mostly independent of the particular structure of the problem, our approach is able to handle arbitrary unknown lower order terms, as long as they fulfill mild regularity conditions, mixed boundary conditions and even systems of equations.

Partner: M. Schlottbom (UT Twente); J.-F. Pietschmann (WWU Münster)

Contact: H. Egger

References

[1] H. Egger, J.-F. Pietschmann, and M. Schlottbom. Identification of chemotaxis models with volume-filling. *SIAM J. Appl. Math.*, 75(2):275–288, 2015.

[2] H. Egger, J.-F. Pietschmann, and M. Schlottbom. Identification of nonlinear heat conduction laws. *J. Inverse Ill-Posed Probl.*, 23(5):429–437, 2015.

Project: Convergence of some adaptive FVM

We consider the vertex-centered finite volume method with first-order conforming ansatz functions. The adaptive mesh refinement is driven by the local contributions of the weighted-residual error estimator. We prove that the adaptive algorithm leads to linear convergence with generically optimal algebraic rates for the error estimator and the sum of energy error plus data oscillations. While similar results have been derived for finite element and boundary element methods, the present work appears to be the first for adaptive finite volume methods, where the lack of the classical Galerkin orthogonality leads to new challenges.

Partner: D. Praetorius (TU Wien)

Contact: C. Erath

References

[1] C. Erath and D. Praetorius. Convergence of some adaptive finite volume methods. *SIAM J. Numer. Anal.*, 54:2228–2255, 2016.

Project: A non-symmetric coupling of the finite volume method and the boundary element method

As model problem we consider the prototype for flow and transport of a concentration in porous media in an interior domain and couple it with a diffusion process in the corresponding unbounded exterior domain. To solve the problem, we develop a new non-symmetric coupling between the vertex-centered finite volume and boundary element method. This discretization naturally provides conservation of local fluxes and, with an upwind option, also stability in the convection dominated case. We aim to provide a first rigorous analysis of the system for different model parameters, stability, convergence, and a priori estimates. This includes the use of an implicit stabilization, known from the finite element and boundary element method coupling. Some numerical experiments conclude the work and confirm the theoretical results.

Partner: G. Of (TU Graz); F.-J. Sayas (University of Delaware, USA)

Contact: C. Erath

References

[1] C. Erath, G. Of, and F.-J. Sayas. A non symmetric coupling of the finite volume method and the boundary element method. *Numer. Math.*, pages 1–28, published online, 2016.

Project: A nonconforming a posteriori estimator for the coupling of cell-centered finite volume and boundary element methods

The coupling of the cell-centered finite volume and the boundary element method is an interesting approach to solving elliptic problems on an unbounded domain, where local flux conservation is important. Based on the piecewise constant interior finite volume solution, we define a Morley-type interpolant built on a non-conforming finite element. Together with the Cauchy data of the exterior boundary element solution, this allows us to define a residual-based a posteriori error estimator. With respect to an energy norm, we prove reliability and efficiency of this estimator and use its local contributions to steer an adaptive mesh-refining algorithm. In two examples we illustrate the effectiveness of the new adaptive coupling method and compare it with the coupling approach with a conforming Morley interpolant.

Contact: C. Erath

References

[1] C. Erath. A nonconforming a posteriori estimator for the coupling of cell-centered finite volume and boundary element methods. *Numer. Math.*, 131:425–451, 2015.

Project: Semi-Lagrangian schemes for transport in a (climate) dynamical core

In today's atmospheric numerical modeling, scalable and highly accurate numerical schemes are of particular interest. To address these issues, Galerkin schemes, such as the spectral element method, have received more attention in the last decade. They also provide other state-of-the-art capabilities such as improved conservation. However, the tracer transport of hundreds of tracers, e.g., in the chemistry version of the Community Atmosphere Model, is still a performance bottleneck. Therefore, we consider two conservative semi-Lagrangian schemes. Both are designed to be multi-tracer efficient, third order accurate, and allow significantly longer time steps than explicit Eulerian formulations. We address the difficulties arising on the cubed-sphere projection and on parallel computers, and show the high scalability of our approach. Additionally, we use the two schemes for the transport of passive tracers in a dynamical core and compare our results with a current spectral element tracer transport advection used by the High-Order Method Modeling Environment.

Partner: M. A. Taylor (Sandia National Laboratories, USA); R. D. Nair (NCAR, USA)

Contact: C. Erath

References

[1] C. Erath, M. A. Taylor, and R. D. Nair. Two conservative multi-tracer efficient semi-lagrangian schemes for multiple processor systems integrated in a spectral element (climate) dynamical core. *Commun. Appl. and Ind. Math.*, 7:71–95, 2016.

Project: Optimal adaptivity for the SUPG FEM

For convection dominated problems, the streamline upwind Petrov-Galerkin method (SUPG) (also named streamline diffusion finite element method (SDFEM)) promotes a non-oscillatory finite element solution. Based on robust a posteriori error estimators, we propose an adaptive mesh-refining algorithm for SUPG and prove that the generated SUPG solutions converge with asymptotically optimal rates towards the exact solution.

Partner: S. A. Funken (Universität Ulm); D. Praetorius (TU Wien)

Contact: C. Erath

Project: Time-dependent cell-centered FVM-BEM coupling

An interesting approach to deal with problems on unbounded domains is to couple the finite volume method with the boundary element method. Previously, novel work has been done for problems of diffusion convection reaction type in an interior domain coupled to a diffusion process in an unbounded exterior problem [1, 2]. In this project, we extend the cell-centered FVM-BEM coupling methodology [2] to problems of other types involving time, e.g., parabolic-elliptic interface problems.

Contact: C. Erath, S. Eriksson

References

[1] C. Erath. Coupling of the finite volume element method and the boundary element method: an a priori convergence result. *SIAM Journal on Numerical Analysis*, 50:574–594, 2012.

[2] C. Erath. A new conservative numerical scheme for flow problems on unstructured grids and unbounded domains. *J. Comput. Phys.*, 245:476–492, 2013.

Project: Higher order integration methods for the optimal control of hyperbolic equations

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 the adjoint equation and the computation of the optimal control.

Partner: S. Ulbrich (TU Darmstadt)

Support: Graduate School Computational Engineering, DFG

Contact: D. Frenzel, J. 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 homogenisation 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: K. Raum (Charité-Universitätsmedizin Berlin); Q. Grimal (Biomedical Imaging Lab, UPMC Paris, France)

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

Contact: A. Gerisch, R. Penta, S. Tiburtius

References

[1] M. Granke, Q. Grimal, W. J. Parnell, K. Raum, A. Gerisch, F. Peyrin, A. Saïed, and P. Laugier. To what extent can cortical bone millimeter-scale elasticity be predicted by a two-phase composite model with variable porosity? *Acta Biomaterialia*, 12:207–215, 2015.

[2] R. Penta and A. Gerisch. The asymptotic homogenization elasticity tensor properties for composites with material discontinuities. *Continuum Mechanics and Thermodynamics*, 29:187–206, 2016.

[3] R. Penta and A. Gerisch. Investigation of the potential of asymptotic homogenization for elastic composites via a three-dimensional computational study. *Computing and Visualization in Science*, 17:185–201, 2016.

[4] R. Penta, K. Raum, Q. Grimal, S. Schrof, and A. Gerisch. Can a continuous mineral foam explain the stiffening of aged bone tissue? A micromechanical approach to mineral fusion in musculoskeletal tissues. *Bioinspiration & Biomimetics*, 11:035004, 2016.

Project: Numerical methods for time-dependent PDE problems from 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. 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: M. A. J. Chaplain (University of St. Andrews, UK); K. J. Painter (Heriot-Watt University, Edinburgh, UK); D. Trucu (University of Dundee, UK); L. Geris (University of Liège, Belgium)

Contact: A. Gerisch, P. Domschke

References

[1] P. Domschke, D. Trucu, A. Gerisch, and M. Chaplain. Structured models of cell migration incorporating molecular binding processes. arXiv:1607.05353, July 2016.

[2] K. J. Painter, J. M. Bloomfield, J. A. Sherratt, and A. Gerisch. A nonlocal model for contact attraction and repulsion in heterogeneous populations. *Bulletin of Mathematical Biology*, 77:1132–1165, 2015.

[3] D. Trucu, P. Domschke, A. Gerisch, and M. A. Chaplain. Multiscale computational modelling and analysis of cancer invasion. In L. Preziosi, M. A. Chaplain, and A. Pugliese, editors, *Mathematical Models and Methods for Living Systems: Levico Terme, Italy 2014*, pages 275–321. Springer International Publishing, 2016.

Project: Defect corrected averaging for highly oscillatory problems

The accurate solution of partial differential equations with highly oscillatory source terms over long time scales constitutes a challenging problem. There exists a variety of methods dealing with problems that include processes, equations or variables on fine and coarse scales. Multiscale methods have in common that they neither fully resolve the fine scale, nor completely ignore it. On the one hand, these methods strive, without significantly sacrificing accuracy or essential properties of the system, to be much more efficient than methods that fully resolve the fine scale. On the other hand, these methods should be considerably more accurate than methods that completely ignore the fine scale. Within this project, we develop a defect corrected averaging procedure, which is based on a modified coarse scale problem that approximates the solution of the fine scale problem in stroboscopic points. Nevertheless, our approximation process is clearly different from the stroboscopic averaging method. We give an error estimate for the solution of the modified problem. The computational efficiency of the approximation is further improved by the application of preconditioning techniques. Tests on numerical examples show the efficiency and reliability of our approach.

Partner: J. Wensch (TU Dresden)

Contact: A. Gerisch

References

[1] J. Wensch, A. Gerisch, and A. Naumann. Defect corrected averaging for highly oscillatory problems. *Applied Mathematics and Computation*, 261:90–103, 2015.

Project: Hierarchical Galerkin methods for hyperbolic problems with parabolic asymptotic

This project is part of the Transregional Collaborative Research Centre TRR 154 *Mathematical modeling, 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 together with reliable a posteriori error estimators. Of particular interest are the isothermal one-dimensional Euler equations with friction, which are used to model gas flow in pipes and networks. Basic physical principles, like the conservation of mass, the balance of momentum, and the boundedness of solutions should be preserved on the discrete level on single pipes and across junctions.

Support: Project C04 within DFG TRR 154

Contact: H. Egger, T. Kugler, J. Lang

References

[1] H. Egger and T. Kugler. Damped wave systems on networks: Exponential stability and uniform approximations. *arXiv:1605.03066*, 2016.

[2] H. Egger, T. Kugler, and N. Strogies. Parameter identification in a semilinear hyperbolic system. *arXiv:1606.03580*, 2016.

Project: Anisotropic meshes and explicit Runge-Kutta methods

We study the stability of explicit Runge-Kutta integration schemes for the linear finite element approximation of linear parabolic equations. The derived bound on the largest permissible time step is tight for any mesh and any diffusion matrix within a factor of $2(d+1)$, where d is the spatial dimension. Both full mass matrix and mass lumping are considered. The bound reveals that the stability condition is affected by two factors. The first one depends on the number of mesh elements and corresponds to the classic bound for the Laplace operator on a uniform mesh. The other factor reflects the effects of the interplay of the mesh geometry and the diffusion matrix.

Partner: W. Huang (University of Kansas, USA); L. Kamenski (WIAS Berlin)

Contact: J. Lang

References

[1] W. Huang, L. Kamenski, and J. Lang. Stability of explicit one-step methods for P1-finite element approximation of linear diffusion equations on anisotropic meshes. *SIAM J. Numer. Anal.*, 54:1612–1634, 2016.

Project: On asymptotic global error estimation and control of finite difference solutions for semilinear parabolic equations

In this project, we extend the global error estimation and control addressed in Lang and Verwer [SIAM J. Sci. Comput. 29, 2007] for initial value problems to finite difference solutions of semilinear parabolic partial differential equations. The approach presented there is combined with an estimation of the PDE spatial truncation error by Richardson extrapolation to estimate the overall error in the computed solution. Approximations of the error transport equations for spatial and temporal global errors are derived using asymptotic estimates that neglect higher order error terms for sufficiently small step sizes in space and time. Asymptotic control in a discrete L^2-norm is achieved through tolerance proportionality and uniform or adaptive mesh refinement.

Partner: K. Debrabant (Southern University of Denmark)

Contact: J. Lang

References

[1] K. Debrabant and J. Lang. On asymptotic global error estimation and control of finite difference solutions for semilinear parabolic equations. *Computer Methods in Applied Mechanics and Engineering*, 288:110–126, 2015.

Project: Robustness of a new molecular dynamics-finite element coupling approach for soft matter systems analyzed by uncertainty quantification

Key parameters of a recently developed coarse-grained molecular dynamics-finite element coupling approach have been analyzed in the framework of uncertainty quantification (UQ). We have employed a polystyrene sample for the case study. The new hybrid approach contains several parameters that cannot be determined on the basis of simple physical arguments. Among others, this includes the so-called anchor points as information transmitters between the particle-based molecular dynamics (MD) domain and the surrounding finite element continuum, the force constant between polymer beads and anchor points, the number of anchor points, and the relative sizes of the MD core domain and the surrounding dissipative particle dynamics domain. Polymer properties such as density, radius of gyration, end-to-end distance, and radial distribution functions are calculated as a function of the above model parameters. The influence of these input parameters on the resulting polymer properties is studied by UQ. Our analysis shows that the hybrid method is highly robust. The variation of polymer properties of interest as a function of the input parameters is weak.

Partner: Shengyuan Liu, Mohammed Rahimi, Michael C. Böhm, Florian Müller-Plathe (Theoretical Chemistry, TU Darmstadt)

Contact: J. Lang, A. Gerisch

References

[1] S. Liu, A. Gerisch, M. Rahimi, J. Lang, M. C. Böhm, and F. Müller-Plathe. Robustness of a new molecular dynamics-finite element coupling approach for soft matter systems analyzed by uncertainty quantification. *The Journal of Chemical Physics*, 142:104105, 2015.

Project: Adjoint-based error control for the simulation and optimization of gas and water supply networks

In this work, the simulation and optimization of transport processes through gas and water supply networks is considered. Those networks mainly consist of pipes as well as other components like valves, tanks and compressor/pumping stations. These components are modeled via algebraic equations or ODEs while the flow of gas/water through pipelines is described by a hierarchy of models starting from a hyperbolic system of PDEs down to algebraic equations. We present a consistent modeling of the network and derive adjoint equations for the whole system including initial, coupling and boundary conditions. These equations are suitable to compute gradients for optimization tasks but can also be used to estimate the accuracy of models and the discretization with respect to a given cost functional. With these error estimators we present an algorithm that automatically steers the discretization and the models used to maintain a given accuracy. We show numerical experiments for the simulation algorithm as well as the applicability in an optimization framework.

Partner: Oliver Kolb (Universität Mannheim)

Contact: J. Lang, P. Domschke

References

[1] P. Domschke, O. Kolb, and J. Lang. Adjoint-based error control for the simulation and optimization of gas and water supply networks. *Applied Mathematics and Computation*, 259:1003–1018, 2015.

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: J. Lang, A. 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, 2016.

Project: PDAS strategy for the KS system of chemotaxis

This project focuses on a numerical scheme applied to the Keller-Segel (KS) system of chemotaxis. The KS chemotaxis system describes the space and time evolution of a population of cells governed by the effects of diffusion and a directed motion in response to chemical gradients. The model problem is composed of a set of coupled nonlinear parabolic partial differential equations, which can be reformulated as a parabolic obstacle problem provided that the conservation of positivity is satisfied. The discrete problem resulting from the finite element discretization is solved by using the primal dual active set (PDAS) strategy. The performance and efficiency of the algorithm are studied and interpreted as a semismooth Newton method.

Contact: H. Egger, M. Lass

Project: A numerical approach to obstacle problems with convection diffusion operators

Numerical solutions of obstacle problems with convection diffusion operators are considered. Different multigrid strategies are applied to the algebraic problems arising from the finite element or finite difference approximations of the given problem. The goal is to obtain optimal computational complexity similar to the multigrid convergence property of PDE-based problems. Experimental results are presented to show the numerical performance and efficiency of the proposed method.

Partner: A. Borzì (Universität Würzburg); E.-J. Park (Yonsei University, South Korea)

Contact: M. Lass

Project: Multigrid methods for the optimal control of elliptic variational inequalities

This research project aims to contribute to the development and advancement of finding faster and more efficient numerical techniques for optimal control problems governed by elliptic variational inequalities (VIs). The prototypical problem is the optimal control of a VI of obstacle type. Different nonlinear multigrid techniques are evaluated and utilized to directly solve an appropriate optimality system of the optimal control problem without regularization. The numerical performance and efficiency of the proposed multigrid algorithms are studied and interpreted in comparison with other existing numerical methods, which typically employ an additional regularization loop for solving this type of problems. The motivation for such extensions is to be able to provide optimality solutions with optimal computational complexity and robustness with respect to optimization parameters. The main challenge here is to show the textbook multigrid convergence behaviour similar to the PDE-based problems in order to obtain optimal computational complexity.

Partner: R. Herzog (TU Chemnitz)

Support: Alexander von Humboldt-Stiftung (Georg Forster-Forschungsstipendium)

Contact: M. Lass

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. However, the state of the system can differ in time and space, and 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 that dynamically switches in space and time between the description of the chemical reactions via the kinetic model and the partial thermodynamic equilibrium.

Contact: A. Lukassen, M. Kiehl

Project: Adaptive dynamical multiscale methods

The flow of gas through pipelines is of great interest in the engineering community. There are many challenges to running a gas transmission network. Various contracts have to be fulfilled, e.g., gas fed in by multiple suppliers has to be routed through the network while consumers' demands have to be met. The aim of operating a gas transmission network is to minimize the running costs. Those costs are mainly the running costs of compressor stations and contractual penalties. This leads to an optimal control problem on a network. Similar optimal control problems also occur for example in water supply networks. While monitoring systems are already quite advanced, efficient simulation and optimization tools are only available to some extent. Of course, before considering optimization tasks, reliable simulation algorithms are essential. Since the application of coarse discretizations or simplified models is often adequate in many parts of the considered networks to resolve the dynamics in the daily operation of gas and water supply networks, information about the quality of the computed solutions is very important. Within this project, we develop an algorithm to adaptively control model and discretization errors in simulations for gas and water supply networks with respect to a given quantity of interest using adjoint techniques.

Partner: O. Kolb (Universität Mannheim)

Support: Project B01 within DFG TRR 154

Contact: P. Mindt, P. Domschke, J. Lang

Project: Stochastic Galerkin methods for incompressible flows

Input data for mathematical models are most of the time not known exactly due to measurement errors or a lack of knowledge in general. The stochastic Galerkin method is one particular approach from the field of Uncertainty Quantification, where this influence on the solution of a partial differential equation is investigated. For a class of established representations of the stochastic input, the methodology exhibits exponential convergence rates but at the same time suffers from the curse of dimensionality. In order to solve the associated large coupled systems of equations efficiently, sophisticated iterative methods and preconditioners are required. The goal of this project is to apply and extend existing methods specifically tailored to flow problems with random data.

Support: Graduate School Computational Engineering, DFG

Contact: C. Müller, S. Ullmann, J. Lang

Project: IMEX-Peer methods with optimized stability regions

The spatial discretization of certain time-dependent partial differential equations (e.g. advection-diffusion-reaction systems) yields large systems of ordinary differential equations in time. Their right-hand sides admit a splitting into a stiff and non-stiff part or, to be more precise, a part that has to be solved using an implicit time integrator and a part to which we can apply an explicit method. However, in order to guarantee consistency for both parts, the implicit and explicit integrators must fit together. A natural way to construct such methods is to start with an appropriate implicit scheme and extrapolate it in a suitable manner. Promising candidates are singly-implicit Peer methods. In Peer methods, all internal stages in a time step have the same order. The choice of the implicit method as well as the extrapolation provide us with some degrees of freedom that we use to optimize the full implicit-explicit (IMEX) Peer scheme with respect to its stability region and convergence properties. Another advantage of Peer methods is that we can adapt the step-size during the solution process. The goal in further research is to construct IMEX-Peer methods with large stability regions that include an adaptive step-size control.

Partner: W. Hundsdorfer (CWI Amsterdam, The Netherlands)

Contact: M. Schneider, J. Lang

References

[1] J. Lang and W. Hundsdorfer. Extrapolation-based implicit-explicit peer methods with optimised stability regions. *arXiv:1610.00518*, 2016.

Project: Finite element methods for chemotaxis models on networks

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 classical Keller-Segel model on a network. A further goal of this project is the determination of appropriate finite element methods for the classical model as well as for some modifications, including hyperbolic models.

Contact: H. Egger, L. Schöbel-Kröhn

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, that 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 problem the coupling of a method for the interior problem and the boundary element method (BEM) is of particular interest. In this project we want to consider finite element based or vertex-centered finite volume based methods to approximate the interior problem. Because of the possible convection domination in the interior, we have to use stabilized versions: for FEM we apply the streamline upwind Petrov Galerkin (SUPG) method, and for FVM a classical upwind strategy. 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.

Contact: R. Schorr, C. Erath

Support: Graduate School Computational Engineering, DFG

Project: A posteriori error estimates for non-symmetric coupling of finite volume and boundary element method

In this project we considered an interface problem often arising in transport problems: a coupled system of partial differential equations with one (elliptic) transport equation on a bounded domain and one equation (in this case the Laplace problem) on the complement, an unbounded domain. Based on the non-symmetric coupling of the finite volume method and boundary element method we introduced a semi-robust residual error estimator and investigated reliability and efficiency. The upper bound turned out to be robust against variation of the model data, the lower bound, however, additionally depends on the Péclet number and is therefore only semi-robust. Still, the results can be used to steer an adaptive refinement algorithm to (heuristically) improve the rate of convergence.

Contact: C. Erath, R. Schorr

Support: Graduate School Computational Engineering, DFG

References

[1] C. Erath and R. Schorr. An adaptive non-symmetric finite volume and boundary element coupling method for a fluid mechanics interface problem. *In press, SIAM J. Sci. Comput.*, 2016.

Project: Inverse problems for incompressible flow

Flow measurements provide an important source of information for the development, calibration, and discrimination of models for fluid flow. While traditional experimental techniques were able to provide only partial information about the flow field, novel measurement modalities such as particle tracking, tomographic particle imaging, or magnetic resonance velocimetry deliver spatially resolved three-dimensional velocity measurements. Like in many other measurement techniques, the measured flow fields are perturbed by a rather large amount of measurement noise which inhibits a use of the results for further investigations. In this project, we utilize specific flow models and methods from inverse problems and optimal control to reconstruct a physically consistent improved flow field that allows for further post-processing [1]. An important point, especially for in vivo applications, is the geometry determination of the actual flow regime. By using suitable a priori information we aim to use the MRV data directly to reconstruct a smooth representation of the flow geometry. To achieve this goal we combine ideas from variational image segmentation/registration, moving mesh techniques and linear elasticity.

Partner: C. Tropea (TU Darmstadt)

Support: DFG IRTG 1529 and Graduate School Computational Engineering, DFG

Contact: T. Seitz, H. Egger

References

[1] H. Egger, T. Seitz, and C. Tropea. Enhancement of flow measurements using fluid-dynamic constraints. *arXiv:1512.08620*, 2015.

Project: Reduced basis method for partial differential equations with random input data

The incorporation of stochastic quantities in numerics increases the complexity in theory and computation. Stochastic methods like stochastic collocation or Monte Carlo require many computationally expensive solutions of the underlying partial differential equation. The reduced basis method approximates the solution on a low-dimensional subspace in order to speed up the calculation and therefore makes stochastic methods feasible. The core of the project is the a posteriori error estimation of the reduced model influenced by random data for time dependent problems.

Support: Graduate School Computational Engineering, DFG

Contact: C. Spannring, S. Ullmann, J. Lang

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

Recently, renewable energy sources 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 sources are far from satisfactory. Hence, in a long-term future, the majority of energy will still be obtained by conventional processes through the use of 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 constitute a major portion of the pollutants and result in acid rain and 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: Z. Sun, J. Lang

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) as is its relative contribution along the wall. Unfortunately, the resolution of magnetic resonance imaging (MRI) is too coarse to determine the behavior of the flow in boundary layers. The aim of this project is to use both the MRI measurements and a fluid dynamical model to provide accurate values of the WSS. From a mathematical point of view there arise a couple of problems like computing an appropriate guess on the geometry of the vessels, 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 (Universitätsklinikum Freiburg) will provide the MRI data, the SLA Institut (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: A. Bauer, C. Tropea (TU Darmstadt); A. Krafft, W. Buchenberg, J. Hennig (Universitätsklinikum Freiburg)

Support: DFG

Contact: G. Teschner, T. Seitz, H. Egger

References

[1] H. Egger, T. Seitz, and C. Tropea. Enhancement of flow measurements using fluid-dynamic constraints. arXiv:1512.08620, 2015.

Project: POD-Galerkin reduced order modeling with space-adapted snapshots for uncertainty quantification

We investigate reduced order modeling as a means to accelerate statistical estimation for problems governed by PDEs with random data. A set of representative snapshots of the

PDE solution are required to build a POD-Galerkin reduced order model. Implementation and analysis usually rely on the property that all snapshots are elements of one and the same discretized space. Regarding accuracy and efficiency, however, it is attractive to compute the snapshots with space-adaptive numerical methods. In this case, each snapshot may belong to a different discretized space, so that conventional methods cannot be applied. This project investigates theoretical and practical consequence that arise from the fact that the snapshot computations are generalized from a fixed discretization space to adapted discretization spaces.

Support: Graduate School Computational Engineering, DFG

Contact: S. Ullmann, J. Lang

References

[1] S. Ullmann, M. Rotkvic, and J. Lang. POD-Galerkin reduced-order modeling with adaptive finite element snapshots. *Journal of Computational Physics*, 325:244–258, 2016.

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-Westfälischen Wasserwerkgesellschaft (RWW). A management system allows one to compute optimal operation plans for the constructions of the water production, the water prepara- tion 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 that provide accuracy with higher order in time, are able to handle stiff source terms, and are compatible with adjoint based optimization.

Partner: A. Martin (FAU Erlangen-Nürnberg); G. Leugering (FAU Erlangen-Nürnberg); G. Steinebach (Hochschule Bonn-Rhein-Sieg); O. Kolb (Universität Mannheim); M. Plath (RWW Rheinisch-Westfälische Wasserwerkgesellschaft mbH); O. Kremsier (GreyLogix Aqua); A. Pirsing (Siemens AG, Siemens Industry Automation); R. Rosen (Siemens AG, Siemens Corporate Technology)

Contact: L. Wagner, J. Lang

References

[1] L. Wagner, J. Lang, and O. Kolb. Second order implicit schemes for scalar conservation laws. In *Lecture Notes in Computational Science and Engineering*, volume 112, pages 33–41, 2016.

Project: Adaptive finite element discretization methods for the numerical simulation of static and dynamic contact problems

Due to the non-smooth and nonlinear character of contact problems, the adaptive numerical simulation based on a posteriori estimators is, on the one hand, in great demand but on the other hand, it is a very challenging task.

One of the most common a posteriori error estimators is the standard residual estimator which is directly derived from the equivalence of the norm of the error and the dual norm of the residual. For contact problems this relation is disturbed due to nonlinearity. Thus, additional effort is required to derive an a posteriori error estimator for contact problems.

This project deals with the construction and the analysis of efficient and reliable residual-type a posteriori error estimators for the numerical simulation of contact problems. We consider static and dynamic contact problems and a discretization by means of continous finite elements.

Partner: A. Veeser (UNIMI, Italy); R. Krause (USI, Italy)

Contact: M. Walloth

References

[1] R. Krause, A. Veeser, and M. Walloth. An efficient and reliable residual-type a posteriori error estimator for the Signorini problem. *Numerische Mathematik*, 130:151–197, 2015.

[2] M. Walloth and R. Krause. Adaptive numerical simulation of dynamic contact problems. In A. Abdulle, S. Deparis, D. Kressner, F. Nobile, and M. Picasso, editors, *Numerical Mathematics and Advanced Applications 2013*, pages 273–282, Berlin, Heidelberg, 2015. Springer.

Project: Residual-type estimators for a discontinuous Galerkin method for the Signorini problem

This project deals with the construction and the analysis of residual-type a posteriori error estimators for the discontinuous finite element solution of contact problems. In order to obtain an efficient, reliable and localized estimator, the local properties of the discontinuous solution are exploited appropriately. To illustrate the performance of the estimator, the theoretical results are accompanied by numerical studies.

Contact: M. Walloth

References

[1] R. Krause, A. Veeser, and M. Walloth. An efficient and reliable residual-type a posteriori error estimator for the signorini problem. *Numerische Mathematik*, 130:151–197, 2015.

[2] M. Walloth. A reliable, efficient and localized error estimator for a discontinuous galerkin method for the Signorini problem. *Preprint 2713, Fachbereich Mathematik, TU Darmstadt*, 2016.

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.

The group has experience, 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, that 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 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) 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*. In addition, the group has various industry partners, including cooperations with Open Grid Europe and Schenck.

Members of the research group

Professors

Yann Disser, Marc Pfetsch, Alexandra Schwartz, Stefan Ulbrich, Winnifried Wollner

Postdocs

Imke Joormann, Oliver Lass, Masoumeh Mohammadi, Andreas Paffenholz, Andreas Tillmann

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Johanna Biehl, Stefanie Bott, Daniela Bratzke, Max Bucher, Elisabeth Diehl, Thorsten Ederer, Sarah Essert, Michael Fischer, Tobias Fischer, Tristan Gally, Jane Ghiglieri, Thea Göllner, Oliver Habeck, Christopher Hojny, Alexander Hopp, Benjamin Horn, Kristina Janzen, Philipp Kolvenbach, Anja Kuttich, Madeline Lips, Francesco Ludovici, Hendrik Lüthen, Hannes Meinlschmidt, Daniel Nowak, Sebastian Pfaff, Anne Philipp, Anne-Therese Rauls, Johann Michael Schmitt, Carsten Schäfer, Paloma Schäfer Aguilar, Cedric Sehrt, Anna Walter

Secretaries

Kirsten Hessenmüller, Monika Kammer, Ursula Röder

Project: Numerical approximation of optimal control problems for hyperbolic conservation laws

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). Switching between different modes may result in additional discontinuities in the solution, which is, however, quite natural in the context of entropy solutions. The goal of the project is a detailed analysis of the resulting optimal controls, an investigation of the differentiability properties of the objective function and a numerical discretization of optimal control problems for switched networks of conservation laws.

Contact: P. Schäfer Aguilar, S. Ulbrich.

References

[1] S. Pfaff. *Optimal control of hyperbolic conservation laws on bounded domains with switching controls*. PhD thesis, 2015.

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

[3] S. Pfaff and S. Ulbrich. Optimal control of scalar conservation laws by on/off-switching. *Optimization Methods and Software*, 2016. To appear.

[4] S. Ulbrich. *Optimal control of nonlinear hyperbolic conservation laws with source terms*. Habilitation, TU München, 2001.

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 discretization of the fluid flow modeled with the 2D Navier-Stokes equations for incompressible fluids and a hyperelastic material.
The model reduction is done by using 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: 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 [1]. 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. The goal of this project is to use the strong link between the aforementioned reformulation of cardinality constrained optimization problems and MPCCs to transfer existing knowledge. Such results include optimality conditions [2] or relaxation techniques [3].

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] 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.

[2] H. Scheel and S. Scholtes. Mathematical programs with complementarity constraints: Stationarity, optimality, and sensitivitys. *Mathematics of Operations Research*, 25(1):1–22, 2000.

[3] S. Scholtes. Convergence properties of a regularization scheme for mathematical programs with complementarity constraints. *SIAM Journal on Optimization*, 11(4):918–936, 2001.

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, S. Ulbrich.

Project: LogiScale - BigData in Logistics: Multi-scale and Combinatorial Optimization Methods

LogiScale is a joint research project with 4flow AG. The project is targeted at developing a multi-scale representation of logistics networks that allows to express data related to costs, time and location in various scales. The idea is to aggregate detailed structural insights and planning solutions on small scales, to couple these with larger scales, and to make this data available on demand for optimization algorithms. A multi-scale representation allows to simultaneously manage data of different granularities without loss of information. In conjunction with this, the aim of the project is to develop methods to allow algorithms to dynamically use data on different scales for optimization. Specifically, the goal is to provide procedures that allow to operate on complex logistics networks, to efficiently optimize both strategic and operative planning phases independently of network size, and to realistically model logistical processes and reduce their planning and operating costs. To this end, a new paradigm will be developed for the internal data flow of logistical optimization algorithms.

Partner: 4flow AG, Max Klimm (HU Berlin), Torsten Mütze (TU Berlin), Martin Skutella (TU Berlin)

Support: European Regional Development Fund (ERDF)

Contact: Y. Disser.

Project: Competitive Exploration of Large Networks

The goal of this project is to deepen the understanding of algorithms that operate on very large networks and the dynamics that arise from the competition or cooperation between such algorithms. To achieve this goal, we want to combine models and techniques from the areas of graph exploration and algorithmic game theory. To date, the literature in these areas is mostly disjoint. By closing this gap, we hope to develop new insights into the important algorithmic and economic challenges faced in large networks, most prominently in those that are part of the internet.

Partner: Jan Hackfeld (TU Berlin), Max Klimm (HU Berlin), DFG Priority Programme (SPP) 1736: "Algorithms for Big Data"; speaker Prof. Dr.-Ing. Ulrich Meyer (Institute for Computer Science, Universität Frankfurt)

Support: DFG

Contact: Y. Disser.

References

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Project: Optimization of Process Chains under Uncertainty (Subproject B1 of Collaborative Research Centre (SFB) 805)

The aim of this subproject is to control uncertainty in process chains using mathematical models and optimization procedures in order to maximize the value of process chains. Uncertainty in the production of components emerges from random variations in the raw material, from unpredictable process behavior or because the customer's use can only be vaguely predicted. The optimization procedures are based on quantified (mixed-integer) linear programs.

Our considerations originate from production processes, e.g., between supplier and customer, which are divided into several stages and form a process chain. A typical optimization problem consists in the choice of a process chain which is as cheap as possible. In the production of components, however, uncertainties in the process chains emerge from more or less random influences. Our aim is to control such uncertainties with the help of mathematical optimization procedures and to minimize their consequences.

The relevant characteristics of uncertainty are stochastic uncertainty and interval uncertainty. In mathematical modeling, the former leads to distribution of prospective uncertain events (scenarios). In the latter case, only uncertainty intervals are known. Therefore, we use extensions of linear programs – especially quantified linear programs – as a mathematical tool, modeling optimization problems under uncertainty. We can generate deterministic equivalent programs (DEP) from them, which are high-dimensional mixed-integer linear programs with a regular block-structured constraint matrix, such that the blocks represent possible scenarios that are coupled by decision variables. Under some circumstances, we can derive bounds for the objective function values from the quantified programs without generating the DEP. If needed, the scenarios can be filtered with specialized reduction methods, to make the mixed-integer program feasible from an algorithmic perspective.

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. Ederer, U. Lorenz, M. E. Pfetsch

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: Analysis and numerical approximation of shape optimization problems governed by the Navier-Stokes and the Boussinesq equations

This project is part of the International Research Training Group (IRTG) 1529: "Mathematical Fluid Dynamics". The project deals with shape optimization problems associated with the Navier-Stokes and the Boussinesq equations on a infinite and discretized level. More precisely, the instationary incompressible Boussinesq equations with Robin boundary conditions for the temperature are considered for shape optimization via the method of mapping by Murat and Simon. This extends our results concerning the shape optimization theory for the instationary incompressible Navier-Stokes equations, cf. [1]. Furthermore, shape differentiability properties of the instationary Navier-Stokes equations are investigated on a discrete level by using a P1/P1 Lagrange Galerkin discretization by Notsu and Tabata. This is done in cooperation with the numerics group of Prof. Notsu at Waseda University during a six month exchange program. Besides the theoretical investigations a Taylor-Hood based discretization of the Boussinesq equations is implemented in order to validate the theoretical results on a discrete level.

Partner: International Research Training Group (IRTG) 1529: "Mathematical Fluid Dynamics"; speakers Prof. Dr. Matthias Hieber (TU Darmstadt) and Prof. Dr. Yoshihiro Shibata (Waseda University, Tokyo)

Support: DFG

Contact: M. Fischer, S. Ulbrich.

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Project: Exploiting Structure in Compressed Sensing Using Side Constraints (EXPRESS)

In the EXPRESS project we study the compressed sensing (CS) problem in the presence of side information and additional constraints. Side information as well as constraints are due to a specific structure encountered in the system model and may originate from the structure of the measurement system or the sensing matrix (shift-invariance, subarray structure, etc.), the structure of the signal waveforms (integrality, box constraints, constellation constraints such as non-circularity, constant modulus, finite constellation size, etc.), the sparsity structure of the signal (block or group sparsity, rank sparsity, etc.) or the channel, as well as the structure of the measurements (quantization effects, K-bit measures, magnitude-only measurements, etc.). We investigate in which sense structural information can be incorporated into the CS problem and how it affects existing algorithms and theoretical results. Based on this analysis, we develop new algorithms and theoretical results particularly suited for these models. It is expected, on the one hand, that exploiting structure in the measurement system, i.e., the sensing matrix, can lead to fast CS algorithms with novel model identifiability conditions and perfect reconstruction/recovery results. In this sense, exploiting structure in the observed signal waveforms and the sparsity structure of the signal representation can lead to reduced complexity CS algorithms with simplified recovery conditions and provably enhanced convergence properties. On the other hand, we expect that quantized measurements, which are of great importance when considering cost efficient hardware and distributed measurement systems, will generally result in a loss of information for which new algorithms and perfect recovery conditions need to be derived.

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: T. Fischer, M. E. Pfetsch, A. Tillmann.

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Project: Global Methods for Stationary 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". In this subproject, adaptive methods for the global solution of nonlinear mixed-integer optimization problems with ODEs are developed. This will be performed on the example of stationary gastransport. One goal is the global decision about optimality and feasibility of such optimization problems. The global solution of large instances is computationally hard and requires the development of new and clever combination with existing mathematical methods. One motivation for the considered optimization problems is the long-term planning of the operation of gastransport networks, i.e., the question whether a given gas amount can be transported from given entries to exits. In this context we first deal with stationary gas flows. The basic model is formed by the Euler equations, which are treated with adaptive techniques. In addition, flow conservation conditions at junctions and nonlinear descriptions of compressor stations as well as integer decisions, e.g., at valves, arise. This yields a mixed-integer feasibility problem for a coupled system of differential and algebraic equations. For the solution of such problems, a simplification or approximation of the system via a coarse discretization and/or model reduction has to be performed, which is then iteratively refined. Here, a priori error bounds will be applied. Integral decisions and non-convexities are handled via variable and spatial branching, respectively. Of particular interest are the adequate combination of branching methods with adaptive techniques for the discretization.

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

Support: DFG

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

Project: Polyhedral Symmetry Handling Techniques

Symmetries in (mixed) binary programs may have a negative impact on the performance of brach-and-bound solvers, since symmetric solutions reappear multiple times during the solving process.

The aim of this project is to 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 by considering further constraints. The goal is to combine symmetry information with the additional properties to derive strong cutting planes for applications.

Partner: Thomas Rehn (Universität Rostock)

Contact: C. Hojny, M. E. Pfetsch.

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Project: Mightiness of Optimization Algorithms

Mightiness of optimization algorithms is a new perspective on algorithmic complexity. Instead of classifying problems by how hard it is to solve them, algorithms are classified by the problems they are able to solve. This work was initiated by Disser and Skutella in [1], where they proved that several algorithms are NP-mighty, that is, they can solve every problem in the complexity class NP. This set of algorithms includes the original variant of the Simplex algorithm, the successive shortest path algorithm and many more. Since then, a lot of algorithms have been proven to be NP-mighty or even PSPACE-mighty, i.e., they can solve every problem in the complexity class PSPACE [2].

There are two main goals of this project. The first goal is to further investigate PSPACE-mightiness of several optimization algorithms. The second and long-term goal is to justify the running times of algorithms that solve problems in the complexity class P of polynomially solvable problems but do not achieve the best possible running time. We plan to investigate the mightiness of such algorithms, conditioned on conjectures as the "Strong Exponential Time Hypothesis" for 3SAT, the "3SUM conjecture" and others. Approaching conditional lower bounds from an algorithm-centered perspective may expose new connections between different conjectures that would contribute to the unification of the conditional sub-classes of P.

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. Hopp, Y. Disser.

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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 non-linear 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: 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 hydroforming. 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: D. Bratzke, A. Walter, S. Ulbrich

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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, S. Ulbrich.

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Project: Mathematical methods and models for the optimal combination of active and passive components in trusses (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 (SFB) 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 second funding period lays in the generalization to dynamic loads and the integration of different hinges as well as different kinds of active elements. 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.

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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

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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 is 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 is 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 are applied. To solve the decomposition problem more efficiently, the information of the defined polyhedron will be used in the integer program solvers.

For the optimization of mechanical connectors, multibody models including contact constraints are 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 are 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 are used. The arising nonconvex geometry optimization problem is 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: T. Göllner, B. M. Horn, H. Lüthen, M. E. Pfetsch, S. Ulbrich.

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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.

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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 an equilibrium problem with equilibrium constraints (EPEC). Applications of this project are for example computation offloading in mobile networks or cognitive radio.
In particular we are investigating Quasi-Nash-Equilibria (QNE), which were introduced in [1]. QNEs are solutions of the concatenated Karush-Kuhn-Tucker conditions for each player written as a constrained variational inequality (VI), where the convex constraints (in [1] linear) 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.

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.

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Project: `polymake`

The mathematical software system `polymake` provides a wide range of functions for convex polytopes, simplicial complexes, and other objects.

While the system exists for more than a decade it was continuously developed and expanded. The most recent version fundamentally changes the way to interact with the system. It now offers an interface which looks 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. There are interfaces to programs written in C, C++, Java, and Perl.

`polymake` is an open source software project. The current version 3.0 can be downloaded freely from `www.polymake.org`.

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

Contact: A. Paffenholz

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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.

Project: Adaptive Multilevel Methods for the Optimal Control of Hyperbolic Equations in Gas Networks (Subproject A02 of Transregio/SFB 154)

This project is part of the Transregio/SFB 154: "Mathematical Modelling, Simulation and Optimization on the Example of Gas Networks". We 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 will derive optimality conditions for the state constrained problem (P) with switching controls. As a basis for numerical optimization methods, we will approximate the state constraints by Moreau-Yosida regularizations and we will study the convergence of the solution of the regularized problem to the solution of the state constrained problem. 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, FAU Erlangen-Nürnberg)

Support: DFG

Contact: J. M. Schmitt, S. Ulbrich.

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Project: Portfolio Optimization with robust risk measures

While in the most common (Markovitz) portfolio optimization problem the variance is used as a measure for the risk of a certain portfolio choice, there exist several other risk measures such as value-at-risk, conditional value-at-risk and their robust counterparts, which have advantageous properties. Under suitable assumptions on the corresponding random variable, these risk measures lead to objective functions consisting of the weighted sum of the expected value and the standard deviation of the return of the considered portfolio choice. Without these assumptions one ends up with a nonsmooth objective function. The aim of this project is to consider portfolio optimization problems with these risk measures and cardinality constraints and to develop suitable solution algorithms.

Partner: Martin Branda (Czech Academy of Sciences and Charles University, Prague); Michal Červinka (Czech Academy of Sciences and Charles University, Prague)

Contact: A. Schwartz, M. Bucher

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[1] M. Branda, M. Cervinka, and A. Schwartz. Sparse robust portfolio optimization via NLP regularizations. Research Report, 2017.

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 (MLFG) in function space accompanied by the theoretical analysis of these problems. While in a classical Nash equilibrium problem we have several players that simultaneously make a decision, in an 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, e.g., in telecommunications, traffic networks and electricity markets. It can be seen as an extension of the single-leader-multi-follower (Stackelberg) game or mathematical program with equilibrium constraints. We start with the theoretical investigation (existence, uniqueness and suitable approximations of Nash equilibria) of finite-dimensional (i.e. static) MLFGs. Next, we develop new numerical methods for the static MLFGs. These outcomes are not only of interest by themselves, but serve us as starting point for the theory as well as the design of numerical solution methods for the dynamic (time-dependent) MLFG. Additionally applications are considered to build a test library for our algorithms.

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

Support: DFG

Contact: A. Schwartz

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: 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 (École Polytechnique), 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] I. Neitzel, T. Wick, and W. Wollner. An optimal control problem governed by a regularized phase-field fracture propagation model. Preprint 2015-18, Hamburger Beiträge zur Angewandten Mathematik, 2015.

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, FAU 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 shocks. Preprint 2016-21, Hamburger Beiträge zur angewandten Mathematik, 2016.

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 come 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 the 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, I. Neitzel, and W. Wollner. A priori error estimates for nonstationary optimal control problems with gradient state constraints. In *PAMM*, volume 15, pages 611–612. WILEY-VCH Verlag, 2015.

[2] F. Ludovici, I. Neitzel, and W. Wollner. A priori error estimates for state constrained semilinear parabolic optimal control problems. Preprint, TU Darmstadt, 2016.

[3] F. Ludovici and W. Wollner. A priori error estimates for a finite element discretization of parabolic optimization problems with pointwise constraints in time on mean values of the gradient of the state. *SIAM J. Control Optim.*, 53(2):745–770, 2015.

1.8 Stochastics

Research in the stochastics group is split into a probability theory part (Aurzada, Betz, Meiners) 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, the analysis of steady-state properties of Markov chains, fixed-point equations for distributions, and percolation.

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, Matthias Meiners, Cornelia Wichelhaus

Postdocs

Christian Mönch, Lorenzo Taggi

PhD Students

Benedikt Bauer, Micha Buck, Johannes Ehlert, Matthias Hansmann, Marvin Kettner, Lisa Kristl, Jan-Erik Lübbers, Florian Müller, Helge Schäfer, Sebastian Schwinn, Reinhard Tent, Stefan Walter

Secretaries

Alexandra Frohn, Ute Hasenzahl

Project: Persistence probabilities

Persistence concerns the question that a stochastic process has a long negative excursion. The first goal is to understand the probability of such a long excursion, which for many naturally scaled processes decays polynomially with an exponent θ called persistence exponent. The analysis of this exponent originates in theoretical physics and turns out to be very difficult even for very natural processes, such as fractional Brownian motion. In this project, we considered the discrete-time counterpart to fractional Brownian motion, i.e. long range dependent random walks.

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

Contact: F. Aurzada, C. Mönch

References

[1] F. Aurzada and N. Guillotin-Plantard. Persistence exponent for discrete-time, time-reversible processes. 2015. Preprint, http://arxiv.org/abs/1502.06799.

[2] F. Aurzada, N. Guillotin-Plantard, A. Devulder, and F. Pène. Random walks and branching processes in correlated Gaussian environment. 2016. Journal of Statistical Physics, to appear, https://arxiv.org/abs/1607.00999.

[3] F. Aurzada, N. Guillotin-Plantard, and F. Pène. Persistence probabilities for stationary increment processes. 2016. Preprint, http://arxiv.org/abs/1606.00236.

[4] F. Aurzada and C. Mönch. Persistence probabilities and a decorrelation inequality for the Rosenblatt process and Hermite processes. 2016. Preprint, https://arxiv.org/abs/1607.04045.

[5] F. Aurzada and T. Simon. Persistence probabilities and exponents. In *Lévy matters. V*, Lecture Notes in Math., pages 183–224. Springer, Cham, 2015.

Project: Small deviations of 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 range of applications in particular in functional analysis and statistics but also in coding theory, approximation theory, and other areas. In the present project, we determined the rate of decay of the small deviation probability for long-range dependent random walks that possess the scaling limit fractional Brownian motion.

Partner: Mikhail Lifshits (St. Petersburg State University and Liköping University)

Contact: F. Aurzada

References

[1] F. Aurzada and M. Lifshits. Small deviations of sums of correlated stationary Gaussian sequences. *Theory of Probability and Its Applications*, 61:626–658, 2016.

Project: First passage times of Lévy processes

First passage times are a classical area of study for Lévy processes. We generalized this theory to moving boundaries, i.e. to the first passage over time-dependent boundaries. Further, we studied cases in which the first passage times have exponential moments.

Partner: Alexander Iksanov (Kiev), Matthias Meiners (formerly TU Darmstadt, now Universität Innsbruck)

Contact: F. Aurzada

References

[1] F. Aurzada, A. Iksanov, and M. Meiners. Exponential moments of first passage times and related quantities for Lévy processes. *Mathematische Nachrichten*, 288:1921–1938, 2015.

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Project: Performance measures in communcation networks

Telecommunication networks are part of our everyday life. In this project, we investigate the performance of future telecommunication networks and develop the mathematical theory that is required for this analysis. Concretely, we consider two types of networks: wireless networks and hybrids of wireless and optical networks. The goal is to understand how different network architectures and the proposed communication protocols influence the performance of the network. The research is carried out with in close connection with the industry partner LG Electronics.

Partner: Martin Reisslein, Anu Mercian, Elliot I. Gurrola (Arizona State University), Michael P. McGarry (University of Texas), Revak R. Tyagi, Ki-Dong Lee (LG Electronics)

Contact: F. Aurzada

References

[1] F. Aurzada and S. Schwinn. Improving the performance of polling models using forced idle times. 2016. Preprint, https://arxiv.org/abs/1612.04557.

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[3] R. R. Tyagi, F. Aurzada, K.-D. Lee, and M. Reisslein. Connection Establishment in LTE-A Networks: Justification of Poisson Process Modeling. *IEEE Systems Journal*, 9:1–12, 2016.

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); Tadahisa Funaki (University of Tokyo)

Support: DFG

Contact: V. Betz, L. Taggi

References

[1] V. Betz and L. Taggi. Ensembles of self-avoiding polygons. *preprint*, 2016.

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

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

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

Project: Enhanced binding through path integrals

The description of electrically charged matter coupled to its quantized radiation field has been an active and successful area of research in the past decade. One possible way to study the problem is to use path integrals, thus converting the problem into a probabilistic one. One particular area where this is promising is the study of the effective mass of coupled particles: as charged particles are surrounded by a cloud of photons, their mass is increased. Probabilistically, this leads to a non-Markovian modification of Brownian motion where in the diffusive scaling a functional central limit theorem holds. The diffusion matrix is known to be smaller than or equal to the one of the original Brownian motion, but is expected to be strictly smaller. This discrepancy, leading to a reduced expected mobility of the particle, corresponds exactly to the increased effective mass. The aim of the project is to quantify and prove the difference of the diffusion constants, and to apply it to models like the Nelson scalar field model where so far enhanced binding has not been shown.

Partner: E. Bolthausen (University of Zürich)

Contact: V. Betz

References

[1] J. Lőrinczi, F. Hiroshima, and V. Betz. *Feynman-Kac-Type Theorems and Gibbs Measures on Path Space*. de Gruyter, 2011.

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 Stephane 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 (Universite Libre de Bruxelles); Martin Ziegler (KAIST, Daejeon, Korea)

Contact: V. Betz

References

[1] V. Betz and S. L. 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. L. 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: Estimation of the random behaviour of fatigue parameters

This project is motivated by experiments of the Collaborative Research Center 666 at the Technische Universität Darmstadt, which 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. The main occuring problem is that experiments collecting data for the estimation of fatigue behaviour are very expensive, therefore only very few data points (between 7 to 15) are available for the material which should be studied. In order to define nevertheless reasonable estimates, the very few measured data 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 density and quantile estimates. For both kind of estimates we derive a general theory which enables 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

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[2] A.-K. Bott and M. Kohler. Nonparametric estimation of a conditional density. *Annals of the Institute of Statistical Mathematics*, 69:189–214, 2017.

[3] M. Hansmann and M. Kohler. Estimation of conditional quantiles from data with additional measurement errors. Preprint, TU Darmstadt, 2016.

[4] M. Hansmann and M. Kohler. Estimation of quantiles from data with additional measurement errors. *Statistica Sinica*, 2017.

Project: Efficient estimation of uncertainty in a simulation model

Whenever complex technical systems are designed 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 lack of knowledge about future use. A good quantification of the uncertainty of the system is essential in order to avoid oversizing and to conserve resources. Uncertainty can be characterized by estimation of quantiles (which enables the characterization of the maximal occurring values) or by estimation of densities (which characterize the occurring randomness completely). The starting point in uncertainty quantification is usually a stochastic model of the technical system. This stochastic model often has parameters which are chosen randomly because their exact values are uncertain and consequently not known, and it computes the outcome of the technical system by computing the value of a function depending on concrete values of the parameters. In case that the distribution of the parameters is known (which is assumed in this project) and that the function, which has to be computed, is given, Monte Carlo can be used to estimate either quantiles or the density of the output of the technical system. Usually, the stochastic model is evaluated using a computer program, and computer experiments can be used to generate values for the Monte Carlo estimates. However, it often happens that generation of the values is rather time consuming, so that standard Monte Carlo estimates cannot be applied. Instead, one has to apply techniques which are able to quantify the uncertainty in the computer experiment using only a few evaluations of the computer program. In this project new methods for efficient estimation of densities and quantiles in this setting are studied, their rate of convergence is analyzed theoretically, and their finite sample size behaviour is analyzed using simulated data. It is also analyzed how real data of the technical system can be used to improve the estimates in case that the simulation model of the technical system does not describe the reality perfectly (which is always the case in applications).

Partner: SFB 805 (TU Darmstadt)

Contact: M. Kohler.

References

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[2] 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.

[3] G. Enss, , M. Kohler, A. Krzyżak, and R. Platz. Nonparametric quantile estimation based on surrogate models. *IEEE Transaction on Information Theory*, 62:5727–5739, 2016.

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[5] M. Kohler, A. Krzyżak, S. Mallapur, and R. Platz. Uncertainty quantification in case of imperfect models: A non-bayesian approach. Preprint, TU Darmstadt, 2016.

[6] M. Kohler, A. Krzyżak, R. Tent, and H. Walk. Nonparametric quantile estimation using importance sampling. *Annals of the Institute of Statistical Mathematics*, 2017.

Project: Estimation of surrogate models for high-dimensional computer experiments

Estimation of surrogate models for computer experiments leads to nonparametric regression estimation problems without noise in the dependent variable. In this project we investigate an empirical maximal deviation minimization principle to construct estimates in this context, and analyze the rate of convergence of corresponding quantile estimates. As an application we consider estimation of high-dimensional computer experiments by neural networks, and show that here we can circumvent the so-called curse of dimensionality by imposing rather general assumptions on the structure of the regression function. The estimates are illustrated by applying them to simulated data and to a simulation model in mechanical engineering.

Partner: Stiftung der Deutschen Wirtschaft

Contact: M. Kohler.

References

[1] B. Bauer, F. Heimrich, M. Kohler, and A. Krzyżak. Estimation of surrogate models for high-dimensional computer experiments. Preprint, TU Darmstadt, 2016.

Project: Nonparametric regression based on hierarchical interaction models

In this project we introduce so-called hierarchical interaction models where we assume that the computation of the value of a function $m : R^d \to R$ is done in several layers, where in each layer a function of at most d^* inputs computed by the previous layer is evaluated. We investigate two different regression estimates based on polynomial splines and on neural networks and show that if the regression function satisfies a hierarchical interaction model and all occurring functions in the model are smooth, the rate of convergence of these estimates depends on d^* (and not on d). Hence in this case the estimates can achieve good rate of convergence even for large d and are in this sense able to circumvent the so-called curse of dimensionality.

Partner: A. Krzyżak, Concordia University, Montreal

Contact: M. Kohler.

References

[1] M. Kohler and A. Krzyżak. Nonparametric regression based on hierarchical interaction models. *IEEE Transactions on Information Theory*, 2017.

Project: Adaptive estimation of quantiles in a simulation model

Let X be an R^d valued random variable, let $m : R^d \to R$ be a measurable function and set $Y = m(X)$. Given a sample of (X, Y) of size n we consider the problem of estimating the quantile of Y of a given level $\alpha \in (0, 1)$. In this setting one promising idea is to apply a surrogate quantile estimate, where in the first step the sample of (X, Y) is used to construct a surrogate estimate of m and in the second step the quantile is estimated by using the surrogate estimate of m. The construction of the surrogate estimate usually depends on a proper choice of parameters, so each parameter leads to a different quantile estimate. Given finitely many such surrogate estimates, we consider the problem of choosing the best of them in the context of quantile estimation. A data-dependent way of selecting the optimal surrogate estimate is proposed. It is shown that the pointwise error of the resulting adaptive surrogate estimate is less than twice the maximal supremum norm error of the given surrogate estimates except on a set of measure less than $c_1 \cdot \log(n)/n$. Furthermore it is shown that this implies that the corresponding surrogate quantile estimate achieves the rate of convergence bounded by the sum of the minimal rate of convergence of the quantile estimates corresponding to the given surrogate estimates and a term of order $\log(n)/n$. The finite sample size behaviour of this quantile estimate is illustrated by applying it to simulated data.

Partner: A. Krzyżak, Concordia University, Montreal

Contact: M. Kohler.

References

[1] M. Kohler and A. Krzyżak. Adaptive estimation of quantiles in a simulation model. Preprint, TU Darmstadt, 2016.

Project: Nonparametric quantile estimation using surrogate models and importance sampling

Nonparametric estimation of a quantile $q_{m(X),\alpha}$ of a random variable $m(X)$ is considered, where $m : R^d \to R$ is a function which is costly to compute and X is an R^d-valued random variable with known distribution. Monte Carlo quantile estimates are constructed by estimating m by some estimate (surrogate) m_n and then by using an initial quantile estimate together with importance sampling to construct an importance sampling surrogate quantile estimate. A general error bound on the error of this quantile estimate is derived which depends on the local error of the function estimate m_n, and the rates of convergence of corresponding importance sampling surrogate quantile estimates are analyzed. The finite sample size behavior of the estimates is investigated by applying them to simulated data.

Contact: M. Kohler.

References

[1] M. Kohler and R. Tent. Nonparametric quantile estimation using surrogate models and importance sampling. Preprint, TU Darmstadt, 2015.

Project: Estimation of queueing characteristics with probing

In this project we estimate queueing characteristics with a probing strategy. In particular, we are interested in the estimation of the traffic intensity for a queueing model, which is time-dependent, i.e. the arrival rate and the general service-time distribution change from one time interval to another. We derive statistical properties of the proposed estimator. Further, we present a method to detect a switch from a stationary interval to another using a sequence of probes to improve the estimation.

Partner: Nelson Antunes (University of Algarve)

Contact: C. Wichelhaus

References

[1] N. Antunes, G. Jacinto, A. Pacheco, and C. Wichelhaus. Estimation of the traffic intensity in a piecewise-stationary m_t / g_t /1 queue with probing. *Performance Evaluation Review*, 44:3–5, 2016.

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 inter-arrival 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: M. von Rohrscheidt (Universität Heidelberg)

Contact: C. Wichelhaus

References

[1] M. von Rohrscheidt and C. Wichelhaus. Bayesian nonparametric inference for m/g/1 queueing systems. *preprint*.

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

In this project we consider the 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 (P3 automotive GmbH)

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. *in preparation*, 2017.

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

In this project we try to classify the asymptotic distribution for unreliable networks of queues. Using the underlying Markov additive structure and a matrix geometric approach we find the exact asymptotics for the stationary distribution of the networks. In particular, we also investigate the asymptotics when the breakdown intensity is small. It has turned out that two different asymptotic regimes suggest two different patterns of large deviations, which is confirmed by a simulation study.

Partner: Pawel Lorek (University of Wroclaw)

Contact: C. Wichelhaus

References

[1] P. Lorek and C. Wichelhaus. The exact asymptotic for the stationary distribution of some unreliable systems. *in preparation*, 2017.

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", established in 2005, considers the enormous prospective potential of the new linear flow splitting technique for sheet metal and develops methodical tools to integrate this technique into the product development processes. The research center is 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 is 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 participates in the SFB 666 within three sub-projects (Kohler, Pfetsch, Ulbrich). The mathematical research is concentrated on development and on evaluation. In the product development process, the aim is to provide an optimal design of the desired product as well as an optimal process control of selected forming methods. This is done by means of discrete optimization and PDE-constrained nonlinear optimization. In the evaluation process, statistical methodologies are 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 second funding period started in January 2013 and in 2016 the collaborative research centre was extended to a third funding period starting in January 2017. Its 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 and mathematicians. Within the collaborative research centre, the engineering sciences address uncertainty in terms of physical and technical phenomena. 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. 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. In the production process, the optimization of process chains under uncertainty is considered in order to reduce costs and uncertainty caused by uncertain market conditions. 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 phenomena 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. In order to perform sensitivity analysis, parameter studies and targeted optimizations, automatic differentiation techniques and numerical adjoint solutions will be used. This will lead 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 154

The Collaborative Research Centre Transregio TRR 154 "Mathematical Modelling, Simulation and Optimization Using the Example of Gas Networks" was established in 2014. 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, and simulation as well as integer, continuous, and stochastic optimization 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. 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, 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, Konrad-Zuse-Zentrum für Informationstech-

nik Berlin (ZIB), and Weierstraß-Institut für Angewandte Analysis und Stochastik (WIAS) – Leibniz-Institut im Forschungsverbund Berlin e.V. are part of TRR 154.
The homepage of TRR 154 is `trr154.fau.de`.

2.5 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 studing engineering applications and to engineering 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.
Seven professors of the Department of Mathematics are Principal Investigators within the Graduate School Computational Engineering (Aurzada, Bothe, Egger, 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. Four more members of the department are Research Group Leaders (Disser, Erath, Schwartz, Ullmann) with scientific focus on Online Optimization, Numerical Analysis, Discrete-Nonlinear Optimization, and Uncertainty Quantification. Together they supervise more than 10 interdisciplinary PhD projects within the Graduate School in close cooperation with a co-supervisor from Engineering or Computer Science.

2.6 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.

2.7 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, Stefan Ulbrich and Martin Ziegler. 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 2015 and 2016 includes leading experts of the field, e.g., R. Danchin, G.P. Galdi, Th. Gallay, Y. Giga, J. Goldstein, M. Gubinelli, G. Karch, H. Knüpfer, H. Koch, Th. Nguyen, T. Ogawa, J. Prüss, O. Sawada, G. Seregin, G. Simonett, S. Shimizu, V. Solonnikov, R. Takada, M. Tucsnak and H. Weber.
Highlights of the program were altogether 8 conferences or bigger workshops in 2015 and 2016, e.g., the "International Workshops on Mathematical Fluid Dynamics" at Waseda University, Tokyo, in March 2015 and November 2016 and in Darmstadt in April 2015 and November 2016.
The workshop on "Young Researchers in Fluid Dynamics" in June 2015 attracted many PhD students and informed them about various activities of the IRTG.
In addition, a joint workshop between SPP 1506, Transport Processes at Fluidic Interfaces, and the IRTG took place in October 2015 in Darmstadt.

2.8 Priority Programme SPP 1506

The DFG priority programme 1506 "Transport Processes at Fluidic Interfaces" investigates transport processes at fluidic interfaces on a continuum mechanical level, with increasing multi-physics phenomena at the interface including transfer of mass and heat across deformable interfaces, capillary and Marangoni effects, effects of absorbed components (surfactants, colloids) as well as phase change (evaporation, condensation) phenomena. The priority programme is anchored within Applied Mathematics, but with strong interdisciplinary links to the Natural and Engineering Sciences. The above-mentioned processes are studied using complementary approaches from the research areas "Mathematical Modeling and Analysis", "Numerical methods and simulation" and "Experiments and Validation". Important goals of the Priority Programme are (i) to derive and expand mathematical models that describe relevant physico-chemical interface phenomena; (ii) to improve and deepen the understanding of mechanisms and phenomena occurring at fluidic interfaces by means of rigorous mathematical analysis of the underlying PDE-systems; (iii) the development and analysis of numerical methods for the simulation of multiphase flow problems which resolve the local processes at the interface; (iv) validation of the models and the numerical simulation methods by means of specifically designed experiments. The SPP1506 is coordinated by Dieter Bothe and Arnold Reusken (RWTH Aachen). It started in 2010 and runs until 2016, comprising 26 projects in the current second funding phase. Besides several summer schools, workshops etc., the Priority Programme supported and co-organized the International Conference on Numerical Methods in Multiphase Flows (ICNMMF-II), held in Darmstadt June 2014. This outstanding event with main speaker including H. Jasak, D. Juric, S. Popinet, A. Prosperetti, M. Shashkov, M. Sussman, S. Takagi and B. van Wachem attracted about 150 participants.

2.9 Priority Programme SPP 1740

DFG Priority Program 1740: "The Influence of Local Transport Processes on Chemical Reactions in Bubble Flows".
Gaseous substances have to be well mixed with a continuous liquid phase to perform a reaction with high yield and selectivity. For this purpose bubbly flows are preferred, in which the gaseous phase is dispersed in the liquid phase (e.g. bubble columns). The time scales of mixing are largely determined by the buoyancy flow and transport resistances of phase boundaries and boundary layers, which are not sufficiently explored yet.
The priority program works on this gap by using new experimental and numerical methods for the determination of reaction-relevant time scales (kinetics) of reaction networks at local (inherent) scale in order to elucidate the interaction between hydrodynamic and reaction in bubbly flows. Here, the close interaction between engineering, chemistry and mathematics is of particular importance.
The central objective of the priority program is to develop new and improved methods for the analysis, modeling and computing: local hydrodynamics with turbulence, local concentration distribution with mass transfer / mass transport, reaction progression with transport limitation.
The SPP1740 is coordinated by Michael Schlüter (TU Hamburg-Harburg). The first funding periode started in 2014 and runs until 2017.
The Technische Universität Darmstadt is involved with two projects:
"Direct numerical simulation of multi-physics reactive mass transfer at single and multiple bubbles" project leader Prof. Dieter Bothe and "Development and Application of a Direct Numerical Method for Reactive Transport Processes in Bubble Systems" project leader Dr. Holger 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. Modelling "competition" often leads to generalized Nash equilibrium problems (GNEPs) or partial differential games. Moreover, modelling "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 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 generalisations. 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 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. Alexis Devulder (University Of Versailles): Persistence probabilities.
- Dr. Nadine Guillotin-Plantard (University of Lyon): Persistence probabilities.
- Elliot I. Gurrola (Arizona State University): Performance measures in communcation networks.
- Prof. Dr. Alexander Iksanov (National University Kiev): First passage times of Lévy processes.
- Dr. Anu Mercian (Arizona State University): Performance measures in communcation networks.
- Prof. Dr. Michael P. McGarry (University of Texas at El Paso): Performance measures in communcation networks.
- Dr. Ki-Dong Lee (LG Electronics): Performance measures in communcation networks.
- Prof. Dr. Mikhail Lifshits (St. Petersburg State University and Liköping University): Small deviations of stochastic processes.
- Prof. Dr. Françoise Pène (University of Western Brittany, Brest): Persistence probabilities.
- Prof. Dr. Martin Reisslein (Arizona State University): Performance measures in communcation networks.
- Dr. Revak R. Tyagi (Arizona State University): Performance measures in communcation networks.

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. Tadahisa Funaki (University of Tokyo): Interacting Brownian motions and motion by mean curvature.
- Prof. Erwin Bolthausen (University of Zürich): Enhanced binding via path integrals.
- Prof. Peter Moerters (University of Bath) and Prof. Steffen Dereich (Universität Münster): Universal shape of condensing waves.

- Prof. Steffen Dereich (Universität Münster): Universal shape of condensing waves.
- Dr. Stephane Le Roux (Free University of Brussels): Metastability in Markov Chains.
- Dr. Benjamin Goddard (University of Edinburgh): Nonadiabatic Transition through Born-Oppenheimer surfaces.
- Prof. Uwe Manthe (Universität Bielefeld): Nonadiabatic Transition through Born-Oppenheimer surfaces.

Bothe

- BASF SE: Entwicklung von stabilen Strömungslösern für viskoelastische Fluidel.
- Freudenberg New Technologies SE & Co. KG: Simulation viskoelastischer Strömungen in OpenFOAM.
- Prof. Dr. Wolfgang Dreyer (WIAS Berlin): Continuum thermodynamics of chemically reacting fluid mixtures.
- Prof. Dr. Anne-Marie Robertson (University of Pittsburgh): Dynamics of buoyant oil droplets.
- Prof. Dr. Michael Schlüter (Institut für Mehrphasenströmung TU Hamburg-Harburg): Numerical and experimental analysis of local flow phenomena in laminar Taylor flow in a square mini-channel.
- Prof. Dr. Martin Wörner (KIT Karlsruhe): Numerical and experimental analysis of local flow phenomena in laminar Taylor flow in a square mini-channel.
- Prof. Dr. Arnold Reusken (RWTH Aachen): Numerical and experimental analysis of local flow phenomena in laminar Taylor flow in a square mini-channel.
- Prof. Dr. Michel Pierre (ENS Cachan, Antenne de Bretagne): Analysis of reaction-diffusuion systems.
- Prof. Dr. Jan Prüss (Universität Halle-Wittenberg): Analysis of Navier-Stokes equations for non-standard boundary conditions and of two-phase fluid systems with mass transfer.
- Prof. Dr. Günter Brenn (TU Graz): The onset of fragmentation in drop collisions.
- Prof. Dr. Jürgen Saal, Dr. Matthias Köhne (Universität Düsseldorf): Analysis of reaction-diffusion-sorption and of reaction-diffusion-migration systems.

Regina Bruder

- Ministry of Education Hesse and Lower Saxony: Development of concepts for further teacher training, projects MAKOS and LEMAMOP.
- 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 (Universität Kassel) and Prof. Dr. Rolf Biehler (Universität Paderborn) and Prof. Dr. Reinhard Hochmuth (Universität Hannover) : Project VEMINT, Development of bridge courses in mathematics.
- Prof. Dr. Anne Prescott (University of Technology Sydney, Australia): Development of competencies in the inservice training of Math-teachers and measurement of competencies and research about inquiry based learning.
- Dr. Eva Sattlberger and Dr. Jan Steinfeld (Ministry of Education Vienna, Austria), Prof. Dr. Tina Hascher (Universität Bern, Dr. Torsten Linnemann (Universität Basel), Prof. Dr. Stefan Siller (Universität Koblenz): O-M-A: project for modelling competencies for the examination MATURA in Austria.
- Prof. Dr. Vincent Geiger, ACU Brisbane, Australia: DAAD-project plan about the development of motivating learning tasks.
- Deutsches Zentrum für Lehrerbildung Mathematik: online-teacher training courses for teachers in service.

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): Regularized theta liftings for symplectic groups.
- Prof. Dr. M. Möller (Goethe-Universität Frankfurt): Cones of effective divisors.

Ulrik Buchholtz

- Prof. Dr. Gerhard Jäger (Universität Bern): Proof theory.
- Prof. Dr. Thomas Strahm (Universitä Bern): Proof theory.
- Prof. Dr. Marc Bezem (University of Bergen): Sheaf theory and coherent logic.
- Prof. Dr. Thierry Coquand (University of Gothenburg): Sheaf theory and coherent logic.
- Dr. Edward Morehouse (Wesleyan University): Categories of cubical sets.
- Egbert Rijke (Carnegie Mellon University): Synthetic homotopy theory.
- Floris van Doorn (Carnegie Mellon University): Synthetic homotopy theory.

Yann Disser

- Dr. Fidaa Abed (TU München): Maintenance scheduling.
- Andreas Bärtschi (ETH Zürich): Graph exploration and delivery.
- Dr. Aaron Bernstein (TU Berlin): Incremental maximization.
- Antje Bjelde (HU Berlin): Online TSP.
- Dr. Katerina Böhmová (ETH Zürich): Interval selection.
- Prof. Dr. Jérémie Chalopin (Aix-Marseille University): Graph exploration and delivery.
- Dr. Lin Chen (Hungarian Academy of Sciences): Maintenance scheduling.
- Dr. Shantanu Das (Aix-Marseille University): Graph exploration and delivery.
- Prof. Dr. Andreas Feldmann (Charles University): Highway dimension.
- Prof. Dr. Martin Gairing (University of Liverpool): Secretary leasing.
- Daniel Graf (ETH Zürich): Graph exploration and delivery.
- Dr. Martin Groß (University of Waterloo): Incremental maximization.
- Jan Hackfeld (TU Berlin): Collaborative exploration, online TSP.
- Christoph Hansknecht (TU Braunschweig): Online TSP.
- Prof. Dr. Max Klimm (HU Berlin): Competitive exploration, secretary leasing.
- Prof. Dr. Adrian Kosowski (Paris Diderot University): Collaborative exploration.
- Prof. Dr. Stefan Kratsch (Universität Bonn): Robust search.
- Dr. Jannik Matuschke (TU München): Graph orientations, network interdiction.
- Prof. Dr. Nicole Megow (Universität Bremen): Robust knapsack, maintenance scheduling.
- Julie Meißner (TU Berlin): Online TSP.
- Matúš Mihalák (Maastricht University): Graph exploration and delivery.
- Dr. Sandro Montanari (ETH Zürich): Rectilinear shortest paths and MST.
- Frank Mousset (ETH Zürich): Collaborative Exploration.
- Dr. Andreas Noever (ETH Zürich): Collaborative Exploration.
- Dr. Alexander Richter (TU Braunschweig): Maintenance scheduling.
- Dr. Kevin Schewior (University of Chile): Online TSP.
- Miriam Schlöter (TU Berlin): Online TSP.
- Daniel Schmand (RWTH Aachen): Secretary leasing.

- Prof. Dr. Alexander Skopalik (Universität Paderborn): Secretary leasing.
- Nemanja Škorić (ETH Zürich): Collaborative Exploration.
- Prof. Dr. Martin Skutella (TU Berlin): Mightiness of the simplex algorithm.
- Prof. Dr. Angelika Steger (ETH Zürich): Collaborative exploration.
- Prof. Dr. Sebastian Stiller (TU Braunschweig): Robust knapsack.
- Prof. Dr. Leen Stougie (University of Amsterdam): Online TSP.
- Andreas Tönnis (RWTH Aachen): Secretary leasing.
- Dr. Przemysław Uznański (ETH Zürich): Collaborative exploration.
- Prof. Dr. Peter Widmayer (ETH Zürich): Message delivery.

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. Volker Mehrmann (TU Berlin), Arbi M. Badlyan (TU Berlin), Prof. Dr. Christopher Beattie (Virginia Tech, USA): Systematic discretization of differential equations with port-Hamiltonian structure.
- Prof. Dr. Bernd Hofmann (TU Chemnitz): Tikhonov regularization under stability assumptions.
- Dr. Matthias Schlottbom (UT Twente, The Netherlands): Advanced numerical methods for fluorescence optical tomography.
- Prof. Dr. Maria Lukačova (JGU Mainz): Asymptotic-preserving methods.
- Dr. Michaela Kesina, Prof. Dr. Peter Egger (ETH Zürich): Gibbs sampling methods for econometric models with panel data.
- Prof. Dr. Cameron Tropea (TU Darmstadt), Prof. Dr. Jürgen Hennig (Uniklinik Freiburg): Estimation of Wall-Shear Stress from Magnetic Resonance Velocimetry Data (DFG).
- SFB Transregio 154: Mathematische Modellierung, Simulation und Optimierung am Beispiel von Gasnetzwerken, Speaker: Prof. Dr. Alexander Martin (FAU Erlangen).

Christoph Erath

- Prof. Dr. Dirk Praetorius (TU Wien): Adaptive vertex-centered FVM with convergence rates.
- Dr. Günther Of (TU Graz), Francisco-Javier Sayas (University of Delaware, USA): Nonsymmetric FVM-BEM coupling.
- Prof. Dr. Stefan A. Funken (Universität Ulm), Prof. Dr. Dirk Praetorius (TU Wien): Optimal adaptivity for SUPG FEM.
- Dr. Mark A. Taylor (Sandia National Laboratories, USA), Dr. Ramachandran D. Nair (National Center for Atmospheric Research, USA): Multi-tracer efficient transport for CAM.

Reinhard Farwig

- Prof. Dr. Y. Giga (Tokyo University): Quasi-optimal Initial Values for the Navier-Stokes System.
- Prof. Dr. H. Kozono (Waseda University, Tokyo) and D. Wegmann: Decay of Non-stationary Navier-Stokes Flow with Nonzero Dirichlet Boundary Data.
- Prof. Dr. H.-O. Bae (Ajou University, Suwon, South Korea): Asymptotic Decay and Concentration-Diffusion Phenomena for the Fractional Navier-Stokes Equations.
- Prof. Dr. Chenyin Qian (Zhejinag Normal University, Jinhua, China): The Global Attractor of Quasi-Geostrophic Equations with Fractional Dissipation in R^2.
- Prof. Dr. Š. Nečasová (Academy of Sciences, Prague): Fundamental Solutions of Fluid Flow past a Moving Obstacle.
- Dr. V. Rosteck (Springer Verlag, Heidelberg): Maximal Regularity of the Stokes System in Unbounded Domains with Navier Slip Boundary Condition.

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), Dr. Kevin J. Painter (Heriot-Watt University, Edinburgh, UK): 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 (Technical University of Madrid, Spain): Multiscale structure-functional modelling of musculoskeletal mineralized tissues.
- Prof. Dr. Jens Lang (TU Darmstadt), Dirk Schröder (TU Darmstadt), Prof. Dr. Rüdiger Weiner (Universität Halle-Wittenberg), Dr. Helmut Podhaisky (Universität Halle-Wittenberg): Peer methods and their application in the Finite Element system KARDOS.
- Prof. Dr. Jens Lang (TU Darmstadt), Prof. Dr. Florian Müller-Plathe (TU Darmstadt), Prof. Dr. Michael Böhm (TU Darmstadt): Uncertainty quantification in multiscale models of soft matter systems.

kgb

- Prof. Dr. John Sullivan (TU Berlin): Constant mean curvature surfaces.
- Prof. Dr. Robert Kusner (University of Massachusetts at Amherst): Constant mean curvature surfaces.
- Prof. Dr. Steffen Fröhlich (Universität Mainz): Constant mean curvature surfaces.
- Prof. Dr. Gerd Schröder-Turk (Universität Erlangen): Periodic surfaces and interfaces.

Robert Haller-Dintelmann

- Joachim Rehberg (WIAS Berlin): Elliptic operators in divergence form with mixed boundary conditions.
- 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 (TU Darmstadt): The Jones extension operator for mixed boundary conditions.

Christian Herrmann

- Prof. Dr. Marina Semenova (Academy of Science Novosibirsk): Representation of algebras with involution.
- Prof. Dr. Martin Ziegler (KAIST): Decidability, complexity, and definability in finite dimensional linear structures.
- Prof. Dr. Alan Weinstein (University of Berkeley): Classification of isotropic triples in symplectic geometry.

Christopher Hojny

- Dr. Imke Joormann (TU Braunschweig), JProf. Dr. Martin Schmidt (FAU Erlangen-Nürnberg): Connected Graph Partitioning.

Ulrich Kohlenbach

- Prof. Dr. G. Lopéz-Acedo (University of Seville): Quantitative asymptotic regularity.
- Prof. Dr. L. Leuştean (University of Bucharest): Quantitative results on Fejér monotone sequences.

Michael Kohler

- Prof. Dr. Luc Devroye (McGill University, Montreal): Nonparametric estimation of a function from noiseless observations at random points.
- Prof. Dr. Adam Krzyżak (Concordia University, Montreal): Nonparametric regression based on hierarchical interaction models.

– Prof. Dr. Harro Walk (Universität Stuttgart): Nonparametric quantile estimation using importance sampling.

– SFB 666 (TU Darmstadt): Estimation of the random behaviour of fatigue parameters.

– SFB 805 (TU Darmstadt): Efficient estimation of uncertainty in a simulation model.

Burkhard Kümmerer

– Prof. Dr. J. Fröhlich (ETH Zürich): Quantum Measurement.

– Prof. Dr. R. Gohm (Aberystwyth): Quantum System Theory, Quantum Markov Processes.

– Dr. C. Koestler (Cork): Quantum System Theory.

– Prof. Dr. H. Maassen (Nijmegen): Quantum Probability.

Mads Kyed

– Prof. Giovanni P. Galdi (University of Pittsburgh): Time-periodic Navier-Stokes equations.

– Prof. Yoshihiro Shibata (Waseda University): Steady free fall of a droplet in a viscous incompressible fluid.

– Prof. Toshiaki Hishida (Nagoya University): Asymptotic structure of a linearized Navier-Stokes flow around a rotating body.

– Dr. Jonas Sauer (MPI Leipzig): A priori estimates for time-periodic solutions to parabolic boundary value problems.

– Dr. Elfriede Friedmann: Time-periodic processes in cell biology.

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.

– Jun.-Prof. Dr. Oliver Kolb (Universität Mannheim): Simulation and optimization of gas and water networks.

– Prof. Dr. Kristian Debrabant (University of Southern Denmark): Global error estimation and control for semilinear parabolic equations.

– Bodo Erdmann (ZIB): Kardos programming.

Hendrik Lüthen

– Dr. Imke Joormann (TU Braunschweig), JProf. Dr. Martin Schmidt (FAU Erlangen-Nürnberg): Connected Graph Partitioning.

- Corinna Gottschalk, Prof. Dr. Britta Peis, Andreas Wierz (RWTH Aachen): Optimization Problems with Color-Induced Budget Constraints.

Matthias Meiners

- Prof. Dr. Frank Aurzada (TU Darmstadt): Exponential moments of first exit times and related quantities for Lévy processes.
- Prof. Dr. Nina Gantert (TU München): Regularity of the speed of biased random walk in a one-dimensional percolation model.
- Prof. Dr. Alexander Iksanov (Taras Shevchenko National University of Kyiv): Moment convergence of first-passage times in renewal theory.
- Dr. Konrad Kolesko (TU Darmstadt): Convergence of complex martingales in the branching random walk: the boundary.
- Dr. Alexander Marynych (Taras Shevchenko National University of Kyiv): Moment convergence of first-passage times in renewal theory.
- Dr. Sebastian Mentemeier (TU Dortmund): Solutions to complex smoothing equations.
- Dr. Sebastian Müller (LATP Marseille): Regularity of the speed of biased random walk in a one-dimensional percolation model.

Hannes Meinlschmidt

- Dr. Joachim Rehberg (WIAS Berlin): Hölder-estimates for nonautonomous parabolic evolution equations on rough domains.
- Prof. Dr. Christian Meyer (TU Dortmund), Dr. Joachim Rehberg (WIAS Berlin): Optimal control of the thermistor problem in three spatial dimensions.
- Prof. Dr. Christian Meyer (TU Dortmund), Dr. Joachim Rehberg (WIAS Berlin): A space of controls for optimal control problems associated to nonlinear evolution equations.
- apl. Prof. Dr. Dirk Horstmann (Universität zu Köln), Dr. Joachim Rehberg (WIAS Berlin): Well-posedness of the full Keller-Segel model on nonsmooth domains.
- Lucas Bonifacius (TU München), Prof. Dr. Ira Neitzel (Universität Bonn), Dr. Joachim Rehberg (WIAS Berlin): Global solutions for quasilinear parabolic equations in a scale of Banach spaces.
- Dr. Karoline Disser, Dr. Joachim Rehberg (WIAS Berlin): Quasilinear parabolic systems on rough domains.

Christian Mönch

- Prof. Dr. Steffen Dereich (Universität Münster), Prof. Dr. Peter Mörters (University of Bath): Distances in complex random networks.

– Dr. Lorenzo Taggi (TU Darmstadt): Frog models on general graphs.

Martin Otto

– Dr. Ivano Ciardelli (Amsterdam): Model theory of inquisitive logics.

– Prof. Dr. Erich Grädel (RWTH Aachen): Guarded team semantics.

Andreas Paffenholz

– Prof. Dr. Christian Haase (FU Berlin): Permutation, Cut, and Marginal Polytopes; Polyhedral Adjunction Theory; Unimodular Triangulations.

– Prof. Dr. Benjamin Nill (Universität Magdeburg): Polyhedral Adjunction Theory.

– Prof. Dr. Francisco Santos (University of Cantabria): Unimodular Triangulations.

– Lindsay Piechnik (High Point University): Unimodular Triangulations.

Marc Pfetsch

– Prof. Dr. Martin Haardt (TU Ilmenau): Compressed Sensing in Signal processing.

– Group of Dr. René Henrion (WIAS Berlin): Gas Transport Optimization.

– Group of Prof. Dr. Thorsten Koch (Zuse-Institut Berlin): Software for Integer Programming and Gas Transport Optimization.

– Prof. Dr. Dirk Lorenz (TU Braunschweig): Compressed Sensing.

– Group of Prof. Dr. Alexander Martin (FAU Erlangen-Nürnberg): Gas Transport Optimization.

– Prof. Dr. Sebastian Pokutta (Georgia Tech., Atlanta): Methods for integer programs.

– Prof. Dr. Marius Pesavento (TU Darmstadt): Mixed-integer programs in signal processing.

– Group of Prof. Dr. Werner Römisch (HU Berlin): Gas Transport Optimization.

– Group of Prof. Dr. Rüdiger Schultz (Universität Duisburg-Essen): Gas Transport Optimization.

– Prof. Dr. Martin Skutella (TU Berlin): Algorithms for Gas Transport Optimization.

– Group of Prof. Dr. Marc Steinbach (Universität Hannover): Gas Transport Optimization.

– Open Grid Europe (OGE): Project FORNE.

Anna-Maria von Pippich

– Dr. G. Freixas (CNRS Paris): Arithmetic Riemann–Roch theorem for singular metrics.

- Dr. S. Herrero (University of Gothenburg), Prof. Dr. Ö. Imamoḡlu (ETH Zürich), and Prof. Dr. Á. Tóth (Eötvös Loránd University): Jensen's formula in higher dimensions.
- Prof. Dr. J. Jorgenson (City College, New York) and Prof. Dr. L. Smajlović (University of Sarajevo): Generalized Eisenstein series.
- Prof. Dr. K. Bringmann (Universität zu Köln) and Dr. B. Kane (University of Hong Kong): Higher Green's functions.

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.
- Prof. Dr. Pedro A. dos Santos (IST Lisbon): Numerical analysis for convolution-type operators.

Nils Scheithauer

- Prof. Dr. R. E. 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 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. C. H. Lam (Academia Sinica, Taipei): Vertex algebras.
- Prof. Dr. H. Shimakura (Tohoku University): Vertex algebras.

Alexandra Schwartz

- Martin Branda (Czech Academy of Sciences and Charles University, Prague): Robust portfolio optimization.
- Oleg Burdakov (Linköping University): Solution algorithms for sparse and cardinality constrained optimization problems.
- Michal Červinka (Czech Academy of Sciences and Charles University, Prague): Robust portfolio optimization.
- Prof. Dr. Christian Kanzow (JMU Würzburg): Solution algorithms for sparse and cardinality constrained optimization problems.

– Dr. Sonja Steffensen (RWTH Aachen): Multi-leader-follower games in function spaces.

Christian Stinner

– Prof. Dr. Tomasz Cieślak (Polish Academy of Sciences, Warsaw): Blow-up in Keller-Segel models.

– Dr. Razvan Gabriel Iagar (ICMAT Madrid): Extinction in diffusive Hamilton-Jacobi equations.

– 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 Mainz): Multiscale models for tumor cell migration.

– Prof. Dr. Christina Surulescu (TU Kaiserslautern): Multiscale models for tumor cell migration.

Andreas Tillmann

– Prof. Dr. Yonina Eldar (Technion), Julien Mairal (INRIA Grenoble Rhône-Alpes): Dictionary Learning for Phase Retrieval.

– Prof. Dr. Dirk Lorenz, Christoph Brauer (TU Braunschweig): Homotopy Methods for ℓ_1-Minimization with ℓ_∞-Constraints.

– Prof. Dr. Marc E. Pfetsch, Tobias Fischer, Prof. Dr. Marius Pesavento, Ganapati Hegde (TU Darmstadt): EXPRESS project.

– Jan-Hendrik Lange (MPI Saarbrücken), Prof. Dr. Marc E. Pfetsch (TU Darmstadt), Bianca Seib: Sparse Recovery with Integrality Constraints.

– Dr. Martin Storath (Universität Heidelberg), Prof. Dr. Andreas Weinmann (Hochschule Darmstadt): Convergence properties of ADMM for Potts models.

– Prof. Dr. Marc E. Pfetsch (TU Darmstadt), Dr. Stefania Petra, Jan Kuske, Prof. Dr. Christoph Schnörr (Universität Heidelberg): Discrete Tomography and Integral Co-Sparse Reconstruction Guarantees.

Stefan Ulbrich

– Prof. Dr. Serge Gratton (INP ENSEEIHT Toulouse): Subspace decomposition methods for optimization.

– Prof. Dr. Peter Groche (TU Darmstadt): Optimization of deep drawing processes.

– 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 (FAU Erlangen-Nürnberg): Gas transport optimization.
- Prof. Dr. Anton Schiela (Universität Bayreuth): Preconditioners for PDE-constrained 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.

Mirjam Walloth

- Prof. Dr. Rolf Krause (University of Lugano): Adaptive finite element discretization methods for the numerical simulation of static and dynamic contact problems.
- Prof. Dr. Andreas Veeser (University of Milan): Adaptive finite element discretization methods for the numerical simulation of static and dynamic contact problems.

Torsten Wedhorn

- Brian Conrad (Stanford University): Adic Spaces.
- Ulrich Görtz (Universität Duisburg-Essen): Algebraic Geometry.
- Jean-Stefan Koskivirta (Imperial College London): EKOR strata.
- Richard Pink (ETH Zürich): G-Zips.

Cornelia Wichelhaus

- Dr. Nelson Antunes (University of Algarve): Estimation of queueing charcateristics with probing.
- Dr. Sebastian Schweer (P3 automotive GmbH): Functional limit theorems for queueing systems.
- Moritz von Rohrscheidt (Universität Heidelberg): Bayesian nonparametric inference for queues.
- Dr. Pawel Lorek (University of Wroclaw): Exact asymptotics for the stationary distribution of unreliable systems.

Winnifried Wollner

- Prof. Dr. M. Braack (CAU Kiel): Space-Time Adaptive Flow Simulations .

- Prof. Dr. R. Herzog (TU Chemnitz): A Conjugate Direction Method for Linear Systems in Banach Spaces.
- Prof. Dr. M. Hintermüller (WIAS Berlin): Free-Material Optimization.
- Dr. A. Linke (WIAS Berlin): Pressure-Robust Stokes Elements.
- Dr. C. Merdon (WIAS Berlin): Pressure-Robust Stokes Elements.
- Prof. Dr. C. Meyer (TU Dortmund): Adaptive Optimal Control of Obstacle Problems.
- Prof. Dr. I. Neitzel (Universität Bonn): Optimizing Fracture Propagation Using a Phase-Field Approach.
- PD Dr. A. Rademacher (TU Dortmund): Adaptive Optimal Control of Obstacle Problems.
- Prof. Dr. R. Rannacher (Universität Heidelberg): A priori Error Analysis on Arbitrary Finite Element Meshes.
- JProf. Dr. M. Schmidt (FAU Erlangen-Nürnberg): Global Mixed-Integer Nonlinear Optimization.
- Prof. Dr. T. Surowiec (Universität Marburg): Free-Material Optimization.
- Prof. Dr. A. Veeser (University of Milan): Finite Element Approximation of PDE Constrained Optimization Problems.
- Dr. T. Wick (CMAP, Ecole Polytechnique): 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). The current Bachelor programme incorporates the old Bachelor programme "Mathematics with Computer Science". The following table shows the enrolement numbers over the last 8 years:

Students in Mathematics programmes

Programme	2009	2010	2011	2012	2013	2014	2015	2016
Diplom	341	260	151	88	58	35	13	4
Bachelor (incl. MCS)	502	624	674	629	646	581	535	518
Master	41	68	141	189	224	276	309	292
Teacher (secondary)	363	410	417	398	380	351	335	289
Teacher (vocational)	38	49	47	42	41	23	18	18

The sum total of the student numbers in our Diplom, Bachelor and Master programmes remains roughly at the same level over the years, but there are some special circumstances to explain some of the variations. Among these are the abolishment of student fees ("Studienguthabengesetz") with the beginning of the academic year 2008/09, 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 with effect for enrolment in winter semester 2016/17 to simplify the admission criteria. In 2012, it was also decided to discontinue enrolement of beginners in the summer semester, and as of the summer of 2013 we do not offer enrolment for beginners in our Bachelor programme in a summer semester.

New enrolments

Programme	2009	2010	2011	2012	2013	2014	2015	2016
Diplom								
Bachelor	235	277	275	173	177	150	122	126
Master	22	36	58	68	73	94	96	89
Teacher (secondary)	104	116	72	56	54	40	48	45
Teacher (vocational	21	22	15	13	8	2	5	7

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. 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 2012/13).

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 and chemistry, and 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 2016/17, about 49 % among the 119 Bachelor students interviewed expressed the objective 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 or chemistry). 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.

Graduates of the Bachelor programme (incl. MCS)

Programme	2010	2011	2012	2013	2014	2015
Total	51	59	80	87	122	90
Female students	14	31	24	29	38	30
Graduation within 3 years	34	37	33	48	51	31
Graduation within 4 years	41	54	71	71	107	68

Graduates of the Master programme

Programme	2010	2011	2012	2013	2014	2015
Total	4	9	27	46	49	68
Female students	3	4	5	19	18	24
Graduation within 2 years	1	2	18	23	19	22
Graduation within 3 years	3	6	22	40	40	55

Graduates in Education for Secondary Schools

Programme	2010	2011	2012	2013	2014	2015
Total	13	16	6	10	18	18
Female students	6	14	4	5	8	9
Graduation within 9 semesters	2	1	0	0	2	3
Graduation within 11 semesters	5	10	2	2	5	7

Graduates in Education for Vocational Colleges

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 for a year at a university abroad, 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 year abroad and also maintains contacts with various popular destinations abroad. Students who return from a year 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 ensures that students can transfer their credits from abroad into their study programme in Darmstadt. This helps to avoid negative effects on the overall duration of studies.

Academic year	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16
Erasmus places	35	36	38	49	56	52	47	45
Erasmus outgoers	15	12	11	18	15	11	8	27
Further outgoers	13	9	8	13	9	7	7	12
Incomers	4	3	2	5	8	3	2	5

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 2014/15 (Source: TUCaN, 31.03.2017)	
Darstellende Geometrie	355
Höhere Mathematik I	153
Mathematik I für Bauwesen	853
Mathematik I für Elektrotechnik	667
Mathematik I für Informatik	1036
Mathematik I für Maschinenbau	745
Mathematik III für Bauwesen	655
Mathematik III für Elektrotechnik	523
Mathematik III für Maschinenbau	776
Mathematik für Chemiker	190
Mathematik und Statistik für Biologie	162
Statistik I für Human- und Sozialwissenschaft	240
Statistik I für Wirtschaftsingenieurwesen	696

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. 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". According to the results published in 2015, 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 (courses)” (1.9) “teaching (lecturers) (1.9), “study entry phase” (1.9), “contact amoung students” (1.6), “libraries” (1.4), “international orientation (master)”, “adequate duration of studies”, “third party funds per researcher”, “PhDs awarded per professor”. 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. In 2011/12 the department has implemented a new 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 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 (Analsyis 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.

Moreover, the department supports students in their learning experience by the following measures:

- the organisation or 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 or professor, available to answer questions; in addition textbooks and up-to-date material for the current teaching 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:

- video capturing of selected lectures

- the learning material and exercises of most of all 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.

- In some research projects new websites and digital tools as test- or/and learning environments are developed, see projects MAKOS, CODI, BASICS Mathematik

- 4 - 5 half-year-online teacher training courses (in service) are running each semester in cooperation with the DZLM, Berlin (www.dzlm.de)

- the task-database `www.madaba.de` with more than 900 interesting math tasks supports teachers to prepare learning environments for math-lessons in school.

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 beginner 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.

http://www3.mathematik.tu-darmstadt.de/fb/mathe/startseite/studienanfaengerinnen-und-anfaenger/mathematikvorkurs.html.
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 singlehandedly.
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. An other 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 is very high to the construction of such tests. The effort stands with the interest of the students in the tests in no satisfactory relation.

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.

01/06/2015 Maren Bierkamp, Dr. Andreas Seidel (Ernst & Young),

08/06/2015 Barbara Peutler (Siemens),

15/06/2015 Theresa Axmann, Nancy Rumpel (R+V Versicherung),

22/06/2015 Dr. Norman Hilbert, Dr. Stefan Hainz (Allolio & Konrad),

16/11/2015 Dr. Susanne Page (TNG Technology Consulting),

23/11/2015 Dr. Hendrik Schmidt (Boehringer-Ingelheim Pharma),

30/11/2015 Dr. Frank Schulz (PTV Group (Logistics Software)),

18/01/2016 Annika Wilmink, Agnetha Pfuhl (Deutsche Flugsicherung),

25/01/2016 Dr. Corinna Hager (Bosch),

01/02/2016 Michel Reiffert (KPMG (Wirtschaftsprüfungsgesellschaft)),

03/05/2016 Dr. Silke Horn (iteratec),

10/05/2016 Dr. Margrit Klitz (Deutsches Zentrum für Luft-, Raumfahrt (DLR)),

17/05/2016 Dr. Matthias Frankenbach (msgGillardon),

24/05/2016 Thomas Forell (Computer Simulation Technology (CST)),

14/06/2016 Elke Förg, Viktoria Wasmayr (Roever Broenner Susat Mazars),

21/06/2016 Christina Hofmeister, Markus Mies (Debeka),

25/10/2016 Jochen Boy (PROSTEP),

01/11/2016 Theodora Vakouftsi (FDM Group),

08/11/2016 Johannes Sedlaczek (Commerzbank),

13/12/2016 Marcus Haas (Deutsche Bundesbank),

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)

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

- *In Silico Cell and Tissue Science* (Associate Editor)

Matthias Hieber

- *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 H. Hofmann

- *Journal of Lie Theory* (Editor)
- *Semigroup Forum* (Honorary Editor)

Klaus Keimel

– *Categories and Algebraic Structures with Applications* (Honorary Editor)

Ulrich Kohlenbach

– *Annals of Pure and Applied Logic* (Coordinating Editor)

– *Logical Methods in Computer Science* (Member of Editorial Board)

– *Mathematical Logic Quarterly* (Member of Editorial Board)

– *Computability* (Member of Editorial Board)

– *Notre Dame Journal of Formal Logic (only 2015)* (Member of Editorial Board)

Michael Kohler

– *AStA Advances in Statistical Analysis* (Associate Editor)

Jens Lang

– *Applied Numerical Mathematics* (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* (Regional Editor Europe)

– *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

Reinhard Farwig

- *Conference "Vorticity, Rotation and Symmetry (III) - Approaching Limiting Cases of Fluid Flow" (2014) at CIRM, Luminy/Marseille, Analysis (de Gruyter) (2015)* (jointly with J. Neustupa (Prague), P. Penel (Toulon))

Klaus Keimel

- *Proceedings Domains X, International Workshop on Domain Theory and its applications, Journal of Logic and Algebraic Programming* ***84****(1) (2015)* (jointly with Klaus Keimel)

Ulrich Kohlenbach

- *Selected papers from WoLLIC 2013 (Special Issue of Journal of Computer and System Sciences, 2017)* (jointly with Leonid Libkin, Ruy de Queiroz)
- *Selected papers from WoLLIC 2014 (Special Issue of Information & Computation, 2017)* (jointly with Pablo Barcelo, Ruy de Queiroz)

Martin Ziegler

- *Proceedings of the 12th International Conference on Computability and Complexity in Analysis (CCA 2015)* (jointly with Martin Ziegler)

Marc Pfetsch

- *Evaluating Gas Network Capacities, SIAM, Philadelphia, USA, MOS-SIAM Series on Optimization, 2015* (jointly with Thorsten Koch, Benjamin Hiller, and Lars Schewe)

4.2 Monographs and Books

[1] R. Bartsch. *Allgemeine Topologie*. De Gruyter, 2015.

[2] S. Bott. *Adaptive SQP Method with Reduced Order Models for Optimal Control Problems with Constraints on the State Applied to the Navier-Stokes Equations*. Dr. Hut Verlag, 2016.

[3] D. Bratzke. *Optimal Control of Deep Drawing Processes based on Reduced Order Models*. Dr. Hut Verlag, 2015.

[4] R. Bruder, N. Feldt-Caesar, A. Pallack, G. Pinkernell, and A. Wynands. *Mathematisches Grundwissen und Grundkönnen in der Sekundarstufe II*. Schrödel Braunschweig.

[5] R. Bruder, P. Grell, J. Konert, C. Rensing, and J. Wiemeyer. *Qualitätsbewertung von Lehr- und Lernvideos* . Waxmann, 2015.
[6] R. Bruder, L. Hefendehl-Hebeker, B. Schmidt-Thieme, and H.-G. Weigand. *Handbuch der Mathematikdidaktik*. Springer Berlin Heidelberg, 2015.
[7] R. Bruder, H. Linneweber-Lammerskitten, and J. Reibold. *Individualisieren und differenzieren*. Springer Berlin Heidelberg, 2015.
[8] R. Bruder and O. Schmitt. *Joachim Lompscher and His Activity Theory Approach Focusing on the Concept of Learning Activity and How It Influences Contemporary Research in Germany*. SpringerOpen, 2016.
[9] 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. Birkhäuser, To appear (2016).
[10] G. P. Galdi and M. Kyed. *Handbook of Mathematical Analysis in Mechanics of Viscous Fluids (edited by Antonin Novotny and Yoshikazu Giga)*, chapter Time Periodic Solutions To The Navier-Stokes Equations. Berlin: Springer, To appear (2016).
[11] F. Heinrich, R. Bruder, and C. Bauer. *Problemlösen lernen*. Springer Berlin Heidelberg, 2015.
[12] I. Joormann. *Analyzing Infeasible Flow Networks*. Dr. Hut Verlag, 2015.
[13] B. Kümmerer. *Dem Bauplan Gottes auf der Spur. Mit dem Lindauer Bücherschatz auf Zeitreise zu Johannes Kepler/On the Trails of God's Blueprint. A Journey Back in Time to Johannes Kepler with Lindau's Literary Treasures*. Ehemals Reichsstädtische Bibliothek Lindau (B), 2016.
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[15] P. Liljedahl, M. Santos-Trigo, U. Malaspina, and R. Bruder. *Problem Solving in Mathematics Education*. SpringerOpen, 2016.
[16] R. Nitsch. *Diagnose von Lernschwierigkeiten im Bereich funktionaler Zusammenhänge*. Wiesbaden: Springer Spektrum, 2015.
[17] S. Pfaff. *Optimal Control of Hyperbolic Conservation Laws on Bounded Domains with Switching Controls*. Dr. Hut Verlag, 2015.
[18] A. Philipp. *Mixed-Integer Nonlinear Programming with Application to Wireless Communication Systems*. Dr. Hut Verlag, 2015.
[19] U. Roder and R. Bruder. *MAKOS – Ein Projekt zur Umsetzung der Abiturstandards*. Springer Fachmedien Wiesbaden, 2015.
[20] C. Rösnick. *Parametrisierte uniforme Berechnungskomplexität in Geometrie und Numerik*. Springer, 2015.
[21] C. Schäfer. *Optimization approaches for actuator and sensor placement and its application to model predictive control of dynamical systems*. Dr. Hut Verlag, 2015.
[22] T. Wedhorn. *Manifolds, Sheaves, and Cohomology*. Springer Spektrum, 2016.

4.3 Publications in Journals and Proceedings

4.3.1 Journals

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[13] F. Aurzada, T. Kramm, and M. Savov. First passage times of Lévy processes over a one-sided moving boundary. *Markov processes and related fields*, 21:1–38, 2015.

[14] F. Aurzada and M. Lifshits. Small deviations of sums of correlated stationary gaussian sequences. *Theory of Probability and Its Applications*, 61:626–658, 2016.

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[17] R. Bartsch. Vietoris hyperspaces as quotients of natural function spaces. *Rostock Math. Kolloq.*, 69:55–66, 2015.

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4.5 Reviewing and Refereeing

Frank Aurzada: Mathematical Reviews; ALEA, Annals of Probability, Bernoulli, Electronic Communications in Probability, Electronic Journal of Probability, ESAIM: Probability and Statistics, Journal of Statistical Physics, Journal of Theoretical Probability, Theory of Probability and its Applications

René Bartsch: Mathematical Reviews; Rostock. Math. Kolloq.

Dieter Bothe: Abstract and Applied Analysis, Advances in Differential Equations, Annales Polonici Mathematici, Bulletin of the London Mathematical Society, Communications in Mathematical Sciences, Communications in Partial Differential Equations, Comptus Rendus Acad. Sci. Paris, Czechoslovak Mathematical Journal, Differential and Integral Equations, Discrete and Continuous Dynamical Systems, Electronic Journal of Differential Equations, ESAIM Journal on Control, Optimisation and Calculus of Variations, European Journal of Applied Mathematics, Handbook on Evolutionary PDEs, International Journal for Numerical Methods in Fluids, Israel Journal of Mathematics, Journal of Evolution Equations, Journal of Mathematical Analysis and Applications, Mathematical Modelling and Numerical Analysis, Mathematische Annalen, Mathematische Nachrichten, Nonlinear Analysis Series A: Theory, Methods and Applications, Nonlinear Analysis Series B: Real World Applications, Nonlinearity, SIAM Journal on Control and Optimization, SIAM Journal on Mathematical Analysis, The IMA Journal of Applied Mathematics, The Proceedings of the American Mathematical Society, Topological Methods in Nonlinear Analysis, Zeitschrift für Analysis und ihre Anwendungen, Zeitschrift für angewandte Mathematik und Mechanik

(ZAMM), Zeitschrift für angewandte Mathematik und Physik (ZAMP) Acta Mechanica, Advances in Colloid and Interface Science, AIChE Journal, Applied Mechanics Reviews, Atomization and Sprays, Chemical Engineering and Technology, Chemical Engineering Science, Colloids and Surfaces A: Physicochemical and Engineering Aspects, Computers and Chemical Engineering, Computers & Fluids, European Journal of Mechanics - B/Fluids, Fluid Dynamics & Materials Processing, Heat and Mass Transfer, Industrial & Engineering Chemistry Research, International Communications in Heat and Mass Transfer, International Journal for Heat and Mass Transfer, International Journal of Multiphase Flow, International Journal on Chemical Reactor Engineering, Journal of Computational Physics, Journal of Fluid Mechanics, The Journal of Physical Chemistry, Physics of Fluids

Regina Bruder: Journal für Didaktik der Mathematik; Journal mathematik lehren, Zentralblatt für Didaktik der Mathemtatik, International Journal of Research in Undergraduate Mathematics Education

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.

Ulrik Buchholtz: Mathematical Reviews; Annals of Pure and Applied Logic, Bulletin of Symbolic Logic, Mathematical Structures in Computer Science, SIGMA, Studia Logica

Yann Disser: Distributed Computing, European Journal of Operations Research, INFORMS Journal of Computing, Journal of Optimization Theory and Applications, Journal of Scheduling, Mathematical Programming, Theoretical Computer Science, ACM-SIAM Symposium on Discrete Algorithms (SODA), European Symposium on Algorithms (ESA), Conference on Web and Internet Economics (WINE), International Colloquium on Automata, Languages, and Programming (ICALP), International Conference on Algorithms and Complexity, Symposium on Theoretical Aspects of Computer Science (STACS)

Herbert Egger: Mathematical Reviews; Applicable Analysis, Applied Numerical Mathematics, Computers and Mathematics with Applications, Inverse Problems, Inverse Problems in Imaging, Mathematics of Computation, Mathematical Modeling and Numerical Analysis, Mathematical Models and Methods in Applied Sciences, Numerische Mathematik, SIAM Journal on Numerical Analysis, SIAM Journal on Scientific Computing

Christoph Erath: Mathematical Reviews; SIAM Journal on Numerical Analysis, SIAM Journal on Scientific Computing, Numerische Mathematik, Applied Mathematics and Computation, Journal of Computational and Applied Mathematics, Journal of Scientific Computing, Monthly Weather Review, Geoscientific Model Development Discussion, Finite Volumes for Complex Applications VIII

Tobias Ewald: Computer Aided Geometric Design

Reinhard Farwig: Mathematical Reviews; Analysis (Berlin, de Gruyter) Annali dell'Università di Ferrara, Sez. VII, Sc. Mat., Applied Mathematics and Computation, Applied Mathematics Letters, Archiv der Mathematik, Asymptotic Analysis, Communications on

Pure and Applied Analysis, Communications in Partial Differential Equations, Differential Equations and Applications, Discrete and Continuous Dynamical Systems-B, J. Evolution Equations, J. Mathematical Analysis and Applications, J. Mathematical Fluid Mechanics, manuscripta mathematica, Mathematical Methods in the Applied Sciences, Mathematische Annalen, Mathematische Nachrichten, SIAM J. Math. Analysis, Zeitschrift für Angewandte Mathematik und Physik

Alf Gerisch: Applied Mathematics and Computation, Computer Methods in Biomechanics and Biomedical Engineering, SIAM Journal on Scientific Computing, Journal of Computational and Applied Mathematics, Journal of Applied Mathematics and Computing, Journal of Mathematical Biology, Journal of Theoretical Biology, Mathematical Biosciences, Journal of the Royal Society Interface, TU Wien "Innovative Projects/Staff", External reviewer in PhD commitee at MOX Group at TU Milan

Karsten Grosse-Brauckmann: Mathematical Reviews; Journal of Approximation Theory, Computer Aided Geometric Design

Christian Herrmann: Zentralblatt; Order, Algebra Universalis, Bull. Sect. of Logic U. of Lodz, Math. Slovaca

Karl H. Hofmann: Referee's Reports in 2015-16 for the following journals and publishers; Bull.Aust.Math.Soc., Bull.Sci.Math., Gazette Aust.Math.Soc., Forum Math., Mathematische Zeitschr., Topology Appl.;Cambridge University Press

Christopher Hojny: Graphs and Combinatorics

Amru Hussein: Mathematical Reviews

Klaus Keimel: Proceedings of the American Mathematical Society, Journal of the London Mathematical Society, Acta Mathematica Sinica, Journal of Algebra and its Applications, Communications in Algebra, Topology and its Applications, Positivity, Order, Mathematica Bohemica, Hacettepe Journal of Mathematics, Annals of Pure and Applied Logic, Journal of Logic and Algebraic Programming, Logical Methods in Computer Science, Theoretical Computer Science, Electronic Notes in Theoretical Computer Science, Mathematical Structures in Computer Science, Logical Methods in Computer Science

Ulrich Kohlenbach: Annals of Pure and Applied Logic, Applied Mathematics and Computation, Bulletin of Symbolic Logic, Electronic Proceedings in Theoretical Computer Science, Logical Methods in Computer Science, Numerical Functional Analysis and Optimization, Optimization

Michael Kohler: Annals of the Institute of Statistical Mathematics, Electronic Journal of Statistics, ESAIM: Probability and Statistics, Journal of Multivariate Analysis, Statistical papers

Angeliki Koutsoukou-Argyraki: Mathematical Reviews (AMS)

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

Mads Kyed: Mathematical Reviews; Mathematische Nachrichten, Nonlinearity, Mathematische Annalen, Journal of Mathematical Fluid Mechanics, Journal of Mathematical Analysis and Applications, Journal of the Mathematical Society of Japan, Methods in the Applied Sciences, International Journal of Non-Linear Mechanics

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 on Analysis, SIAM Journal Scientific on Computing

Oliver Lass: IEEE American Control Conference, Journal of Applied Mathematics and Mechanics, ESAIM: Control, Optimisation and Calculus of Variations

Matthias Meiners: Mathematical Reviews, Zentralblatt; Annals of Probability, Advances in Applied Probability, Electronic Journal of Probability, Journal of Applied Probability, Statistics and Probability Letters, Stochastic Processes and their Applications

Martin Otto: Annals of Pure and Applied Logic, Journal of Symbolic Logic, Journal of Logic and Computation, ACM/IEEE Symposium on Logic in Computer Science, International Colloquium on Automata Languages and Programming, Computer Science Logic, Artificial Intelligence, Acta Informatica, Mathematical Foundations of Computer Science, DFG, Alexander von Humboldt Foundation

Andreas Paffenholz: Journal of Algebraic Combinatorics, European Journal of Combinatorics, Discrete and Computational Geometry, Annals of Combinatorics, SIAM Journal on Discrete Mathematics, Journal of Combinatorial Theory, Series A

Marc Pfetsch: 18th Conference on Integer Programming (IPCO) 2016, 19th Conference on Integer Programming (IPCO) 2017, Applied Mathematical Modelling, Discrete Applied Mathematics, Discrete Optimization, Linear Algebra and Its Applications, Management Science, Mathematical Programming Computation, Public Transport, TOP, Transportation Science, Transactions on Signal Processing

Anna-Maria von Pippich: Acta Arith., Elem. Math., Int. J. Number Theory, Ramanujan J.

Thomas Powell: Annals of Pure and Applied Logic, Archive for Mathematical Logic, Association for Computing Machinery, Lecture Notes in Computer Science, Leibniz International Proceedings in Informatics, Logic Journal of the IGPL

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; Journal of Functional Analysis, Journal of the London Mathematical Society, Concrete Operators, Mediterranean Journal of Mathematics, Banach Journal of Mathematical Analysis, Mathematische Zeitschrift, Operator Theory: Advances and Applications

Nils Scheithauer: Algebra and Number Theory, Annals of Mathematics, Compositio Mathematica, Communications in Mathematical Physics, Duke Mathematical Journal, International Journal of Number Theory

Werner Schindler: Journal of Cryptographic Engineering, CHES 2015, CHES 2016

Alexandra Schwartz: Applied Mathematics and Computation, Asia-Pacific Journal of Operational Research, Journal of Optimization Theory and Applications, Optimization, Optimization Letters, SIAM Journal on Optimization

Christian Stinner: Mathematical Reviews, Zentralblatt; Annali dell'Università di Ferrara, Communications on Pure and Applied Analysis, Differential and Integral Equations, Discrete and Continuous Dynamical Systems - Series A, Discrete and Continuous Dynamical Systems - Series B, Funkcialaj Ekvacioj, Journal of Evolution Equations, Mathematical Methods in the Applied Sciences, Mathematical Models and Methods in the Applied Sciences, Nonlinear Analysis: Real World Applications, Nonlinear Analysis: Theory, Methods & Applications

Thomas Streicher: Mathematical Reviews; Applied Categorical Structures, Journal of Pure and Applied Algebra, Theory and Applications of Categories, Journal of Symbolic Logic, Mathematical Logic Quarterly

Andreas Tillmann: IEEE Transactions on Information Theory, Inverse Problems, Signal Processing (Elsevier), Applied and Computational Harmonic Analysis (Elsevier), IEEE Transactions on Signal Processing, IEEE Signal Processing Letters, EURASIP Journal on Advances in Signal Processing, Applied Optics, Signal Processing with Adaptive Sparse Structured Representations Workshop (SPARS) 2017

Patrick Tolksdorf: Mathematical Reviews; Journal of Mathematical Fluid Mechanics

Stefan Ulbrich: Computers & Mathematics with Applications, IMA Journal on Numerical Analysis, Numerische Mathematik, SIAM Journal on Control and Optimization, SIAM Journal on Optimization

Mirjam Walloth: Journal of Computational and Applied Mathematics, SIAM Journal on Numerical Analysis

Cornelia Wichelhaus: Bernoulli, Applied Probability Trust, Stochastic Processes and their Applications, Operational Research, Opsearch, Acta Mathematica Scientia

Winnifried Wollner: Mathematical Reviews; Applications of Mathematics, Applied Mathematics and Computation, Applied Numerical Mathematics, Calcolo, Computational Optimization and Applications, ESAIM: Control, Optimization and Calculus of Variations, Journal of Applied Mathematics and Computing, Journal of Mathematical Analysis and Applications, Journal of Optimization Theory and Applications, Journal of Scientific Computing, Numerical Algorithms, SIAM Journal on Control and Optimization, SIAM Journal on Numerical Analysis, SIAM Journal on Optimization

HoTT-Lean: *HoTT library for Lean*

The homotopy type theory library for the Lean proof assistant. For more information, see `github.com/leanprover/lean2`

Contributor at TU Darmstadt: Ulrik Buchholtz

HOMME: *Integrating Semi-Lagrangian schemes*

A spectral-element dynamical core based on the High-Order Method Modeling Environment (HOMME) framework is the default dynamical core for the Community Atmosphere Model (CAM, version 5.2 and higher) - CAM-SE. The grid system in HOMME is based on the cubed-sphere geometry resulting from a gnomonic equiangular projection of the sphere. It has been shown that this approach is highly scalable, up to 170 000 cores. Atmospheric models used for practical climate simulation must be capable of handling the transport of hundreds of tracers. For computational efficiency, conservative multi-tracer semi-Lagrangian type transport schemes are appropriate. The integration of two schemes, SPELT and CSLAM, and the coupling to the spectral element dynamical core is part of the software contribution.

Contributor at TU Darmstadt: Christoph Erath

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 outer-approximation-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)

netmic: *A program that computes Irreducible Infeasible Subsystem Arc Covers in Flow Networks*

netmic is a python-package that implements several solution approaches for Irreducible Infeasible Subsystem Arc Covers for the special case of Network Flow problems. The main focus is on heuristics, but there are also exact solution approaches included. Additionally, netmic contains a generator for infeasible flow network in-

stances.
For more information, see `www.tu-braunschweig.de/mo/staff/joormann`

Contributor at TU Darmstadt: Imke Joormann

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 (CFD), optimisation and moving finite elements.

Contributor at TU Darmstadt: Jens Lang, Alf Gerisch, Dirk Schröder

polymake: *Software for Geometric Combinatorics*
polymake started out as a tool for the algorithmic treatment of convex polyhedra. By now it also deals with toric varieties, tropical polytopes, and other objects. The software is jointly developed by the polymake team, lead by Ewgenij Gawrilow (TomTom) and Michael Joswig.
For more information, see `www.polymake.org`

Contributor at TU Darmstadt: Andreas Paffenholz

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 Zuse-Insitut Berlin and FAU Erlangen-Nürnberg.
For more information, see `scip.zib.de`

Contributor at TU Darmstadt: Tobias Fischer, Tristan Gally, Marc E. Pfetsch

AutoDiff: *Automatic Differentiation with Matlab*
AutoDiff is a Matlab Toolbox which allows one to compute derivatives of arbitrary order fast and reliably, see `https://de.mathworks.com/matlabcentral/fileexchange/56856-autodiff`

Contributor at TU Darmstadt: Ulrich Reif

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

donlp2: *Solving general smooth nonlinear optimization problems, last version 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. In the period under review the technique of taking numerical gradients has been revised again and several minor flaws were removed. Three commercial licenses have been sold during this period and 38 academic (free) licenses were given. 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. 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. It is accessible from anywhere in the world and indeed users from about 80 countries are visiting it. 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. This English version has been extended by 14 newly implemented methods and many other implementations were completely redesigned. There were about 28500 visits in 2013 and 36000 in 2014 compared to 6000 in 2011 and 12000 in 2012. For more information, see `numawww.mathematik.tu-darmstadt.de`

Contributor at TU Darmstadt: Peter Spellucci

DOLPHIn: *Dictionary learning method for 2D noisy (sparse) phase retrieval.*
Matlab implementation. For more information, see
`http://www.mathematik.tu-darmstadt.de/~tillmann/#dolphin`

Contributor at TU Darmstadt: Andreas Tillmann

ℓ_1-Houdini: *Homotopy method for ℓ_1-minimization under ℓ_∞-constraints.*
Matlab implementation. For more information, see
`http://www.mathematik.tu-darmstadt.de/~tillmann/#l1houdini`

Contributor at TU Darmstadt: Andreas Tillmann

Triangular Taylor Hood finite elements: *Matlab code for mixed P2/P1 finite elements*
This 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. Introductory examples of a Poisson problem and a Burgers' problem is also available. For more information, see `https://de.mathworks.com/matlabcentral/fileexchange/49169`.

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: Winnifried Wollner

5 Theses

5.1 Habilitations

2015

Gregoriades, Vassilios, *Descriptive Set Theory: Advancements in Effective Theory and Applications* (Ulrich Kohlenbach)

Huy, Nguyen Thieu, *Invariant Manifolds and Asymptotic Behavior of Solutions to Evolution Equations* (Matthias Hieber)

Schröder, Matthias, *The Coincidence Problem in Computable Analysis* (Thomas Streicher)

2016

Stinner, Christian, *Qualitative Behavior of Solutions to Parabolic Equations with Different Types of Diffusion* (Umhabilitation von TU Kaiserslautern)

5.2 PhD Dissertations

2015

Alfes, Claudia, *CM values and Fourier coefficients of harmonic Maass forms* (Jan Bruinier)

Bott, Ann-Kathrin, *Nichtparametrische Schätzung von (bedingten) Verteilungen ausgehend von Daten mit zusätzlichen Messfehlern* (Michael Kohler)

Bott, Stefanie, *Adaptive SQP Method with Reduced Order Models for Optimal Control Problems with Constraints on the State Applied to the Navier-Stokes Equations* (Stefan Ulbrich)

Bratzke, Daniela, *Optimal Control of Deep Drawing Processes based on Reduced Order Models* (Stefan Ulbrich)

Burggraf, Timo, *Development of an automatic, multidimensional, multicriterial optimization algorithm for the calibration of internal combustion engines* (Stefan Ulbrich)

Egert, Moritz, *On Kato's conjecture and mixed boundary conditions* (Robert Haller-Dintelmann)

Joormann, Imke, *Analyzing Infeasible Flow Networks* (Marc Pfetsch)

Möller, Claudia, *A New Strategy for Exact Determination of the Joint Spectral Radius - Eine neue Strategie zur exakten Bestimmung des gemeinsamen Spektralradius* (Ulrich Reif)

Pfaff, Sebastian, *Optimal Control of Hyperbolic Conservation Laws on Bounded Domains with Switching Controls* (Stefan Ulbrich)

Philipp, Anne, *Mixed-Integer Nonlinear Programming with Application to Wireless Communication Systems* (Stefan Ulbrich)

Sauer, Jonas, *Navier-Stokes Flow in Partially Periodic Domains* (Reinhard Farwig)

Schade, Katharina Clara, *Alongside the parabolic quasilinear method in fluid dynamics* (Matthias Hieber)

Schäfer, Carsten, *Optimization approaches for actuator and sensor placement and its application to model predictive control of dynamical systems* (Stefan Ulbrich)

Tiburtius, Sara, *Homogenization for the multiple scale analysis of musculoskeletal mineralized tissues* (Jens Lang)

2016

Alex, Tristan , *Minimal Surfaces in Riemannian Fibrations* (Karsten Große-Brauckmann)

Bolkart, Martin, *The Stokes Equations in Spaces of Bounded Functions and Spaces of Mean Oscillation* (Matthias Hieber)

Feldt-Caesar, Nora , *Konzeptualisierung und Diagnose von mathematischem Grundwissen und Grundkönnen - eine theoretische Betrachtung und exemplarische Konkretisierung am Ende der Sekundarstufe II* (Regina Bruder)

Hufler, Tobias, *Automorphe Formen auf orthogonalen und unitären Gruppen* (Jan Bruinier)

Körnlein, Daniel, *Quantitative Analysis of Iterative Algorithms in Fixed Point Theory and Convex Optimization* (Ulrich Kohlenbach)

Koutsoukou-Argyraki, Angeliki, *Proof Mining for Nonlinear Operator Theory* (Ulrich Kohlenbach)

Möller, Sven, *A Cyclic Orbifold Theory for Holomorphic Vertex Operator Algebras and Applications* (Nils Scheithauer)

Odathuparambil, Sonja, *Ambient Spline Approximation on Manifolds* (Ulrich Reif)

Rath, Alexander, *Global Error Estimation for Stiff Differential Equations* (Jens Lang)

Schmitt, Oliver, *Reflexionswissen zur linearen Algebra in der Sekundarstufe II* (Regina Bruder)

Schröder, Dirk, *Peer Methods in Optimal Control* (Jens Lang)

Steinberg, Florian, *Computational Complexity Theory for Advanced Function Spaces in Analysis* (Martin Ziegler)

Tolksdorf, Patrick, *On the L^p-theory of the Navier-Stokes equations on Lipschitz domains* (Robert Haller-Dintelmann)

Vrzina, Miroslav, *Constant Mean Curvature Annuli in Homogeneous Manifolds* (Karsten Große-Brauckmann)

2015

Beck, Sönke Till, *Asymptotic stationary distribution of regular pertubed Markov chains* (Volker Betz)

Höll, Roman, *Optimierung von Stabwerken unter globalen Knickbedingungen* (Stefan Ulbrich)

Kleinke, Anja, *Filterung in der quantenstochastischen Analysis* (Burkhard Kümmerer)

Korotkov, Tatjana, *Jump and Volatility Components in German Equity Trading* (Stefan Ulbrich)

Kringel, Lars, *Lösung von Rangbeschränkten Semidefiniten Programmen durch Completely Positive Programming* (Stefan Ulbrich)

Meier, Max, *Ein robuster Optimierungsansatz für Kreditportfolios mit Chance Constrains* (Stefan Ulbrich)

Nalliah, Neslyn Jesica, *Der Zahlbegriff im Spiegel der Multiplikation* (Burkhard Kümmerer)

Pfeiffer, Thilo, *Dynamic Pricing for Airline Partners* (Stefan Ulbrich)

Schiller, Benjamin, *Peer-to-Peer Networks - Anerkennung aus der Informatik* (Thorsten Strufe)

Schramm, Johannes, *Logic Formalization and Automated Deductive Analysis of Business Rules* (Reiner Hähnle)

Senina, Olga, *Multilevel Optimierungsverfahren für PDE restringierte Probleme mit Nebenbedingungen an den Gradienten* (Stefan Ulbrich)

Terpstra, Maria, *Density Estimation in a Simulation Model* (Michael Kohler)

Yugenthiran, Sujanthy, *Methoden zur Berechnung von Flüssen in Netzwerken* (Werner Krabs)

2016

Hosenfeld, Dominik Berthold, *Zur adaptiven Wahl der Glättungsparameter in der nichtparametrischen Regressionsschätzung* (Michael Kohler)

Mercan, Necati, *Eine graphische Oberfläche zur Entwicklung geeigneter Zielfunktionen in der Fahrzeugsimulation* (Martin Kiehl)

5.4 Master Theses

2015

Adami, Thomas, *Robuste Strategien zur Portfoliooptimierung* (Stefan Ulbrich)

Akman, Tugba, *Gradientenformeln für nichtlineare Wahrscheinlichkeitsrestriktionen mit Normalverteilungen und Anwendung auf Downlink Beamforming* (Stefan Ulbrich)

Alkeilani Alkadri, Nabil, *Post-Quantum Commitment Schemes* (Johannes Buchmann)

Arbib, Said, *Aufgabensets für die Gestaltung einer Lernumgebung zur Differentialrechnung in der Fachoberschule* (Regina Bruder)

Barz, Garret, *Mathematische und numerische Analyse eines Affine-Scaling-Innere-Punkte-Verfahrens für nichtlineare Optimierung mit einer linearen Gleichungsnebenbedingung und Box-Restriktionen* (Irwin Yousept)

Bergner, Arnold, *Nash-Gleichgewicht: Geschichte und mathematische Perfektheit* (Alexandra Schwartz)

Blum, Andreas Erich, *Individuelle Förderung mathematischer Kompetenzen im Unterricht an Berufsschulen* (Josef Rützel)

Brahm, Nadine Lisanne, *Nonparametric Quantile Estimation based on Nearest Neighbor Surrogate Models* (Michael Kohler)

Buck, Micha, *Verhalten einer Irrfahrt mit Absorption* (Frank Aurzada)

Diehl, Jasmin, *Optimization of Trusses with Buckling Stabilization by Mixed-Integer Second-Order Cone Programming* (Stefan Ulbrich)

Dimitrov, Dimitar Iliev, *Return distribution and Performance of Funds concentrated on Renewable energies* (Dirk Schiereck)

Erbenich, Vanessa Ines Philine, *On the Efficiency of Lattice-Based Encryption* (Johannes Buchmann)

Fehr, Victoria, *Sanitizable Signcryption - Sanitizable Signatures on Encrypted Data* (Marc Fischlin)

Feldman, Yulia, *Dichteschätzung in einem Simulationsmodell* (Michael Kohler)

Fitzke, Michael, *Schätzung von Sprungstellen einer Regressionsfunktion durch Kernschätzung* (Michael Kohler)

Frank, Isabelle, *Portofoliooptimierung unter Einbeziehung illiquider Vermögenstitel* (Dirk Schiereck)

Freimeyer, Sebastian, *Entwicklung und Erprobung einer alternativen, IEC 61131-konformen, Industriesteuerung für berufliche Schulen unter ökonomischen und didaktischen Gesichtspunkten* (Jens Gallenbacher)

Fricke, Mathis, *Characterization of particle size distributions via angular light scattering* (Herbert Egger)

Fritzsche, Linda, *The Business Model of German building Societies and the Management of Interest Rate Risk* (Dirk Schiereck)

Fujara, Nicola Sophia, *Faire Gewinnverteilung in kooperativen Spielen* (Werner Krabs)

Gnegel, Franziska, *Siegel Modular Forms and L-Functions* (Jan Hendrik Bruinier)

Gries, Mathis Yannik, *Lokale Lösungen der Korteweg-de Vries-Gleichung in Bourgain Räumen* (Matthias Hieber)

Habeck, Oliver, *Semiglatte Newton-Verfahren für Kontaktprobleme mit Reibung* (Stefan Ulbrich)

Hansmann, Matthias, *Quantilschätzung in einem Simulationsmodell: Theorie und Anwendung* (Michael Kohler)

Hanst, Maleen, *Extrema des diskreten zweidimensionalen freien Gaußschen Feldes* (Volker Betz)

Heeg, Simon, *Mixed finite element methods for the Darcy flow problem* (Herbert Egger)

Hölzel, Tanja, *Bedeutung von Selbstbeobachtung in beruflichen Schulen* (Josef Rützel)

Huyen, Chan Bao, *Robust Growth-Optimal Portfolios* (Stefan Ulbrich)

Isufaj, Fatima, *Lösungsmethoden für das 3-dimensionale Packungsproblem mit Nebenbedingungen* (Marc Pfetsch)

Janzen, Kristina, *Optimale Sensorplatzierung in dynamischen Prozessen mit Methoden des optimalen Designs von Experimenten* (Stefan Ulbrich)

Kettner, Marvin, *Prinzipien großer Abweichungen für Markovketten* (Frank Aurzada)

Knobloch, Eduard, *Integrierte Produktions- und Bestandsplanung unter Berücksichtigung flexibler Personalressourcen* (Christoph Glock)

Knof, Albrun, *Markov-Operatoren und ihre Dilatationen erster Ordnung* (Burkhard Kümmerer)

Korn, Marco Rudolf, *Untersuchung über die Implementierung von lernfeldorientierten Lehrplänen für Ausbildungsberufe aus dem Bereich der Elektro- und Informationstechnik.* (Gerhard Faber)

Kreis, Mathias, *Verbesserung von Wirtschaftsprognosen durch Bagging und Boosting* (Jens Krüger)

Kreiß, Alexander, *Crossing probabilities in triangular percolation: Smirnov's theorem* (Volker Betz)

Krüger, Thomas, *The Q-Codegree of Lattice Polytopes* (Andreas Paffenholz)

Kugler, Thomas, *A Finite Element Method for the Damped Wave Equation* (Herbert Egger)

Lang, Sandra, *Approximation projektiver Tensornormen mit konvexer algebraischer Geometrie* (Burkhard Kümmerer)

Lang, Mirko, *Eine L1-Theorie der bedingten Dichteschätzung* (Michael Kohler)

Leja, Jessica Anna, *Numerische Modellierung von Wandelanleihen und ihre Bedeutung für Immobilienunternehmen* (Jens Lang)

Maasz, Manuel, *Optimales Stabwerkdesign mit globalen Knicknebenbedingungen unter Verwendung des Sequential Semidefinite Programming Verfahrens* (Stefan Ulbrich)

Mayer, Christoph Manuel, *Implementing a Tool Kit for Ring-LWE Based Cryptography in Arbitrary Cyclotomic Number Fields* (Johannes Buchmann)

Mindt, Pascal, *Ein implizites Box-Verfahren für Transportgleichungen mit Flussumkehr* (Jens Lang)

Möller, Jens-Henning, *Multiplier estimate in spaces with mixed norms* (Reinhard Farwig)

Mühlbauer, Julia, *Nichtparametrische Schätzung eines Maximums von Quantilen* (Michael Kohler)

Niel, Lisa Jannic, *Intra-Operative Landmark Extraction for Semi-Automatic Brain Shift Correction* (Georgios Sakas)

Nowak, Daniel, *Optimale Aktorplatzierung in Stabwerken zur Erhöhung der kritischen Knicklast* (Stefan Ulbrich)

Otterbein, Markus, *Konvexe Relaxationen bei der robusten Stabwerkoptimierung unter dynamischen Lasten* (Stefan Ulbrich)

Radu, Bogdan, *A mixed finite element method for the acoustic wave equation* (Herbert Egger)

Räsch, Sascha Andreas Boris, *A linear direct/iterative solver on bordered block diagonal matrices for circuit simulations* (Herbert Egger)

Rössler, Maximilian, *Hecke operators on vector valued modular forms* (Nils Scheithauer)

Rothermel, Nina Karin, *Nichtparametrische Quantilschätzung unter Verwendung von Importance Sampling* (Michael Kohler)

Rotkvic, Marko, *Reduzierte Basis-Modelle für Adaptive Finite Elemente Lösungen* (Jens Lang)

Salupo, Giuseppe, *Robuste Optimierung des Conditional Value at Risk und Kredit-Portfolio-Management* (Stefan Ulbrich)

Schaffland, Tim Fabian, *Nichtparametrische Schätzung eines Modells für latente Variablen* (Michael Kohler)

Scherf, Nadine, *IbeA - Ein Instrument zur Erfassung des beruflichen Aspirationsfeldes - Eine Evaluation des Diagnoseinstruments für Berufsorientierung und Forschung* (Birgit Ziegler)

Schimmel, Janina, *Stochastic Processes and Queues* (Frank Aurzada)

Schmidt, Roman, *Nichtparametrische Schätzung einer Regressionsfunktion und ihrer Ableitungen* (Michael Kohler)

Schünemann, Sascha, *Adaptive density estimation in a simulation model* (Michael Kohler)

Schwinn, Sebastian, *Backoff-Algorithmen von Slotted-Aloha-Systemen* (Frank Aurzada)

Sedlaczek, Johannes, *Choquet-Theorie vollständig positiver Operatoren* (Burkhard Kümmerer)

Seyfert, Anton, *Periodische Lösungen von Evolutionsgleichungen in Interpolationsräumen* (Matthias Geißert)

Stähler, Maximilian, *Optimale Randsteuerung von hyperbolischen Erhaltungsgleichungen mit Anwendung auf Verkehrsnetze* (Stefan Ulbrich)

Starik, Sebastian, *Schätzung von Quantilen basierend auf Spline-Ersatzmodellen* (Michael Kohler)

Stumpf, Johanna, *Characterisation of the Expressive Power of Modal Logic with Inclusion Atoms* (Martin Otto)

Thies, Holger, *Case-Studies in Exact Real Arithmetic: Implementations and empirical Evaluation* (Martin Ziegler)

Ulsenheimer, Fabian, *Schätzung von Quantilen basierend auf adaptiven Partitionenschätzer* (Michael Kohler)

Walter, Anna, *Mathematical Programs with Equilibrium Constraints mit Anwendung auf die Optimierung von Kontaktproblemen* (Stefan Ulbrich)

Wasmayr, Viktoria, *Adaptive Schätzung von bedingten Dichten* (Michael Kohler)

Wassermann, Elena, *Adaptive Dichteschätzung mit zusätzlichen kleinen Messfehlern* (Michael Kohler)

Weber, Tobias, *Combiners for Robust Pseudorandom Number Generators* (Marc Fischlin)

Weismüller, Carina, *Didaktische Rekonstruktion einer digitalen Lernumgebung zu mathematischen Basiskompetenzen* (Regina Bruder)

Wolf, Felix, *Bisimulation-Invariant MSO over Classes of Finite Transition Systems* (Achim Blumensath)

Zhu, Liqun, *Estimation of a quantile in a high dimensional simulation model using importance sampling* (Michael Kohler)

2016

Alt, Lukas Sebastian, *Adaptive Schätzung von Quantilen in einem Simulationsmodell unter Verwendung von Importance Sampling* (Michael Kohler)

Althaus, Lea, *On Acoustic Tomography using Paraxial Approximations* (Herbert Egger)

Bauer, Sascha, *Nichtparametrische Quantilschätzung basierend auf Ersatzmodellen und Importance Sampling* (Michael Kohler)

Bauer, Benedikt, *Zur Schätzung von Ersatzmodellen für Computerexperimente im Hochdimensionalen* (Michael Kohler)

Beck, Pascal, *Untersuchung eines SQP-Algorithmus mit gleichungsrestringierter Phase* (Stefan Ulbrich)

Beisenherz, Fabian, *Nichtparametrische Schätzungen basierend auf latenten Variablen* (Michael Kohler)

Berg, Viktoria, *Adaptive Schrittweitenkontrolle für IMEX-PEER-Verfahren* (Jens Lang)

Bergen, Christoph, *Kopositive und vollständig positive Programme und ihre Anwendung auf quadratische Programme* (Stefan Ulbrich)

Bethcke, Johannes, *Synthesis of a Hydrostatic Power Transmission System using MINLP* (Marc Pfetsch)

Bischof, Daniel, *Diversification effects in asymptotically independent portfolios* (Michael Kohler)

Bitter, Vitali, *Analysis der MHD-Gleichungen in Besovräumen* (Reinhard Farwig)

Bonin, Julian, *Schätzung einer Funktion durch Interpolation eines Teils der beobachteten Daten* (Michael Kohler)

Brendel, Jacqueline, *Efficient Proactiv Secret Sharing* (Johannes Buchmann)

Brunning, Katharina, *Sherali-Adams Relaxierungen von Graphenisomorphie Polytopen* (Marc Pfetsch)

Buck, Johannes Jeremias, *Eisensteinreihen zur Weildarstellung und Thetareihen* (Jan Hendrik Bruinier)

Carkit, Ercan, *Numerische Methoden der nichtlinearen optimalen Versuchsplanung* (Stefan Ulbrich)

Christoffer, Frauke , *Gültige Relaxierungen der Eulergleichungen durch Diskretisierung zur Lösung von Zulässigkeitsproblemen in der Gasnetzwerkoptimierung* (Stefan Ulbrich)

Chu, Ba Duong, *Hierarchische Splines - Datenstruktur und Anwendungen* (Ulrich Reif)

Diehl, Elisabeth Andrea Gertrud, *Erdwärmesondenspeicher - Nichtlineare gemischt-ganzzahlige Optimierung von Ersatzmodellen auf Basis Statistischer Versuchsplanung* (Ingo Sass)

Dosch, Christina, *Rekursive Schätzung von Quantilen in einem Simulationsmodell* (Michael Kohler)

Eckel, Pascal Roland, *Eine alternative Lösungsmethode für Optimierungsprobleme mit Komplementaritäts- oder Kardinalitätsrestriktionen basierend auf semi-infiniten Programmen* (Alexandra Schwartz)

Ehlert, Johannes Florian, *Quasifreie Zustände auf CCR-C*-Algebra und Verschränkung* (Burkhard Kümmerer)

Eiter, Thomas Walter, *Fourier Multipliers on Locally Compact Abelian Groups and their Applications to Partial Differential Equations* (Mads Kyed)

Fischer, Carsten, *Nonparametric estimation of densities and quantiles* (Michael Kohler)

Frenzel, David, *Calcul stochastique du capital économique - application de la méthode LSMC au secteur de l'assurance* (Lyon, Frankreich)

Fürnstall, Lena, *Maximal regularity for evolution equations governed by non-autonomous forms* (Robert Haller-Dintelmann)

Gerny, Friedrich, *Numerische Behandlung von Optimalsteuerungsproblemen für skalare Erhaltungsgleichungen mit an-/aus-Schaltungen mit Anwendung auf ein Verkehrsmodell mit Ampelschaltungen* (Stefan Ulbrich)

Görich, Daniel, *Politische und ökonomische Determinanten von Sonderwirtschaftszonen* (Michael Neugart)

Göttmann, Sabrina, *Integration of Learning and Forgetting Effects in the Economic Lot Scheduling Problem and Achieving Feasible Solutions Using the Common-Cycle Approach by Hanssmann and the Time-Varying Lot-Size Approach by Dobson* (Christoph Glock)

Grasser, Tim, *Schätzung von Dichten und Quantilen in einem Simulationsmodell* (Michael Kohler)

Grimm, Vanessa Rebecca, *Thetareihen und Heckeoperatoren* (Nils Scheithauer)

Grimm, Philip Hans, *Ein kombinatorischer Branch-and-Bound-Algorithmus für die Berechnung der Restricted Isometry Konstanten* (Marc Pfetsch)

Herbst, Alexander, *Adaptive estimation of conditional densities* (Michael Kohler)

Heun, Sebastian, *Globales Optimieren eines robusten Stabwerks mit einem gemischt ganzzahligen Programm* (Stefan Ulbrich)

Hopf, Jonathan, *Schätzung von Quantilen ausgehend von Daten mit Messfehlern* (Michael Kohler)

Hornauer, Miriam, *Ein zweiseitiges Relaxierungsverfahren für mathematische Programme mit Komplementaritätsrestriktionen mit starken Konvergenzeigenschaften* (Alexandra Schwartz)

Islam, Chris-Gabriel, *Verbesserung von Umsatzprognosen durch Kombinationsmethoden - Eine Anwendung am Beispiel von T-Systems* (Jens Krüger)

Ivanov, Bozhidar, *Shortest Paths with Conflicts* (Marc Pfetsch)

Janocha, Daniel, *Stochastic Modeling of Stock Prices Incorporating Jump Diffusion and Shot Noise Models* (Matthias Meiners)

Kanbay, Hatice, *Professionalität des Lehrers / der Lehrerin speziell Professionalität des Lehrers/der Lehrerin mit Migrationshintergrund* (Josef Rützel)

Kertels, Fabian, *Singular weight products on lattices with small discriminant* (Nils Scheithauer)

Keukoua Wantiep, Guenole, *Portfolio Selection under Distributional Uncertainty: A Relative Robust CVaR Approach* (Stefan Ulbrich)

Kinz, Monika, *Optimale Pausenplanung von LKW-Fahrern mit integrierter Parkplatzwahl* (Marc Pfetsch)

Knauf, Nils, *Schätzung von Quantilen ausgehend von Daten mit zusätzlichen Messfehlern* (Michael Kohler)

Knell, Manuel-Elias, *Sinnfragen im Analysisunterricht - Diskussion zum Mehrwert von Mathematik* (Regina Bruder)

Köhler, Jan, *Schnittebenenverfahren zur Optimierung submodularer Funktionen* (Marc Pfetsch)

Kohrt, Nils, *Zur Portfolio Auswahl unter Verteilungsunsicherheit - Ein robuster CVaR Ansatz* (Stefan Ulbrich)

Kreß, Klaus, *Periodic and almost periodic solutions to evolution equations* (Matthias Hieber)

Kuske, Jan Ferdinand, *Discrete tomography with sparse gradients* (Marc Pfetsch)

Landmann, Philipp, *Phasenübergänge bei räumlichen Zufallspermutationen: Theorie und Numerik* (Volker Betz)

Lange, Jan-Hendrik, *Integrality Aspects of Sparse Recovery via l1-Minimization* (Marc Pfetsch)

Lato, Ellen Angelika Dagmar, *Fehlerangriffe auf gitterbasierte Verschlüsselungsverfahren* (Johannes Buchmann)

Lautenbach, Stefan, *Aussagen zur Konvergenzgeschwindigkeit in der multivariaten Dichteschätzung* (Michael Kohler)

Maliqi, Beqir, *Eine Anwendung von Fehlerschranken auf Optimierungsprobleme mit Kardinalitätsrestriktionen* (Alexandra Schwartz)

Nattler, Julian, *Über die Aussagekraft von Rankings* (Marc Pfetsch)

Pantalia, Preetkamal Singh, *Schätzung von Quantilen in einem Simulationsmodell unter Verwendung von Importance Sampling* (Michael Kohler)

Park, Sung-Ho, *Alternating Directions Method of Multipliers - Implementation for L1-problems* (Stefan Ulbrich)

Pfifferling, Lena, *A disjunctive programming approach for the link activation problem* (Stefan Ulbrich)

Pohl, Daniel, *Die Darstellung von QCQPs als verallgemeinerte vollständig positive Programme und ein Approximationsalgorithmus zur Lösung von copositiven Programmen* (Stefan Ulbrich)

Raab, Pia Josephine, *Residuenbasierte Fehlerschätzer für Hindernisprobleme* (Mirjam Walloth)

Rauls, Anne-Therese, *Optimalsteuerung der semilinearen isothermen Eulergleichungen* (Stefan Ulbrich)

Rieß, Susanne, *Lattice-based Key Exchange Protocols* (Johannes Buchmann)

Rohleder, Mischa, *Zur adaptiven Wahl der Bandbreite des Kerndichteschätzung* (Michael Kohler)

Ruppert, Simon Moritz, *Adaptive Finite Element Method for Non-Linear Magnetostatics* (Herbert Egger)

Schäfer, Sven Oliver, *Desingularisierung von Clifford-Tori durch Minimalflächen in* S^3 (Karsten Große-Brauckmann)

Schäfer Aguilar, Paloma, *Smoothing-type method for a Branch-and-Bound algorithm for Mixed-Integer Semidefinite Programs* (Stefan Ulbrich)

Schmidt, Dominik, *Schätzung von extremen Quantilen in einem Simulationsmodell* (Michael Kohler)

Schmitt, Andreas, *Extended formulations and symmetry handling* (Marc Pfetsch)

Schneider, Moritz, *Numerical methods for parameter dependent eigenvalue problems* (Herbert Egger)

Schöbel-Kröhn, Lucas Wilfried, *Galerkin Approximation and Asymptotic Stability for the Thermistor Problem* (Herbert Egger)

Schönherr, David Hans Alfred, *Optimierung der Rechenvorschriften für eine Abstraktion der Zeit-Wege-Linien* (Andreas Oetting)

Schorr, Robert, *Adaptive non-symmetric coupling of Finite Volume Method and Boundary Element Method* (Christoph Erath)

Schulz, Olga, *Schätzung einer zeitabhängigen Dichte* (Michael Kohler)

Schürr, Jonathan Armin Heinrich, *Einige getwistete Nenneridentitäten der falschen Monster-Lie-Algebra* (Nils Scheithauer)

Seib, Bianca Mercedes, *Rekonstruktion dünnbesetzter Lösungen mit Ganzzahligkeitsbedingungen* (Marc Pfetsch)

Smolarek, Nadine, *Anwendung der kopositiven Programmierung auf ein Downlink Transmit Beamforming Problem* (Stefan Ulbrich)

Tabbert, Anne Nicola, *Modeling Truss Structures using Vanishing and Cardinality Constraints* (Alexandra Schwartz)

Teschner, Gabriel Christian, *Finite-Elemente-Methoden für die Primitive Equations* (Herbert Egger)

Tichai, Alexander, *On Lightcone Embeddings of Twin Buildings of a Kac-Moody Group of Indefinite Type* (Andreas Mars)

Tille, Lisa, *Portfolio-Optimierung unter Verteilungsunsicherheit: Ein robuster CVaR-Ansatz* (Stefan Ulbrich)

Vetter, Marco, *Schätzung von Interaktionsmodellen durch neuronale Netze* (Michael Kohler)

Vogt, Katja, *Gemischt-ganzzahlige Optimierungsmethoden für Klassifikationsprobleme* (Marc Pfetsch)

Weber, Marcel, *Holes in mixed integer problems* (Marc Pfetsch)

Weinberger, Jonathan, *The Cubical Model of Type Theory* (Thomas Streicher)

Werner, Johannes Manuel Friedemann, *Copositive Programmierung als Ansatz zur Lösung des optimalen Beamformingproblems* (Stefan Ulbrich)

Werner, David, *Nichtlineare robuste Optimierung via sequentieller konvexer bilevel Optimierung* (Stefan Ulbrich)

Weyer, Jonas Helmut, *Reduzierte Modelle auf Basis von POD für die optimale Steuerung der Navier-Stokes-Gleichungen auf veränderlichen Gebieten* (Stefan Ulbrich)

Wittmann, René Marc, *Polynomial Time Approximations for the Cutting Stock Problem* (Marc Pfetsch)

Wrona, Marc Philipp, *The Primitive Equations with horizontal Viscosity and Diffusion* (Matthias Hieber)

Wu, Jing, *Varianzreduktionstechniken bei Monte-Carlo-Methoden* (Volker Betz)

5.5 Staatsexamen Theses

2015

Astheimer, Lisa Christina, *Binnendifferenzierende technologiegestützte Lehrmaterialien zu Ebenendarstellungen und Matrizenanwendungen* (Regina Bruder)

Bayazit, Ersin, *Lehrfunktion adaptiver Testschleifen* (Regina Bruder)

Düx, Clarissa, *Feedbackgestaltung zu adaptiven Testschleifen* (Regina Bruder)

Frank, Thomas, *Entwicklung eines binnendifferenzierten Lernmaterials zu Folgen und Reihen* (Regina Bruder)

Hampel, Carina, *Längsschnittliche Analyse der Testergebnisse im Vorkursprojekt VEMINT* (Regina Bruder)

Horvatinovic, Laura, *Berücksichtigung typischer Fehler in der Differentialrechnung in adaptiven Testschleifen* (Regina Bruder)

Jäckel, Marie-Ines, *VEMINT - Testentwicklung zu Grundlagen der Differentialrechnung* (Regina Bruder)

Jäger, Karina, *Eine Selbstlernumgebung zu Termen und linearen Gleichungen* (Regina Bruder)

Johlke, Felix, *Eine Langzeitanalyse systematischer Fehler im Bereich der linearen und quadratischen Funktionen* (Regina Bruder)

Kessler, Nora, *Eine digitale Selbstlernumgebung zu linearen und quadratischen Funktionen* (Regina Bruder)

Kleinehollenhorst, Ina-Dorothea, *Grundwissensdiagnose zu funktionalen Zusammenhängen in der Oberstufe im Projekt MAKOS* (Regina Bruder)

Malzacher, Daniel, *Projektideen zur Förderung der Modellierungskompetenz in Q4* (Regina Bruder)

Möllerberndt, Anna Luise, *VEMINT - Testentwicklung zu Funktionsuntersuchungen und den Grundlagen der Integralrechnung* (Regina Bruder)

Reutzel, Carolin, *Entwicklung und Erprobung von Aufgabensets für einen binnendifferenzierenden Oberstufenunterricht* (Regina Bruder)

Schreiber, Insa Maria, *Ein Kompetenztraining zum Argumentieren in der Oberstufe zur Zahlentheorie* (Regina Bruder)

Schwarzer, Lena, *Eine datenbankbasierte Qualitätsbeurteilung von Viduotutorials* (Regina Bruder)

Steineck, Stefanie, *Interviewleitfaden zur Evaluation adaptiver Testschleifen* (Regina Bruder)

Stephan, Rafael, *Itemkonstruktion für adaptive Testschleifen* (Regina Bruder)

Freifrau von Lindenfels, Julia, *Binnendifferenzierende Lehrmaterialien zur Einführung in die Lineare Algebra* (Regina Bruder)

Wilde, Sonja Carolin, *Förderung mathematischer Modellierungskompetenz in Q4* (Regina Bruder)

Wittor, Mathias Michael, *VEMINT – Testentwicklung zu Ableitungsregeln und Extrema* (Regina Bruder)

Wünsch, Michael, *Möglichkeiten für Kompetenztrainings zum Problemlösenlernen in der gymnasialen Oberstufe* (Regina Bruder)

2016

Biedenbach, Marius, *Anforderungsanalyse und Lernmaterial zu geometrischen Begründungen in der S II* (Regina Bruder)

Gehb, Carsten, *Förderung von Grundwissen und Grundkönnen mit Nachlernumgebungen zu Testschleifen in der Analysis* (Regina Bruder)

Haracic, Björn Sebastian, *Diagnose und Förderung mit Lernmaterialien zu Extremwerten* (Regina Bruder)

Hartmann, Sebastian, *Zusammenhänge zwischen Denkstilen und Modellierungsfähigkeiten* (Regina Bruder)

Hecker, Katharina, *Entwicklung und Erprobung von Fördermaterialien zu quadratischen Funktionen* (Regina Bruder)

Hinkel, Matthias, *Aufgabengestütztes mathematisches Argumentieren in der gymnasialen Oberstufe* (Regina Bruder)

Kaufmann, Christina, *Fördermaterialien zur Reaktivierung heuristischer Hilfsmittel* (Regina Bruder)

Klenk, Lena, *Exponentialfunktionen im hessischen Kerncurriculum - Bausteine zu einer binnendifferenzierten Umsetzung* (Regina Bruder)

Leutzsch, Theresa, *Indivisiblen in Geschichte und Gegenwart. Wegbereiter der Infinitesimalrechnung und ihre Rolle in der mathematischen Fachdidaktik* (Burkhard Kümmerer)

Maczey, Semjon, *Diagnose und Förderung von Grundkenntnissen zur linearen Algebra* (Regina Bruder)

Müller, Sarah, *Eingangsdiagnose zu ausgewählten Grundlagen im beruflichen Bereich* (Regina Bruder)

Neufeld, Andreas, *Medienbasierte Aufklärung von Fehlermustern beim Umgang mit Darstellungen funktionaler Zusammenhänge* (Regina Bruder)

Özen, Ferit, *Fördermaterialien zu Termumformungen in den Sekundarstufen* (Regina Bruder)

Schröder, Lena Katharina, *Untersuchung von Grundwissen zum Ableitungsbegriff mit verschiedenen Itemformaten* (Regina Bruder)

Sevili, Suzan, *Qualitative Analyse von Schüleraktivitäten beim Bearbeiten von Fördermaterialien* (Regina Bruder)

Stegmann, Christine, *Problemlösetraining in Optimierungssituationen in Q4* (Regina Bruder)

Venhaus, Johanna, *Paralleltestentwicklung zur Diagnose von mathematischem Grundkönnen am Übergang zur Sekundarstufe II* (Regina Bruder)

Witczak, Sven, *Lernstilbezogene Fördermaterialien zu linearen Gleichungen* (Regina Bruder)

5.6 Bachelor Theses

2015

Altenburg, Florian, *Branching Random Walk* (Volker Betz)

Avramidis, Dimitrios, *Robust Portfolio Optimization by second-order cone programming* (Stefan Ulbrich)

Ayar, Özlem, *The Theorem of Malgrange-Ehrenpreis* (Mads Kyed)

Bahlke, Philipp, *Semismooth Support Vector Machines* (Stefan Ulbrich)

Behrmann, Nadine, *Least Infeasible Flow* (Marc Pfetsch)

Beiter, Elisabeth Theresa, *The law of the iterated logarithm* (Michael Kohler)

Belhadj, Khalid, *Distributions and Fundamental Solutions* (Mads Kyed)

Bernd, Kathrin Kornelia, *On the Numerical solution of Adjoint Equation for Computing Sensitivities in Optimal Control* (Lund, Schweden)

Bochenko, Timo, *Theorem of Pollard* (Michael Kohler)

Brandes, Ariel Bengt David, *Smoothness and Decay of the Limiting Quicksort Density Function* (Matthias Meiners)

Brandy, Malte Johannes Alexander, *Separability Criteria for States on Multipartite Operator Algebras* (Burkhard Kümmerer)

Brozek, Christopher, *Minimal Feedback Vertex Sets in directed Graphs with bounded degree* (Matthias Mnich)

Büchling, Alexandra, *Consistency of the kernel density estimates* (Michael Kohler)

Burghardt, Lars, *A compression algorithm for graphs with small vertex cover* (Matthias Mnich)

Büttgenbach, Frank Gert, *Differential-algebraic equations with applications to circuit simulation* (Herbert Egger)

Celik, Safak, *Universal consistency of the partitioning estimate* (Michael Kohler)

Cuca, Aleksandar, *Universally consistent pattern recognition based on nearest neighbor estimates* (Michael Kohler)

Dechert, Stefan, *Universal consistency and rate of convergence of the nearest neighbour estimate* (Michael Kohler)

Deutelmoser, Heike Simone, *The commutant lifting theorem and interpolation problems* (Steffen Roch)

Dietz, Alexander, *Weierstrass Preparation Theorem* (Ulrich Reif)

Dietzel, Anne, *On the universal consistency of nearest neighbor regression estimates* (Michael Kohler)

Dillmann, Jana, *The basic principle of life insurance mathematics* (Michael Kohler)

Dobermann, Eduard, *Dominant of the s-t-cut polytopes* (Michael Joswig)

Eckel, Pascal Roland, *Truss optimization with buckling constraints* (Stefan Ulbrich)

Eisenbach, Jan-Philipp, *Holomorphic automorphic products of singular weight on* $II_{n,2}(2_{II}^{+2})$ (Nils Scheithauer)

Fuhrländer, Mona, *MPEC-based heuristics for L0-minimization* (Marc Pfetsch)

Garvert, Linda Christin, *Incremental Network Design with Maximum Flows* (Stefan Ulbrich)

Groth, Jonas, *The consistency of the k-th nearest neighbor estimate* (Michael Kohler)

Haftstein, Markus, *Non-abelian Galois Cohomology and a Theorem of Serge Lang* (Philipp Habegger)

Heininger, Tim Uwe, *Estimation of the implied volatility of american options by mathematical programming with equilibrium constraints* (Stefan Ulbrich)

Hettig, Stella, *Modelling of a pension insurance* (Frank Aurzada)

Hofmann, Adrian, *Sparse Forward Mode of Automatic Differentiation and its Implementation* (Stefan Ulbrich)

Hohgräfe, Jan, *Cox-Ross-Rubinstein model and hedging of exotic options* (Volker Betz)

Hornauer, Miriam, *Global Linear Convergence of a Non-Interior Path Following Algorithm for Linear Complementarity Problems* (Stefan Ulbrich)

Kaddar, Sara, *On the universal consistency of the conditional kernel density estimate* (Michael Kohler)

Käfer, Sebastian, *Universal consistency of the kernel density estimate* (Michael Kohler)

Kampfmann, Oliver, *Estimation of a time-dependent density* (Michael Kohler)

Khalil, Suleman Ahmed, *Poincaré Series with Cut-off Functions* (Jan Hendrik Bruinier)

Kiefer, Paul, *Hecke Characters and Theta Series for Imaginary Quadratic Number Fields* (Jan Hendrik Bruinier)

Klein, David Christian, *The Panjer recursion in non-life insurance mathematics* (Michael Kohler)

Klimm, Svenja, *Portfolio Optimization with Conditional Value-at-Risk Objective and Constraints* (Stefan Ulbrich)

Klingenberg, Florian Tim, *The Two-Sample t-Test and its Application in Non-life Insurance Mathematics* (Michael Kohler)

Knoll, Steven, *Methods to sparsify matrices and their effect on the performance of l1-solvers* (Marc Pfetsch)

Kreß, Johanna, *Robust Portfolio Optimization* (Stefan Ulbrich)

Kullmann, Felix Peter, *Approximation Schemes for Generalized Flow* (Marc Pfetsch)

Kupka, Jennifer, *Hyberbolic Geodesics and Aspects of Number Theory* (Anna-Maria von Pippich)

Langer, Sophie, *The chain-ladder method* (Michael Kohler)

Liedtke, Aline Maren, *Adaptive constraint reduction for training support vector machines* (Stefan Ulbrich)

Lin, Yongguang, *Theorem of Malgrange-Ehrenpreit* (Mads Kyed)

Markina, Julia, *Constraint Reduction for Support Vector Machines* (Stefan Ulbrich)

Matei, Alexander, *On Unconstrained Robust Optimization and Its Application to an Elasticity Problem* (Stefan Ulbrich)

Michaelis, Niklas, *Individual minimax lower bounds for nonparametric regression estimates* (Michael Kohler)

Mokhtarzada, Sajia, *The theorem of Stone and its application to kernel estimates* (Michael Kohler)

Müller, Christian, *On the universal consistency of the kernel regression estimate* (Michael Kohler)

Müller, Erik Jörn, *Investigation of a parametric active set method applied to linear programs* (Marc Pfetsch)

Müller, Moritz, *The Laplace Equation on Rectangles* (Robert Haller-Dintelmann)

Neudert, Maximilian Gerhard, *Finite Volume Method - an introduction to partial differential equations based on a model problem in two dimensions* (Christoph Erath)

Olumee, Mesih, *Rational points on elliptic curves of special form* (Orsola Tommasi)

Pauli, Sabrina, *Minkowski´s Reduction Theory* (Philipp Habegger)

Polat, Tolga, *Theorem of Stone* (Michael Kohler)

Potrikus, Pia, *Truss optimization based on a conic quadratic model with local buckling constraints* (Stefan Ulbrich)

Prasse, Alexander Klaus, *The Weil conjecture for curves* (Nils Scheithauer)

Preuschoff, Tilman, *Fourier Transformation on locally compact abelian groups* (Mads Kyed)

Remmel, Patrick, *Parallel-in-Time methods for the solution of ordinary differential equation systems* (Jens Lang)

Respondek, Robert Dominique, *Tractable Approximations to Robust Conic Optimization-problems* (Stefan Ulbrich)

Rohrbach, Felix Jonathan, *Robust Optimization Methods for the Tail Assignment Problem* (Marc Pfetsch)

Rudloff, Niklas, *Optimal stopping of partial sums* (Volker Betz)

Sándor, Balázs, *An improved implementation of A Posteriori Error Estimators in the FEM* (Jens Lang)

Schachler, Sohejl, *Rates of convergence for nonparametric regression with unbounded data* (Michael Kohler)

Schatz, Andreas, *The linear Schrödinger equation* (Matthias Hieber)

Schier, Roland, *Models for Steiner tree problems* (Marc Pfetsch)

Schmitt, Sören, *Perfect Numbers* (Werner Krabs)

Schmollgruber, Alan Stefan, *Estimation of the distribution of the total loss in non-life insurance mathematics* (Michael Kohler)

Schnarz, Anna, *Incremental Network Design with Maximum Flows* (Stefan Ulbrich)

Schneider, Thomas, *The Newton-Polygon* (Ulrich Reif)

Schwab, Michel Johannes, *Optimization of trusses under local buckling constraints* (Stefan Ulbrich)

Schwarzkopf, Marie-Christine Alice, *Robust Optimization of Trusses* (Stefan Ulbrich)

Sorokin, Dmitry, *Mixing Times for Card Shuffling Schemes* (Volker Betz)

Strauss, Jessica, *Introduction to nonparametric regression* (Michael Kohler)

Thoß, Florian, *Balanced Proper Orthogonal Decomposition: Application to a flow control problem* (Stefan Ulbrich)

Tran, Thao Vi, *The method of marginal totals in non-life insurance mathematics* (Michael Kohler)

Trapp, Franziska, *Support Vector Machines and their Application to Breast Cancer Prognosis* (Stefan Ulbrich)

Ücüncü, Semih, *Shatter Coefficient and VC-Dimension* (Michael Kohler)

Veltcheva, Ioanna, *Valuation functions for payment streams in insurance mathematics* (Frank Aurzada)

Voigt, Felix, *Theta Bodies and the Convex Hull of Complex Varieties* (Burkhard Kümmerer)

Walz, Benedikt Marius, *Coupling from the Past - Theory and Implementation* (Volker Betz)

Weiß, Maximilian, *Convergence speed for the kernel density estimate* (Michael Kohler)

Wilfert, Florian Maximilian, *Martingal central limit theorem* (Volker Betz)

Wolfenstetter, Franziska Renate, *Introduction to Non-Life Insurance Mathematics* (Michael Kohler)

Wörl, Ann-Christin, *Nonzero structures of Hessians and starcolorings* (Marc Pfetsch)

2016

Assing, Charlotte, *Optimal structure of gas transmission trunklines* (Stefan Ulbrich)

Baden, Manuel, *Renewal theory and applications in risk theory* (Frank Aurzada)

Bandhauer, Alexander, *On the data-dependent choice of parameters in pattern recognition by splitting of the sample* (Michael Kohler)

Bauer, Stephanie Katrin, *On loss reserving in non-life insurance mathematics* (Michael Kohler)

Bechtel, Sebastian, *Elementary proofs of the F. and M. Riesz Theorems and applications* (Robert Haller-Dintelmann)

Bechtold, Florian Tim, *The Feynman-Kac formula and applications to Quantum theory* (Volker Betz)

Benzing, Jan, *Adaptive choice of the bandwidth of nonparametric regression estimate via splitting the sample* (Michael Kohler)

Bouaraba, Kai Vincent, *The Leech lattice as a lattice over the Eisenstein integers* (Nils Scheithauer)

Braun, Alina, *Cover Times* (Volker Betz)

Diehl, Katharina, *Semismooth Newton Methods for Second Order Cone Programming* (Stefan Ulbrich)

Du Bois, Sophie Ann L, *Cycles in random permutations* (Volker Betz)

Erturan, Caner, *Comparison of risks in insurance mathematics* (Matthias Meiners)

Ewering, Andreas Jörg, *Queue length in M/M/1 queues* (Frank Aurzada)

Fernengel, Bernd Michael, *Mathematical Foundations of scattering theory - Cook´s method* (Robert Haller-Dintelmann)

Flindt, Konrad, *Kneser´s neighborhood method* (Nils Scheithauer)

Gabel, Fabian Nuraddin Alexander, *The Helmholtz decomposition in L2* (Robert Haller-Dintelmann)

Goßmann, Marc, *The Ihara zeta function* (Anna-Maria von Pippich)

Gründing, Dirk Maria, *Direct Numerical Simulation of Mass Transfer in Two-Phase Flow with Realistic Coefficients* (Anerkennung aus M.Sc. Maschinenbau, TU Darmstadt)

Gutermann, Jannis, *Compact Flows* (Marc Pfetsch)

Habrich, Oliver André, *Stationary Stochastic Processes - A Central Limit Theorem for Martingales* (Frank Aurzada)

Hald, Martin, *Characterization of p-groups with commutator group of order p* (René Bartsch)

Heil, Caroline Esther, *Robust Linear Optimization With Recourse* (Winnifried Wollner)

Himburg, Sandra Michaela, *Relaxations for mathematical programs with vanishing constraints* (Winnifried Wollner)

Höbere, Resul, *The Collective Model of Insurance Mathematics* (Matthias Meiners)

Hoffmann, Timo, *Free material optimization for stress constraints* (Stefan Ulbrich)

Hövelmann, Adrian, *A simulation enviroment for modular constructed electrical circuits useing different ODE and DAE-solver* (Martin Kiehl)

Jäger, Maike Elisa, *The Diameter of Lattice Polytopes* (Andreas Paffenholz)

Jansen, Erik, *Step size selection in finite differences with application in the sensitivity analysis for ODEs* (Alf Gerisch)

Jurisic, Momcilo, *Choice of parameters in nonparametric regression by splitting the sample* (Michael Kohler)

Kirpicev, Denis, *Preference relations in mathematical economics* (Volker Betz)

Klein, Simon, *The Stoer-Wagner algorithm for minimum cuts in undirected graphs* (Marc Pfetsch)

Klimmek, Franziska, *Period Polynomials and Manin's Period Theorem* (Jan Hendrik Bruinier)

Kohlmeyer, Ines, *The face algorithm for linear optimization problems* (Marc Pfetsch)

Könen, Mareike Gisela, *Introduction and Examples* (Volker Betz)

Kreisl, Lena, *Area Constrained Elastic Curves* (Karsten Große-Brauckmann)

Lauber, Felix, *Semidefinite Programming* (Winnifried Wollner)

Leis, Annabel, *The Interior-Point-Method for Linear Programs* (Winnifried Wollner)

Lenhart, Dominic, *Pure-strategy Nash Equilibria in the Tullock Rent-Seeking Games* (Alexandra Schwartz)

Lioutikov, Michelle, *On the classification of even unimodular lattices* (Nils Scheithauer)

Mair, Sebastian, *Stochastische Eigenschaften und Parameterschätzung* (Michael Kohler)

Mao, Kevin, *Optimal data fitting with piecewise-affine models* (Marc Pfetsch)

Marakis, Vassilios, *Approximation of continuous functions by neural networks* (Michael Kohler)

Merz, Kerstin, *On the Strong Universal Consistency of the Partitioning Estimate* (Michael Kohler)

Metzler, Ingmar, *The Weil representation and theta functions* (Jan Hendrik Bruinier)

Mohring, Sarah, *A recognition algorithm for unit interval graphs* (Marc Pfetsch)

Moos, Michael Werner, *Low-rank approximation for semidefinite programs* (Winnifried Wollner)

Muehlbauer, Julian Maximilian, *An analysis of variance for a single factor and its application to non-life insurance mathematics* (Michael Kohler)

Muth, Julius Friedrich, *Solving Combinatorial Optimization Problems via Inclusion-Exclusion* (Marc Pfetsch)

Nouri, Sepiedeh, *Covering and packing numbers* (Michael Kohler)

Ott, Claire Tabea, *Linear Rank-Width and Interpretations* (Achim Blumensath)

Polenz, Björn, *Methods for Support Vector Machines and Applications* (Stefan Ulbrich)

Rasch, Janes, *Markov chains and the page rank algorithm* (Volker Betz)

Roth, Lukas, *The traveling salesman problem* (Volker Betz)

Sancar, Kenan Philipp, *Maximum entropy distributions* (Frank Aurzada)

Scheffer, Angelo, *Smoothing methods for linear optimization problems* (Stefan Ulbrich)

Scheuermann, Nadine Edith Ottilie, *Percolation* (Volker Betz)

Schickentanz, Dominic Tobias Raphael, *Ergodic Theorems and Applications* (Frank Aurzada)

Schmitt, Jannik, *Wigner´s theorem for random matrices* (Frank Aurzada)

Schneiter, Clément Denis Raymond, *Theorem of Malgrange-Ehrenpreis* (Mads Kyed)

Seibert, Anna-Maria, *Minimax rate of convergence for nonparametric regression in the case of unbounded data* (Michael Kohler)

Serra da Silva, Anita, *Random walks and electrical networks* (Volker Betz)

Talebi, Saeid, *Empirical comparison of procedures for the choice of smoothing parameters in nonparametric regression* (Michael Kohler)

Tautz, Hendrik, *Jacobi´s four square theorem* (Anna-Maria von Pippich)

Tran, Theresa Thanh Mai, *Image Segmentation via Minimum Cuts in Planar Graphs* (Marc Pfetsch)

Uftring, Patrick Jürgen, *On Läuchli´s realizability* (Ulrich Kohlenbach)

Vock, Christian Willy, *Weyl´s character formula and some applications* (Nils Scheithauer)

Werner, Philipp, *An introduction into non-life insurance mathematics* (Michael Kohler)

Williams, Jack Peter Richard, *Mixing time, relaxation time and spectral analysis of transition matrices* (Volker Betz)

Wolfenstetter, Andreas Klaus-Dieter, *A fast algorithm for approximate counting of q-colorings* (Volker Betz)

Zedler, Nora Anna Barbara, *The simplex gradient and noisy optimization problems* (Stefan Ulbrich)

Zeuch, Marcel, *On strictly continous convergence* (René Bartsch)

Zinn, Timo, *Weight constrained shortest path problems* (Marc Pfetsch)

6 Presentations

6.1 Talks and Visits

6.1.1 Invited Talks and Addresses

Frank Aurzada

22/04/2015 *Persistence probabilities*
Seminar talk, Bielefeld

01/07/2015 *Persistence probabilities*
Seminar talk, Münster

20/09/2015 *Persistence probabilities*
Workshop on Recent Trends in Stochastic Analysis and Related Topics, Hamburg

22/09/2015 *Quantization of jump processes*
Annual Meeting of the DMV, Hamburg

22/10/2015 *Persistence probabilities*
Seminar talk, Mannheim

René Bartsch

01/10/2016 *A general approach to the concept of second dual spaces*
Workshop on Interactions between Algebra and Functional Analysis, Prague

Volker Betz

06/11/2015 *Spatial Random Permutations*
Workshop Stochastic Systems, Bielefeld

15/06/2015 *Spatial random Permutations and BEC (Mini Course)*
Summer School at the Lago Maggiore, Italy

21/10/2015 *Spatial random permutations*
Seminar, Universität Münster

20/05/2015 *Metastable Markov Chains*
Colloquium, Orleans

25/11/2015 *Spatial Random Permutations*
Seminar, Universität Zürich

28/01/2016 *Wave packet dynamics in the optimal superadiabatic approximation*
Workshop on Mathematical Quantum Chemistry, Banff

05/07/2016 *Spatial random permutations*
Workshop on Condensation, Bath

15/04/2016 *Metastable markov Chains*
Seminar, KAIST, Daejeon, Korea

09/09/2016 *Spatial Random Permutations*
Workshop on Mathematical Physics, Yerevan, Armenia

Regina Bruder

23/02/2015 *Workshop for In-Service-Teacher Training in. 'Math Lessons with using Technology on upper Secondary Level'*
Salzburg, Austria

24/02/2015 *Workshop for In-Service-Teacher Training in. 'Math Lessons with using Technology on upper Secondary Level'*
Salzburg, Austria

25/02/2015 *Workshop for In-Service-Teacher Training. 'Initial differentiation in math lessons on secondary level I'*
Salzburg, Austria

26/02/2015 *Workshop for In-Service-Teacher Training. 'Initial differentiation in math lessons on secondary level I'*
Salzburg, Austria

27/02/2015 *Workshop for In-Service-Teacher Training. 'Initial differentiation in math lessons on secondary level I'*
Eisenstadt, Austria

28/02/2015 *Talk for Math-Teachers about 'Tasks'*
Baden (Austria)

20/03/2015 *'Development of competencies in mathematics: Argumentation'*
Pädagogische Hochschule in Baden, Switzerland

05/05/2015 *Talk about Longterm Development of Competencies in Problemsolving*
TU Braunschweig

20/07/2015 *Workshop about 'Task-Analysis and Task-Development'*
Universität Hildesheim

21/07/2015 *Workshop about 'Task-Analysis and Task-Development'*
Universität Hildesheim

28/10/2015 *Workshop 'Diagnosis and support for a longterm development of competencies: Modelling, Argumentation, Problemsolving'*
Pädagogisches Institut München

22/09/2015 *Comparison of the difficulty of Abitur- and Matura- Examination in Germany and Austria*
Talk at DMV-Conference, Hamburg

18/02/2016 *Judgement with quality criteria of teaching and learning videos*
Talk, Wildau

19/02/2016 *Initial differentiation and development of competencies with task-sets and blossom-tasks*
Workshop, Hamburg

05/03/2017 *Argumentation - based on the project LEMAMOP*
Workshop at JULE-conference

30/04/2016 *The O-M-A-model for measurement of competencies in Austria's Matura*
Talk at the conference of the working group empiric educational research (together with S. Siller and G. Greefrath)

12/05/2016 *'Problem solving'*
Workshop for teacherstudents in the second phase of teacher education, Potsdam

24/05/2016 *A concept of competence-trainings for mathematical argumentation, modelling and problem solving. Results and experience of the project LEMAMOP in Lower Saxony*
Talk at Kolloquium of the RWTH Aachen

25/07/2016 *Survey on conceptualisation of the role of competencies, knowing and knowledge in mathematics education research*
Talk at ICME-Conference, Hamburg (together with M.Niss et al)

27/07/2016 *Joachim Lompscher and His Activity Theory Approach Focusing on the Concept of Learning Activity and How It Influences Contemporary Research in Germany*
Talk at ICME-Conference, Hamburg

29/07/2016 *Mathematical Argumentation*
Workshop with teachers at ICME-Conference, Hamburg

17/09/2016 *'Learning materials of the project LEMAMOP for longterm development of mathematical competencies'*
Talk at DZLM-conference, Berlin

06/10/2016 *Concepts of teacher education in modelling*
Talk at ISTRON-Conference, Augsburg

13/10/2016 *Workshop with teachers about the MAKOS-project*
LISUM, Brandenburg

11/11/2016 *Concepts of learning mathematics*
Talk at the INTERPEDAGOGICA, Vienna

21/11/2016 *Concepts for initial differentiation in math lessons*
Workshop with teachers, Berlin

Jan H. Bruinier

04/02/2015 *Kudla's modularity conjecture and formal Fourier-Jacobi series*
Seminar *Autour des Cycles Algebraiques*, University of Paris, Jussieu

02/03/2015 *Kudla's modularity conjecture and formal Fourier-Jacobi series*
Winter seminar, AG Algebra, Manigod

16/03/2015 *Kudla's modularity conjecture and formal Fourier-Jacobi series*
Advanced Seminar in Algebraic Geometry, Universität Zürich

08/04/2015 *Classes of Heegner divisors and traces of singular moduli*
Workshop *The Kudla program*, CRM Montreal, 06.04.15–10.04.15

05/05/2015 *Classes of Heegner divisors and traces of singular moduli*
Workshop *Automorphic Forms – Geometry and Arithmetic*, Erwin Schrödinger Institut, Wien, 03.05.15–14.05.15

23/06/2015 *Modular forms and moduli spaces*
Kolloquium des Departments Mathematik, Universität Erlangen-Nürnberg

08/07/2015 *Modular forms and moduli spaces*
Hausdorff-Colloquium, Universität Bonn

09/07/2015 *Wie viele Primzahlen gibt es?*
Sommerschule *Faszination Mathematik*, Heidelberg

23/09/2015 *Classes of Heegner divisors and traces of singular moduli*
Number Theory Seminar, MPI für Mathematik, Bonn

24/09/2015 *Heegner divisors in generalized Jacobians and traces of singular moduli*
Minisymposium *Recent trends in the arithmetic of automorphic forms*, DMV Jahrestagung 2015

04/12/2015 *Classes of Heegner divisors in generalized Jacobians*
ℕ-cube days III, Chalmers University, Gothenburg, 04.12.15–05.12.15

19/01/2016 *Classes of Heegner divisors in generalized Jacobians*
Forschunsseminar Arithmetische Geometrie, HU Berlin

10/03/2016 *Kudla-Rapoport divisors on unitary Shimura varieties*
Winterseminar der AG Algebra, Manigod

06/06/2016 *Modularity of generating series for special divisors on arithmetic ball quotients II*
Conference *Arakelov theory and automorphic forms*, HU Berlin, 06.06.16–09.06.16

07/10/2016 *Kudla-Rapoport divisors on arithmetic ball quotients*
The Riemann Conference, Universität Münster, 04.10.16–07.10.16

19/12/2016 *Generating series of special divisors on arithmetic ball quotients*
Number Theory Seminar, Universität Köln

Johannes Buck

17/11/2016 *A generalization of the beer mats puzzle*
Graduate Student Seminar, Basel

Pia Domschke

10/12/2015 *Mathematical modelling of cancer invasion: The role of cell adhesion variability*
Workshop on "New Mathematical and Computational Problems involved in Cell Motility, Morphogenesis and Pattern Formation", Isaac Newton Institute for Mathematical Sciences, Cambridge, UK

14/01/2016 *Structured models of cell migration incorporating molecular binding processes*
Applied Analysis Seminar, Heidelberg

07/07/2016 *Adaptive modelling, simulation and optimization of gas and water supply networks*
IGDK1754 Munich – Graz, München

Herbert Egger

10/03/2015 *Finite element methods for saddlepoint problems with applications to Darcy and Stokes flow I*
Waseda Workhop on Mathematical fluid dynamics, Tokyo, Japan

11/03/2015 *Finite element methods for saddlepoint problems with applications to Darcy and Stokes flow II*
Waseda Workhop on Mathematical fluid dynamics, Tokyo, Japan

12/03/2015 *Finite element methods for saddlepoint problems with applications to Darcy and Stokes flow III*
Waseda Workhop on Mathematical fluid dynamics, Tokyo, Japan

13/03/2015 *Finite element methods for saddlepoint problems with applications to Darcy and Stokes flow IV*
Waseda Workhop on Mathematical fluid dynamics, Tokyo, Japan

20/07/2015 *Modeling and Simulation of Gas Flow in Pipes I*
TRR154 Workshop, FAU Erlangen

21/07/2015 *Modeling and Simulation of Gas Flow in Pipes II*
TRR154 Workshop, FAU Erlangen

22/07/2015 *Modeling and Simulation of Gas Flow in Pipes III*
TRR154 Workshop, FAU Erlangen

23/07/2015 *Modeling and Simulation of Gas Flow in Pipes IV*
TRR154 Workshop, FAU Erlangen

24/07/2015 *Modeling and Simulation of Gas Flow in Pipes V*
TRR154 Workshop, FAU Erlangen

18/01/2016 *Variational Methods for Radiative Transfer*
Karlsruhe PDE Seminar, KIT

14/06/2016 *Parameter identification in a semilinear hyperbolic system*
Seminars "Partielle Differentialgleichungen und Inverse Probleme", TU Chemnitz

26/09/2016 *Variational Methods for Radiative Transfer*
Chemnitz FEM Symposium, TU Chemnitz

29/11/2016 *A variational discretization framework for compressible flow in pipeline networks*
Kolloquium AG Modellierung, Numerik, Differentialgleichungen, TU Berlin

02/12/2016 *Kinetic descriptions for particle systems: modelling and numerical approximation*
TRR 146 Retreat, Mainz

Christoph Erath

14/03/2016 *Adaptive Coupling of Finite Volume and Boundary Elements Methods*
Workshop on boundary elements and adaptivity, Universität Basel (Prof. Dr. Helmut Habrecht)

14/10/2015 *Koppeln auf unstrukturierten Gittern – adaptive FVM-BEM*
Mathematisches Kolloquium (Antrittsvorlesung), TU Darmstadt

10/07/2015 *Adaptive Coupling of Finite Volume and Boundary Element Methods*
Kolloquium, 25. Treffen des Rhein-Main Arbeitskreises, TU Darmstadt

09/06/2015 *Adaptive Coupling of Finite Volume and Boundary Element Methods*
Kollquium, Institut für Numerische Mathematik, TU Graz (Dr. Günther Of, Prof. Dr. Olaf Steinbach)

Reinhard Farwig

22/01/2015 *Werden Lösungen der Navier-Stokes-Gleichungen singulär?*
Mathematical Colloquium, Universität Mainz

03/02/2015 *Optimal initial value conditions for the Navier-Stokes equations.*
Seminar Talk, Institut Elie Cartan de Lorraine (University of Lorraine, Nancy)

03/02/2015 *Do Solutions of the Navier-Stokes Equations Get Singular?*
Mathematical Colloquium, University of Lorraine, Metz-Nancy

27/02/2015 *Optimal initial value conditions for the Navier-Stokes equations*
Seminar Talk, Shinju University, Matsumoto, Japan

10/03/2015 *Quasi-optimal initial value conditions for the Navier-Stokes equations*
10th Japanese-German International Workshop on Mathematical Fluid Dynamics, Waseda University, Tokyo

05/06/2015 *Quasi-optimal initial value conditions for the Navier-Stokes equations*
International Conference: Asymptotic Problems: Elliptic and Parabolic Issues, Vilnius

08/03/2016 *260 Years of Equations of Fluid Mechanics – 10 Years of Lq tilde spaces*
International Conference ”The Navier-Stokes Equations and Related Topics”, Nagoya

23/06/2016 *Quasi-optimal initial value conditions for the Navier-Stokes equations and questions of uniqueness*
International Conference ”Navier-Stokes equations and related PDEs”, NIMS, Daejeon, South Korea

07/09/2016 *Almost optimal initial value conditions for the Navier-Stokes equations uniqueness: existence, uniqueness, continuity, and stability*
International Conference on PDE: Towards regularity, The Institute of Mathematics, Polish Academy of Sciences, Warsaw

04/10/2016 *Almost optimal initial value conditions for the Navier-Stokes equations: existence, uniqueness, continuity, and stability*
International Conference "New trends in Partial Differential Equations", Centro di Recerca Matematica E. de Giorgi, Pisa

08/11/2016 *Almost optimal initial value conditions for the Navier-Stokes equations: existence, uniqueness, continuity, and stability*
Seminar Talk, Institute of Mathematics, Czech Academy of Sciences, Prague

Tobias Fischer

15/07/2015 *Branch-and-Cut for Linear Programs with Overlapping SOS1 Constraints*
International Symposium on Mathematical Programming (ISMP), Pittsburgh

Tristan Gally

14/07/2015 *Solving Mixed-Integer Semidefinite Programs for Robust Truss Topology Design*
International Symposium on Mathematical Programming (ISMP), Pittsburgh

Alf Gerisch

25/06/2015 *A structured population model for cell migration and cell surface-bound processes*
ICMS Workshop on "Computational and multiscale mathematical modelling of cancer growth and spread", Edinburgh, UK

24/07/2015 *Sensitivity Analysis and Quantification of Uncertainty: Method and application in a model of tumour invasion*
Isaac Newton Institute for Mathematical Sciences, Cambridge, UK

11/12/2015 *Nonlocal models for interaction driven cell movement*
Workshop on "New Mathematical and Computational Problems involved in Cell Motility, Morphogenesis and Pattern Formation", Isaac Newton Institute for Mathematical Sciences, Cambridge, UK

19/10/2016 *What is...? Homogenisierung*
What is...? Seminar, Fachbereich Mathematik, TU Darmstadt

Karsten Grosse-Brauckmann

18/09/2015 *A property distinguishing the gyroid*
Shape up, Exercises in materials geometry, Berlin

10/12/2015 *Riemannian fibrations and conjugate surface constructions*
Frankfurt

18/06/2016 *New minimal surfaces in the 3-sphere*
Differentialgeometrie-Kolloquium Mainz

Matthias Hieber

07/01/2015 *Spectral theory and complex fluids*
Oberwolfach

15/05/2015 *Periodic solutions to seminlinear evolution equations*
GAMM-Workshop, Budapest, Hungary

03/07/2015 *Die Gleichungen von Navier-Stokes und Fluide mit Mikrostrukturen*
Kolloquium, Universität Düsseldorf, Düsseldorf

09/07/2015 *Analysis of the Ericksen-Leslie-system*
Conference on PDE, Parma, Italy

17/07/2015 *A general approach to periodic solutions to evolution equations*
TULKA-meeting, Ulm

17/08/2015 *A journey through the world of incompressible, viscous fluid flows*
International Conference on Analysis, Sapporo, Japan

14/09/2015 *Periodic solutions in Fluid Dynamics*
International Conference on Fluid Dynamics, Porquerolles, France

23/09/2015 *Analysis on the Ericksen-Leslie model*
International Conference on PDE, Petropolis, Brasil

19/10/2015 *Stability analysis for evolution equations I*
Lecture Series, VIASN, Hanoi, Vietnam

20/10/2015 *Stability analysis for evolution equations II*
Lecture Series, VIASN, Hanoi, Vietnam

21/10/2015 *Stability analysis for evolution equations III*
Lecture Series, VIASN, Hanoi, Vietnam

16/11/2015 *Analysis of incompressible fluid flows I*
Lecture Series, University of Tokyo, Tokyo, Japan

17/11/2015 *Analysis of incompressible fluid flows II*
Lecture Series, University of Tokyo, Tokyo, Japan

18/11/2015 *Analysis of incompressible fluid flows III*
Lecture Series, University of Tokyo, Tokyo, Japan

19/11/2015 *Analysis of incompressible fluid flows IV*
Lecture Series, University of Tokyo, Tokyo, Japan

20/11/2015 *Analysis of incompressible fluid flows V*
Lecture Series, University of Tokyo, Tokyo, Japan

12/01/2016 *The Ericksen-Leslie Model with general stress tensor*
International Conference on FSI, Bordeaux, France

18/02/2016 *Analysis and Modelling of Liquid Crystal Flows*
Analysis-Seminar Courant Institute, New York, USA

07/03/2016 *Thermodynamical modeling of Liquid Crystal Flows*
International Conference on Navier-Stokes, Nagoya, Japan

21/03/2016 *Dynamics of the Ericksen-Leslie-model*
Princeton University, Analysis Seminar, Princeton, USA

19/05/2016 *Maximal Regularity approach to evolution equations*
International Conference on Analysis, Vanderbuilt University, Nashville, USA

07/06/2016 *Global well-posedness of the primitive equations*
International Conference on Hydromechanics, Banff, Canada

29/08/2016 *Geophysical Flows I*
Lecture Series, Summer School, Prague, Czech Republic

30/08/2016 *Geophysical Flows II*
Lecture Series, Summer School, Prague, Czech Republic

31/08/2016 *Geophysical Flows III*
Lecture Series, Summer School, Prague, Czech Republic

04/10/2016 *The Hydrostative Stokes Operator*
International Conference on Analysis, Hannover

10/11/2016 *Two-phase free boundary value problems for Newtonian and Non-Newtonian Fluids*
International Conference Fluid Mechanics, Tokyo, Japan

14/11/2016 *Well-posedness of the primitive equations*
International Conference on PDE, RIMS, Kyoto, Japan

Karl H. Hofmann

11/11/2015 *Strukturmathematik: In memoriam Günther Pickert (1917-2015)*
Gedächtnisveranstaltung G.Pickert, Universität Gießen

29/01/2016 *Proliegruppen: ein Spaziergang*
Konferenz Fuktionalanalysis, Universität Wuppertal

Christopher Hojny

15/07/2015 *Polyhedral Symmetry Handling via Fundamental Domains*
International Symposium on Mathematical Programming (ISMP), Pittsburgh

Benjamin Horn

07/09/2016 *Shape optimization for contact problems based on isogeometric analysis*
International Conference and Workshop on Numerical Simulation of 3D Sheet Metal Forming Processes (NUMISHEET), Bristol

Amru Hussein

12/07/2016 *Global strong L^p well-posedness of the 3D primitive equations*
PDE Real Analysis Seminar at Graduate School of Mathematics, University of Tokyo

03/05/2016 *Well-posedness for the primitive equations for the ocean and the atmosphere*
Seminar talk, Universität Hagen

21/09/2016 *Global strong L^p well-posedness of the 3D primitive equations*
Seminar talk, Universität Bern

Imke Joormann

26/01/2016 *Unzulässigkeit in Netzwerken*
AG Seminar, RWTH Aachen

08/07/2016 *Optimierung von Gasnetzwerken*
Deutsche Schülerakademie, Jugenddorf-Christopherusschule Braunschweig

Klaus Keimel

03/07/2015 *Healthiness conditions for predicate transformers*
Kyoto University, Japan

10/09/2015 *The Cuntz semigroup: Domain theoretical methods for C^*-algebras*
International Conference on Logical Algebras and Semi-rings, Beihang University, Beijing, China

14/09/2015 *On healthiness conditions for predicate transformer semantics*
Academy of Mathematics and System Science, Beijing, China

12/05/2016 *Domain theoretical methods for C^*-algebra*
Seminar, University of Ljubljana, Slovenia

06/06/2016 *Elliott's topological enrichment of the Cuntz semigroup*
Oberseminar C^*-algebras. SFB 878, Universität Münster

Ulrich Kohlenbach

16/04/2015 *Proof Mining: state of the art and future directions*
Utrecht Workshop on Proof Theory

20/07/2015 *Quantitative results on Fejér monotone sequences*
11th International Conference on Fixed Point Theory and Applications, Istanbul, Turkey

20/09/2015 *Convergence Theorems in Mathematics: Reverse Mathematics and Weihrauch degrees versus Proof Mining*
Dagstuhl Seminar: Measuring the Complexity of Computational Content

06/10/2015 *Effective bounds in convex optimization by logical methods*
12th International Seminar on Optimization and Related Areas. Lima, Peru

05/01/2016 *Logical analysis of proofs in convex optimization and nonlinear semigroup theory that are based on WKL*
New Challenges in Reverse Mathematics, Institute for Mathematical Sciences, Singapore

11/06/2016 *From Kreisel's 'Unwinding of Proofs' to the Program of 'Proof Mining'*
Intuitionism, Computation, and Proof: Selected themes from the research of G. Kreisel, IHPST Paris

26/07/2016 *Tutorial on Proof Mining (4 lectures)*
Hilbert Bernays Summer School on Logic and Computation 2016, U Göttingen

05/12/2016 *Proof Theory of CAT(κ)-spaces*
Algorithmic Randomness Interacts with Analysis and Ergodic Theory. BIRS-CMO, Oaxaca, Mexico

Michael Kohler

25/02/2016 *On data-based optimal stopping under stationarity and ergodicity*
University of Oxford

Barbara Krauth

01/09/2015 *Handlungsorientierter Mathematik-Unterricht in der Sek I – Wege zur Prävention von typischen Fehlvorstellungen und Schwierigkeiten*
Talk at Conference for holding classes in heterogeneous learning groups, Frankfurt/Main

21/09/2015 *Möglichkeiten von Diagnose mathematischer Kompetenzen und Binnendifferenzierung im Rahmen des Pilotprojekts "Gestufte Berufsfachschule"*
Talk at Conference for concept development for holding classes in the pilot project "Gestufte Berufsfachschule", Kassel

07/10/2015 *Materialvorstellung aus dem hessischen Projekt MAKOS zur Implementierung des neuen Kerncurriculums (KC) Oberstufe*
Teacher further training talk at Conference Teaching Mathematics and Natural Sciences (MNU), Darmstadt

11/11/2015 *Binnendifferenzierung im Mathematikunterricht Teil 1*
Teacher further training talk at a comprehensive school (Eichendorffschule), Kelkheim

21/12/2015 *Binnendifferenzierung im Mathematikunterricht Teil 1*
Teacher further training talk at school for adults (AHR), Frankfurt

13/01/2016 *Kompetenzorientiert unterrichten*
Talk at Conference for concept development for the transition from school to university (Hochschule RheinMain), Wiesbaden

05/03/2016 *Materialvorstellung aus dem hessischen Projekt MAKOS zur Implementierung des neuen Kerncurriculums (KC) Oberstufe*
Teacher further training talk at Conference for Young Teachers, Offenbach

22/03/2016 *Binnendifferenzierung im Mathematikunterricht Teil 2*
Teacher further training talk at a comprehensive school (Eichendorffschule), Kelkheim

23/03/2016 *Binnendifferenzierung im Mathematikunterricht Teil 2*
Teacher further training talk at school for adults (AHR), Frankfurt

27/04/2016 *Binnendifferenzierung im Mathematikunterricht Teil 1*
Teacher further training talk at a comprehensive school (WeilTalSchule), Weilmünster

29/04/2016 *Möglichkeiten von Diagnose mathematischer Kompetenzen und Binnendifferenzierung im Rahmen des Pilotprojekts "Gestufte Berufsfachschule" – Teil 2*
Talk at Conference for concept development for holding classes in the pilot project "Gestufte Berufsfachschule", Darmstadt

20/06/2016 *Binnendifferenzierung im Mathematikunterricht Teil 2*
Teacher further training talk at a comprehensive school (WeilTalSchule), Weilmünster

13/10/2016 *Materialvorstellung aus dem hessischen Projekt MAKOS zur Implementierung des neuen Kerncurriculums (KC) Oberstufe*
Teacher further training talk at Conference for Teachers, Darmstadt

Burkhard Kümmerer

24/03/2015 *Dem Bauplan Gottes auf der Spur. Mit dem Lindauer Bücherschatz auf Zeitreise zu Johannes Kepler*
Stadtarchiv, Geschichtsverein und Volkshochschule Lindau, Altes Rathaus Lindau

29/06/2015 *On the Trail of God's Blueprint. A Journey Back in Time to Johannes Kepler with Lindau's Literary Treasures*
Kuratoren-Führung durch die Ausstellung in der Ehemals Reichsstädtischen Bibliothek Lindau anlässlich des 65-ten Nobelpreisträgertreffens in Lindau

05/10/2015 *Dem Bauplan Gottes auf der Spur. Mit dem Lindauer Bücherschatz auf Zeitreise zu Johannes Kepler*
Kuratorenführung durch die Ausstellung in der Ehemals Reichsstädtischen Bibliothek Lindau

10/11/2015 *Unendlich: Unglaublich – Unheimlich – Unmöglich*
Ringvorlesung "'Reise in die Unendlichkeit'", Universität Frankfurt

26/11/2015 *Mathematik, die beleidigte Königin der Wissenschaften*
Odenwaldakademie, Gymnasium Michelstadt

18/03/2016 *Mathematik, die beleidigte Königin der Wissenschaften*
Freiherr-vom-Stein-Schule, Hünfelden

26/06/2016 *Dem Bauplan Gottes auf der Spur. Mit dem Lindauer Bücherschatz auf Zeitreise zu Johannes Kepler*
Kuratorenführung durch die gleichnamige Ausstellung in der Ehemals Reichsstädtischen Bibliothek Lindau für die Kepler-Gesellschaft Weil der Stadt

28/06/2016 *On the Trail of God's Blueprint. A Journey Back in Time to Johannes Kepler with Lindau's Literary Treasures*
Kuratoren-Führung durch gleichnamige die Ausstellung in der Ehemals Reichsstädtischen Bibliothek Lindau anlässlich des 66-ten Nobelpreisträgertreffens in Lindau

Thomas Kugler

20/01/2016 *What is...? Numerische Methoden für turbulente Strömungen*
What is...? Seminar, Fachbereich Mathematik, TU Darmstadt

Jens Lang

15/03/2015 *IMEX Peer Methods with Optimized Stability*
CWI Amsterdam, The Netherlands

03/07/2015 *Ein Schritt Mehr: Von Rosenbrock zu Peer*
Farewell Colloquium in Honour of Prof. Dr. Bernhard A. Schmitt, Marburg

25/07/2016 *Adaptive Modelling, Simulation and Optimization of Water and Gas Supply Networks*
World Congress of Computation Mechanics 2016, Seoul, South Korea

Oliver Lass

13/07/2015 *Robust optimization of a permanent magnet synchronous motor geometry*
International Symposium on Mathematical Programming (ISMP), Pittsburgh

21/03/2016 *Robust optimization using a second order approximation technique in parametrized shape optimization*
Conference on Iterative Methods, Copper Mountain

06/06/2016 *Robust optimization using a second order approximation technique and model order reduction*
European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS), Hersonissos

09/08/2016 *A second order approximation technique for robust optimization in parametrized shape optimization*
International Conference on Continuous Optimization (ICCOPT), Tokyo

27/09/2016 *Nonlinear robust optimization using a second order approximation technique and model order reduction*
ALOP Workshop: Reduced Order Models in Optimization, Trier

Francesco Ludovici

06/07/2015 *An overview of optimal control for complex system*
MathMods Summer School: Mathematics as a code of modernity, San Benedetto del Tronto

Hendrik Lüthen

16/07/2015 *Partitioning into Induced Connected Isomorphic Subgraphs*
International Symposium on Mathematical Programming (ISMP), Pittsburgh

Matthias Meiners

12/02/2015 *Solutions to complex smoothing equations*
Oberseminar Stochastik, TU Dortmund

04/05/2015 *Solutions to complex smoothing equations*
Oberseminar Stochastik, Universität Mannheim

28/11/2015 *Fixed points–idée fixe in mathematics*
Theoretic and Applied Aspects of Cybernetics, Kiew

02/03/2016 *Solutions to complex smoothing equations*
12th German Probability and Statistics Days, Bochum

17/03/2016 *Biased random walk on a one-dimensional percolation cluster*
Oberseminar Strukturtheorie, TU Graz

03/11/2016 *Biased random walk on a one-dimensional percolation cluster*
Oberseminar Wahrscheinlichkeitstheorie, Universität Köln

Hannes Meinlschmidt

27/01/2015 *Optimalsteuerung des 3D Thermistor-Problems*
Seminar Nonlinear Optimization and Inverse Problems, Weierstraß Institut für Analysis und Stochastik (WIAS), Berlin

13/07/2015 *Optimal Control of PDAEs as Abstract DAEs of Index 1*
International Symposium on Mathematical Programming (ISMP), Pittsburgh

25/08/2015 *Optimal control problems with quasilinear parabolic equations in divergence form*
Kolloquium Lehrstuhl Optimalsteuerung, TU München

13/01/2016 *Hölder estimates for non-autonomous parabolic problems with rough data and applications to quasilinear problems*
Berliner Oberseminar: Nichtlineare partielle Differentialgleichungen (Langenbach-Seminar), Weierstraß Institut für Analysis und Stochastik (WIAS), Berlin

13/07/2016 *The full Keller-Segel model is well-posed*
Berliner Oberseminar: Nichtlineare partielle Differentialgleichungen (Langenbach-Seminar), Weierstraß Institut für Analysis und Stochastik (WIAS), Berlin

11/08/2016 *Optimal control of the 3D Thermistor Problem*
International Conference on Continuous Optimization (ICCOPT), Tokyo

Pascal Mindt

06/07/2016 *What is...? Ein Finite Volumen Verfahren*
What is...? Seminar, Fachbereich Mathematik, TU Darmstadt

Jens-Henning Moeller

07/09/2016 *Periodic Solutions to the 2D Euler Equations*
Towards Regularity, Warsaw, Poland

Sven Möller

26/06/2015 *Simple Currents, AIAs and Orbifold Construction of Holomorphic VOAs*
4th Seminar on Conformal Field Theory, Darmstadt

23/09/2016 *A Cyclic Orbifold Theory for Holomorphic VOAs and Applications*
Lie Group/Quantum Mathematics Seminar, Rutgers University, USA

Martin Otto

05/11/2015 *Finite global realisations of local overlap specifications*
Cambridge Computer Laboratory, Cambridge

10/11/2015 *Amalgamation, groupoids, symmetries in finite structures*
Logic Seminar, Leeds

03/12/2015 *Local to global: amalgamation and symmetries in finite structures*
Logic and Discrete Structures Seminar, RWTH Aachen

10/12/2015 *Up to bisimulation - but keep it finite!*
Workshop on fixpoint logics, automata and expressivenes, Amsterdam

26/07/2016 *Amalgamation and symmetries in the finite*
Workshop on Model Theory of Finite and Pseudofinite Structures, Leeds

26/08/2016 *Back and forth between malleable finite models*
Berkeley Logic Colloquium, Berkeley

Andreas Paffenholz

04/12/2015 *Structure and Classifications of Lattice Polytopes*
Seminar Geometrie und Visualisierung, TU München

02/08/2016 *Classifications of Lattice Polytopes*
Computational Commutative Algebra and Convex Polytopes, RIMS Kyoto

Raimondo Penta

25/11/2015 *Asymptotic homogenization for fluid and drug transport in malignant vessels and the impact of microvascular tortuosity on tumor blood flow*
Seminar of the Applied Mathematics & Mathematical Physics Section, Imperial College London, UK

29/09/2015 *Investigation of multiphase composites via asymptotic homogenization and its application to the bone hierarchical structure*
M3TB2015 – Multiscale Models in Mechano and Tumor Biology: Modeling, Homogenization, and Applications, TU Darmstadt

28/08/2015 *Effective governing equations for poroelastic growing media*
Workshop on Porous Media Modelling in Biological Processes: Perspectives on Analytical and Computational Methods Enabling Data Inversion, University of Dundee, UK

Sebastian Pfaff

05/07/2016 *Optimal Boundary Control of Scalar Conservation Laws with Switching Controls*
European Conference on Operational Research (EURO), Poznań

Marc Pfetsch

03/06/2015 *Overlapping SOS1 Constraints*
Mixed Integer Programming Workshop (MIP), Chicago

23/06/2015 *Die "diskrete" Seite der Mathematischen Optimierung*
Vorlesungsreihe: "Was steckt dahinter?", TU Darmstadt

29/02/2016 *Compressed Sensing and Discrete Optimization*
Oberseminar, Aachen

Anna-Maria von Pippich

05/02/2015 *Regularisierte Determinanten und arithmetische Riemann–Roch Isometrie*
Mathematical Colloquium, Universität Heidelberg

02/05/2015 *On Kronecker limit type formulae*
Conference European women in mathematics – German chapter, Universität Marburg

24/09/2015 *Kronecker limit type formulae and regularized determinants*
DMV Annual Meeting 2015, Universität Hamburg

17/11/2015 *On the wave representation of Eisenstein series*
Arithmetic Geometry Seminar, HU Berlin

14/12/2015 *Kronecker limit type formulae for Eisenstein series*
Number Theory Seminar, Universität Köln

28/04/2016 *Riemann–Roch isometries in the non-compact orbifold setting*
Workshop Moduli spaces and modular forms, Mathematisches Forschungsinstitut Oberwolfach

31/05/2016 *Riemann–Roch isometries in the non-compact orbifold setting*
Workshop Moduli, integrability, and dynamics, Mittag–Leffler Institute, Stockholm

15/07/2016 *Spezielle Zetawerte in Zahlentheorie und Geometrie*
Mathematical Colloquium, Universität Kiel

21/07/2016 *An analytic class number type formula for* $\mathrm{PSL}_2(\mathbb{Z})$
Conference Building bridges: 3rd EU/US workshop on automorphic forms and related topics, University of Sarajevo

03/08/2016 *Special zeta values in number theory and geometry*
Mathematical Colloquium, University of Chile, Santiago

09/08/2016 *Special zeta values in number theory and geometry*
Mathematical Colloquium, PUC Santiago

08/09/2016 *An analytic class number type formula for* $\mathrm{PSL}_2(\mathbb{Z})$
Conference Arakelov geometry – Archimedean and non-archimedean aspects, Universität Regensburg

16/11/2016 *Kronecker limit type formulas for non-holomorphic Eisenstein series*
Workshop Spectral theory, automorphic forms and arithmetic, University of Kopenhagen

29/11/2016 *A Rohrlich type formula for the hyperbolic 3-space*
Arithmetic Geometry Seminar, HU Berlin

Thomas Powell

15/09/2015 *Bar recursion over finite partial functions*
Continuity, Computability, Constructivity (CCC 2015), Kochel am See

04/11/2016 *Learning procedures arising from Gödel's functional interpretation*
Logic Seminar, LMU München

22/01/2016 *A constructive interpretation of open induction*
Dagstuhl Seminar on Well Quasi-Orders in Computer Science

27/10/2016 *Learning, loops and limits*
Logic Seminar, Universität Bern

Ulrich Reif

07/05/2015 *Interpolation and Approximation with Polymomials*
Kolloquium Universität Bayreuth

22/04/2015 *Multivariate Approximation by Polynomials and Splines*
Workshop Multivariate Splines and Algebraic Geometry, Oberwolfach

25/09/2015 *Ambient B-Splines*
Second Symposium on Approximation of Curves and Surfaces, Rhodes

23/05/2016 *Approximation and Modeling with Ambient B-Splines*
AT15, San Antonio

02/06/2016 *Interpolation and Approximation with Polymomials*
Kolloquium Universität Hamburg

23/06/2016 *Approximation with Ambient B-Splines and Intrinsic PDEs on Manifolds*
Curves and Surfaces, Toensberg

22/09/2016 *Approximation with Ambient B-Splines and Intrinsic PDEs on Manifolds*
MAIA, CIRM Marseille

Steffen Roch

07/07/2016 *Extension-restriction theorems for algebras of approximation sequences*
WOAT 2016, IST Lissabon

21/09/2016 *The finite sections method for infinite Toeplitz matrices*
IPN Mexico-City

27/09/2016 *Extension-restriction theorems for algebras of approximation sequences*
CINVESTAV, Mexico-City

14/10/2016 *38 Jahre Separabilität*
Kolloquium zum 75. Geburtstag von Prof. B. Silbermann, TU Chemnitz

Ulrike Roder

10/02/2015 *Das hessische Projekt MAKOS zur Implementierung des neuen Kerncurriculums (KC) Oberstufe*
Talk at Conference Society for Didactics of Mathematics (GDM), Basel

23/04/2015 *Das hessische Projekt MAKOS zur Implementierung des neuen Kerncurriculums (KC) Oberstufe*
Teacher further training talk at Justin-Wagner Schule, Roßdorf

08/03/2016 *Entwicklung eines Förderkonzepts zu Grundwissen und Grundkönnen am Übergang in die Sekundarstufe II*
Talk at Conference Society for Didactics of Mathematics (GDM), Heidelberg

09/03/2016 *Das hessische Projekt MAKOS zur Implementierung des neuen Kerncurriculums (KC) Oberstufe*
Talk at Conference Society for Didactics of Mathematics (GDM), Heidelberg

12/03/2016 *Das hessische Projekt MAKOS zur Implementierung des neuen Kerncurriculums (KC) Oberstufe*
Teacher further training talk at "Tag der Mathematik", Wetzlar

Martin Saal

09/07/2015 *Calderon-Zygmund Operators in Morrey spaces*
Oberseminar/ Universität Konstanz

09/09/2015 *Calderon-Zygmund Operators in Morrey spaces*
Colloquium/University of Concepcion

10/09/2015 *Nonlinear Integro-Differential Equations*
Research seminar/University of Bio-Bio, Concepcion

24/09/2015 *Calderon-Zygmund Operators in Morrey spaces*
Workshop on PDE XIV/LNCC, Petropolis

01/10/2015 *Calderon-Zygmund Operators in Morrey spaces*
Workshop on Analysis and PDE/Leibniz Universität Hannover

18/05/2016 *Exponential stability of a thermoviscoelastic mixture with second sound*
International Conference on Evolution Equations and Shanks Lecture/Vanderbilt University, Nashville

19/07/2016 *The Primitive equations with linearly growing initial data*
Oberseminar/ Karlsruher Institut für Technologie

13/09/2016 *The Primitive equations with linearly growing initial data*
Workshop on PDE XV/LNCC, Petropolis

Nils Scheithauer

17/11/2015 *Borcherds' products of singular weight*
Seminar Automorphic Forms and Applications, National Research University HSE, Moscow

19/11/2015 *Modular forms for the Weil representation*
Seminar Automorphic Forms and Applications, National Research University HSE, Moscow

13/01/2016 *Automorphic products of singular weight*
Algebra and Geometry Seminar, Sapienza University, Rome

19/03/2016 *Construction and classification of holomorphic vertex operator algebras*
Special Session on Vertex Algebras and Related Algebraic and Geometric Structures, AMS Sectional Meeting, Stony Brook

19/05/2016 *Orbifolds*
Talks in mathematical physics, ETH Zürich

21/06/2016 *From Bernoulli numbers to strings*
Kolloquium über Reine Mathematik, Universität Hamburg

Werner Schindler

17/02/2016 *Wirksamkeit von Blindingtechniken gegen Seitenkanalangriffe*
SmartCard Workshop 2016, Darmstadt

Johann Michael Schmitt

08/08/2016 *Optimal control of hyperbolic balance laws with state constraints*
International Conference on Continuous Optimization (ICCOPT), Tokyo

Alexandra Schwartz

11/02/2015 *Rigging the Game: Spieltheorie und Wettbewerbsdesign*
Mathematisches Kolloquium, Darmstadt

04/03/2015 *Eine kontinuierliche Umformulierung von Problemen mit Kardinalitätsrestriktionen*
Workshop "Women in Optimization", Heidelberg

14/10/2015 *Spieltheorie: Alles im Gleichgewicht?*
Schülerinnen- und Schülernachmittag zur Mathematik, Darmstadt

26/01/2016 *NewtonPlag*
Hochschul- und Berufsinformationstage (Hobit), Darmstadt

10/03/2016 *Spieltheorie und Wettbewerbsdesign*
Joint Annual Meeting of GAMM and DMV, Braunschweig

28/10/2016 *Multi-Leader-Follower Games in Function Space*
with Sonja Steffensen, Kickoff-Meeting SPP 1962, Berlin

Tobias Seitz

13/02/2016 *Filtering distributed flow measurements using fluid-dynamic constraints*
Workshop on Mathematical Analysis for Nonlinear Phenomena, Kanazawa, Japan

22/06/2016 *What is...? Ein schlecht gestelltes Problem*
What is...? Seminar, Fachbereich Mathematik, TU Darmstadt

Florian Steinberg

16/04/2016 *Computational complexity theory for spaces of integrable functions*
Seminar talk, KAIST

Christian Stinner

06/01/2015 *Finite time versus infinite time blowup for a fully parabolic Keller-Segel system*
Seminar talk, Leibniz Universität Hannover

16/06/2015 *Finite time versus infinite time blowup for a fully parabolic Keller-Segel system*
Seminar talk, LMU München

10/09/2015 *Finite time versus infinite time blowup for a fully parabolic Keller-Segel system*
Workshop in Nonlinear PDEs, Brussels

17/09/2015 *Finite time versus infinite time blowup for a fully parabolic Keller-Segel system*
Seminar talk, Universität Mannheim

23/02/2016 *Finite time versus infinite time blowup for a fully parabolic Keller-Segel system*
International Workshop on Mathematical Analysis of Chemotaxis, Tokyo University of Science

01/06/2016 *On a multiscale model involving cell contractivity and its effects on tumor invasion*
Seminar talk, Ludwig-Maximilians-Universität München

05/09/2016 *Finite time versus infinite time blow-up for a fully parabolic Keller-Segel system*
7th Euro-Japanese Workshop on Blow-up, Bedlewo

Thomas Streicher

25/02/2015 *An Effective Spectral Theorem for Bounded Self Adjoint Operators*
University of Leeds

08/06/2015 *Choice Sequences versus Formal Topology*
Workshop on Formal Topology, Mittag-Leffler Institute

13/02/2016 *Splitting Dictoses*
Workshop on Homotopy Type Theory, Bonn

13/04/2016 *Isomorphic Talks are Equal?*
University of Verona

05/05/2016 *An Effective Spectral Theorem for Bounded Self Adjoint Operators*
PCC 2016, LMU München

09/06/2016 *An Effective Spectral Theorem for Bounded Self Adjoint Operators*
ENS Lyon

22/06/2016 *An Effective Spectral Theorem for Bounded Self Adjoint Operators*
University of Ljubljana

20/07/2016 *Isomorphic Types are Equal?*
FOMUS Workshop, Bielefeld

Andreas Tillmann

19/03/2015 *Computational Aspects of Sparse Recovery*
Workshop "Sparse Tomographic Reconstruction: Theoretical and Numerical Aspects", Heidelberg

23/03/2015 *Computational Aspects of Sparse Recovery*
Annual Meeting of the International Association of Applied Mathematics and Mechanics (GAMM), Lecce

20/05/2015 *Polyhedral Approaches to Sparse Recovery*
Seminar at INRIA Grenoble Rhône-Alpes

15/07/2015 *Branch & Cut Methods for Exact Sparse Recovery*
International Symposium on Mathematical Programming (ISMP), Pittsburgh

27/01/2016 *Maschinelles Lernen zur Signalrekonstruktion aus phasenlosen Messdaten*
Oberseminar Operations Research, RWTH Aachen

04/04/2016 *New Applications of Sparsity-Based Learning*
Workshop "Data Science meets Optimization", Aachen

09/09/2016 *Exploiting hidden sparsity for image reconstruction from nonlinear measurements*
Dolomites Workshop on Constructive Approximation and Applications, Alba di Canazei

Stefan Ulbrich

27/01/2015 *Multilevel methods for PDE-constrained optimization based on adaptive discretizations, reduced order models and error estimators*
Colloquium of the Modeling, Numerics, Differential Equations Group, TU Berlin

17/06/2015 *Multilevel methods for PDE-constrained optimization based on adaptive discretizations and reduced order models*
Plenary Talk, British-French-German Conference on Optimization, London

13/07/2015 *Optimization of nonlinear hyperbolic conservation laws with switching controls*
International Symposium on Mathematical Programming (ISMP), Pittsburgh

05/08/2015 *Multilevel methods for PDE-constrained optimization based on adaptive discretizations and reduced order models*
Plenary Talk, 10th Int. Conference on Numerical Optimization and Numerical Linear Algebra (ICNONLA), Yanan, Shaanxi, China

13/08/2015 *Methods for robust PDE-constrained optimization and applications*
International Congress on Industrial and Applied Mathematics (ICIAM), Bejing, China

10/11/2015 *Methods for robust PDE-constrained optimization and applications*
UQ15: Direct and Inverse Problems for PDEs with Random Coefficients, WIAS, Berlin

02/12/2015 *Robust optimization for engineering applications*
Bosch AG, Renningen

21/03/2016 *Preconditioners for time-dependent PDE-constrained optimization and their application based on Parareal time-domain decomposition*
Conference on Iterative Methods, Copper Mountain

14/06/2016 *Efficient methods for PDE-constrained optimization based on adaptive discretizations and reduced order models*
Mathematical Colloquium, Department of Mathematics, FAU Erlangen-Nürnberg

10/08/2016 *Preconditioners for time-dependent PDE-constrained optimization and an implementation based on Parareal time-domain decomposition*
International Conference on Continuous Optimization (ICCOPT), Tokyo

29/09/2016 *Robust PDE-constrained optimization based on approximation techniques and reduced order models*
Invited special lecture, CAAM, Rice University, Houston

Sebastian Ullmann

04/12/2015 *Model order reduction with adaptive finite element POD and application to uncertainty quantification*
Seminar in Numerical Analysis, Universität Basel

02/06/2016 *POD-Galerkin reduced-order modeling with adaptive finite element snapshots*
Numerik Kolloquium, Universität Ulm

Fabian Völz

21/06/2016 *Elliptic and hyperbolic Eisenstein series as theta lifts*
Forschungsseminar Arithmetische Geometrie, Berlin

20/07/2016 *Elliptic and hyperbolic Eisenstein series as theta lifts*
Building Bridges: Workshop on Automorphic Forms and Related Topics, Sarajevo, Bosnia and Herzegovina

Miroslav Vrzina

14/07/2016 *The existence problem for unduloids in* $\mathbb{H}^2 \times \mathbb{R}$
Oberseminar Partielle Differentialgleichungen, Universität Konstanz

David Wegmann

25/05/2015 *Decay of Non-stationary Navier-Stokes Flow with Nonzero Dirichlet Boundary Data*
14th Kacov School, Mathematical Theory in Fluid Mechanics

05/06/2015 *Decay of Non-stationary Navier-Stokes Flow with Nonzero Dirichlet Boundary Data*
Asymptotic Problems, Vilnius, Lithuania

03/03/2016 *Decay of Non-stationary Navier-Stokes Flow with Nonzero Dirichlet Boundary Data*
The 12th Japanese-German International Workshop on Mathematical Fluid Dynamics, Waseda University, Tokyo, Japan

03/05/2016 *Decay of Non-stationary Navier-Stokes Flow with Nonzero Dirichlet Boundary Data*
Smirnov Seminar on Mathematical Physics, Steklov Institut, St. Petersburg, Russia

08/09/2016 *Decay of Non-stationary Navier-Stokes Flow with Nonzero Dirichlet Boundary Data*
Towards Regularity, Warsaw, Poland

Cornelia Wichelhaus

27/01/2015 *Nichtparametrische Analyse stochastischer Netzwerke*
Seminar Talk / Karlsruher Institut für Technologie

Winnifried Wollner

29/01/2015 *Optimal Control for Fracture Propagation Modeled by a Phase-Field Approach*
Colloquium of the EPN, Quito

09/06/2015 *Pointwise convergence of the feasibility violation for Moreau-Yosida regularized optimal control problems*
Kolloquium an der Universität der Bundeswehr, München

18/02/2016 *Optimization of partial differential equations subject to pointwise constraints on the gradient of the state*
Kolloquium an der Universität Bonn

14/04/2016 *Optimization of partial differential equations subject to pointwise constraints on the gradient of the state*
Kolloquium am Weierstraß Institut für Analysis und Stochastik (WIAS), Berlin

20/09/2016 *Adaptive finite elements in numerical optimization*
Autumn School Algorithmic Optimization, Trier

27/09/2016 *Optimal Control of PDEs*
TRR 154 Lecture Series, Darmstadt

11/10/2016 *Optimal L2 Error for a Modified Crouzeix-Raviart Stokes Element*
Symposium on Simulation and Optimization of Extreme Fluids, Heidelberg

6.1.2 Contributed Talks

Paloma Schäfer Aguilar

14/11/2016 *Smoothing-type method for a Branch-and-Bound algorithm for mixed-integer semidefinite programs*
Optimization Seminar, TU Darmstadt

Tristan Alex

27/03/2015 *Periodische Minimalflächen in homogenen 3-Mannigfaltigkeiten*
Workshop der AG Geometrie und Approximation, Höchst im Odenwald

11/03/2016 *Eine Minimalfläche im Heisenbergraum*
Workshop der AG Geometrie und Approximation, Höchst im Odenwald

Frank Aurzada

02/03/2016 *Persistence exponents of Markov chains*
German Probability and Statistics days, Bochum

René Bartsch

27/07/2016 *Hyperstructures in topological categories*
TopoSym 2016, Prague

Johanna Biehl

25/04/2016 *Multilevel Optimization based on Reduced Order Models with Application to Fluid Structure Interaction*
Graduate School CE Research Colloquium, TU Darmstadt

Anke Böttcher

17/11/2016 *Numerical approximation of Allen-Cahn type equations*
Seminar der AG Numerik, TU Darmstadt

Dieter Bothe

25/02/2015 *A Survey on DNS Methods for Multiphase Flows*
Atomization and Sprays, TU Darmstadt

12/03/2015 *On the multi-physics of mass-transfer across fluid interfaces: modeling & numerical simulation*
IUTAM Symposium on Bubbly Flows, Oaxaca, Mexico

19/03/2015 *A Hybrid Level Set / Front Tracking Method on Unstructured Meshes*
GVC-Fachausschuss Computational Fluid Dynamics, Lüneburg

01/09/2015 *Direkte Numerische Simulation der Multiphysik des reaktiven Stoffübergangs an Einzelblasen und Blasengruppen*
Jahreskolloquium des SPP 1740, Hamburg

23/09/2015 *Modeling of mass transfer across contaminated fluid interfaces*
DMV Jahrestagung, Hamburg

10/11/2015 *Modeling and Direct Numerical Simulation of Transport Processes at Fluid Interfaces*
International Workshop on the Multi-Phase Flow; Analysis, Modeling and Numerics, Waseda University, Tokyo, Japan

16/11/2015 *Modeling and simulation of mass-transfer across contaminated fluid interfaces*
RIMS Workshop on Mathematical Analysis of Viscous Incompressible Fluid, Kyoto University, Japan

07/04/2016 *Grundlagen und Anwendungen der Volume of Fluid Methode (VOF)*
750. DECHEMA-Kolloquium, Frankfurt

19/05/2016 *On mass-transfer across clean / contaminated fluid interfaces*
International Conference on Evolution Equations, Vanderbilt University, Nashville, USA

24/05/2016 *Modeling and Simulation of Mass-Transfer at Clean/Contaminated Fluid Interfaces*
ICMF, Firenze, Italy

02/06/2016 *Transport phenomena at interfacel*
International Symposium InPROMPT 2016, Berlin

Bogdan Radu

23/06/2016 *Mixed finite element methods for the acoustic wave equation*
Seminar der AG Numerik, TU Darmstadt

07/07/2016 *Mixed finite element methods for the acoustic wave equation*
AANMPDE, Strobl

Max Bucher

11/02/2015 *Was ist ein Nash-Gleichgewicht?*
Seminar "What is ...?", TU Darmstadt

13/04/2015 *A Continuous Reformulation of Cardinality Constrained Optimization Problems*
Graduate School CE Retreat, Seeheim-Jugenheim

03/08/2015 *A Continuous Reformulation of Cardinality Constrained Optimization Problems*
Graduate School CE Research Colloquium, TU Darmstadt

05/09/2016 *A Continuous Reformulation of Cardinality Constrained Optimization Problems - Optimality Conditions and an Error Bound via Piecewise Decomposition*
Graduate School CE Research Colloquium, TU Darmstadt

Ulrik Buchholtz

28/05/2015 *Primitive recursive homotopy type theory*
ASL annual meeting, Urbana, IL, USA

03/07/2015 *Weak dependent type theories*
Mathematics seminar, University of Stockholm, Sweden

22/01/2016 *The quaternionic Hopf fibration in HoTT*
Homotopy type theory seminar, Carnegie Mellon University, Pittsburgh, PA, USA

12/02/2016 *The quaternionic Hopf fibration in HoTT*
Workshop on homotopy type theory, Max Planck Institute for Mathematics, Bonn, Germany

16/05/2016 *Projective spaces in synthetic homotopy theory*
Workshop on homotopy type theory and univalent foundations, Fields Institute, Toronto, Canada

26/05/2016 *The quaternionic Hopf fibration in HoTT*
TYPES meeting 2016, Novi Sad, Serbia

21/07/2016 *Synthetic homotopy theory and higher inductive types*
FOMUS Workshop (Foundations of Mathematics: Univalent Foundations and Set Theory), Bielefeld, Germany

22/07/2016 *Proof theory of homotopy type theory: what we know so far*
FOMUS Workshop (Foundations of Mathematics: Univalent Foundations and Set Theory), Bielefeld, Germany

28/08/2016 *Infinity group theory in HoTT*
Theory seminar, IT University, Copenhagen, Denmark

23/09/2016 *Higher groups and projective spaces in HoTT*
Homotopy type theory seminar, Carnegie Mellon University, Pittsburgh, PA, USA

Yann Disser

05/01/2015 *The Simplex Algorithm is NP-mighty*
ACM-SIAM Symposium on Discrete Algorithms (SODA), San Diego

04/01/2016 *Undirected Graph Exploration with* $\theta(\log\log n)$ *Pebbles*
Combinatorial Optimization Workshop (COW), Aussois

Pia Domschke

23/02/2015 *Modelling the role of adhesion in the heterogeneous dynamics of cancer invasion*
Research Group Workshop Kleinwalsertal, Hirschegg

21/06/2015 *Structured models of cell migration incorporating membrane reactions (Poster)*
ICMS Workshop on "Computational and multiscale mathematical modelling of cancer growth and spread", Edinburgh, UK

28/09/2015 *Structured models of cell migration incorporating membrane reactions (Poster)*
International Workshop of Multiscale Models in Mechano and Tumor Biology, Darmstadt

08/03/2016 *Adaptive Modelling, Simulation and Optimization of Gas and Water Supply Networks*
GAMM/DMV Conference 2016, Braunschweig

12/07/2016 *Adaptive Modelling, Simulation and Optimization of Gas and Water Supply Networks*
7ECM Berlin 2016

Thorsten Ederer

10/03/2015 *Experimentelle Validierung einer algorithmischen Systemsynthese*
Technical Operations Research Workshop (TOR), Trifels

16/07/2015 *Benchmarks of Distributed Solvers for Mixed-Integer Linear Programs on a High Performance Computer*
International Symposium on Mathematical Programming (ISMP), Pittsburgh

02/09/2015 *Algorithmic System Design Using Scaling and Affinity Laws*
Annual International Conference of the German Operations Research Society (OR), Wien

26/02/2016 *Technical Operations Research – Optimale Strukturfindung*
HDT-Seminar: Ventilatoren – Von der Produkt-Optimierung zur quantitativen Methode der Systemsynthese, Essen

06/04/2016 *Auslegung von mechanischen Getrieben mittels MINLP*
Technical Operations Research Workshop (TOR), Trifels

06/06/2016 *Gearbox Design via Mixed-Integer Programming*
European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS), Hersonissos

02/09/2016 *A Mixed-Integer Nonlinear Program for the Design of Mechanical Transmission Systems*
Annual International Conference of the German Operations Research Society (OR), Hamburg

Herbert Egger

29/05/2015 *On numerical methods for parameter identification in radiative transfer*
AIP 2015, Helsinki, Finland

16/03/2016 *On enhancement of flow measurements using fluid-dynamic constraints*
Inverse Problems in the Alps, Obergurgl

06/06/2016 *A fictitious domain levelset method for inclusion detection*
ECCOMAS Congress 2016, Crete, Greece

07/07/2016 *Damped wave systems on networks: Exponential stability and uniform approximations*
AANMPDE 2016, Strobl

02/08/2016 *Damped wave systems on networks: Exponential stability and uniform approximations*
HYP 2016, RWTH Aachen

Kord Eickmeyer

04/03/2016 *Model Checking for Successor-Invariant FO on Graphs Excluding a Topological Minor*
Workshop on Algorithmic Model Theory, Siegen

30/08/2016 *Model Checking for Invariant FO on Restricted Graph Classes*
Computer Science Logic, Marseille

Christoph Erath

15/06/2016 *Adaptive vertex-centered finite volume methods with convergence rates*
MAFELAP 2016 (eingeladen im Minisymposium), Brunel University London, UK

08/03/2016 *A non symmetric FVM-BEM coupling method*
GAMM 2016, Braunschweig

23/10/2015 *A non symmetric FVM-BEM coupling method*
13. Söllerhaus Workshop on Fast BEM in Industrial Applications, Hirschegg, Österreich

24/02/2015 *Finite Volume Method-Coupling-Boundary Element Method*
Research Group Workshop Kleinwalsertal, Hirschegg

Sofia Eriksson

26/02/2015 *Stable Numerical Methods with Boundary and Interface Treatment for Applications in Aerodynamics*
Research Group Workshop Kleinwalsertal, Hirschegg

19/01/2017 *Coupling of the cell-centered finite volume method and the boundary element method for time-dependent advection-diffusion problems*
Seminar der AG Numerik, TU Darmstadt

Tobias Ewald

04/03/2015 *Hölder regularity of geometric subdivision schemes: Applications and generalization*
Workshop on Subdivision, Refinability, Signals and Approximation, Bernried

27/03/2015 *Geometrische Subdivisionsalgorithmen*
AG-Seminar, Höchst

11/08/2015 *Analysis of Geometric Subdivision Schemes*
ICIAM 2015, Beijing

23/06/2016 *Analysis of Geometric Subdivision Schemes*
Conference on Mathematical Methods for Curves and Surfaces, Toensberg

Michael Fischer

12/03/2015 *Shape optimization and the stabilized characteristics finite element method*
Japanese-German International Workshop on Mathematical Fluid Dynamics, Waseda University, Tokyo

17/07/2015 *Shape Optimization of the Boussinesq Equations via a Characteristics P1/P1 FE Discretization*
International Symposium on Mathematical Programming (ISMP), Pittsburgh

07/08/2015 *Shape Optimization of the Boussinesq Equations via a Characteristics P1/P1 FE Discretization*
Joint International Conference and Autumn School, TU Darmstadt

30/11/2015 *Shape Optimization of the Navier-Stokes equations*
Optimization Seminar, TU Darmstadt

02/03/2016 *Shape optimization with the Boussinesq equations*
Japanese-German International Workshop on Mathematical Fluid Dynamics, Waseda University, Tokyo

Tobias Fischer

23/11/2015 *Branch-and-Cut for Linear Programs with Overlapping SOS1 Constraints*
Graduate School CE Research Colloquium, TU Darmstadt

27/06/2016 *Branch-and-Cut for Linear Programs with Complementarity and Cardinality Constraints*
Optimization Seminar, TU Darmstadt

Tristan Gally

12/07/2016 *SCIP-SDP: A Framework for Solving Mixed-Integer Semidefinite Programs*
International Congress on Mathematical Software (ICMS), Berlin

31/10/2016 *SCIP-SDP: A Framework for Solving Mixed-Integer Semidefinite Programs*
Optimization Seminar, TU Darmstadt

Alf Gerisch

23/02/2015 *A nonlocal model for contact attraction and repulsion in heterogeneous populations*
Research Group Workshop Kleinwalsertal, Hirschegg

23/02/2016 *Can a Continuous Mineral Foam Explain the Stiffening of Aged Bone Tissue?*
Bio-inspired Materials 2016, Potsdam

12/07/2016 *Cross-diffusion in structured models of cancer invasion*
ECMTB 2016, Nottingham, UK

Thea Göllner

24/03/2015 *Geometry Optimization of Branched Sheet Metal Structures with a Globalization Strategy by Adaptive Cubic Regularization*
Annual Meeting of the International Association of Applied Mathematics and Mechanics (GAMM), Lecce

Oliver Habeck

24/10/2016 *Globale Methoden für stationären Gastransport*
Optimization Seminar, TU Darmstadt

Robert Haller-Dintelmann

02/12/2015 *The Kato square root property for mixed boundary conditions*
Workshop "PDE 2015 – Theory and Applications of Partial Differential Equations", Berlin

28/09/2016 *Sobolev extension operators for functions with partially vanishing trace*
10th Euro-Maghrebian Workshop on Evolution Equations, Blaubeuren

Karl H. Hofmann

18/03/2015 *Some basic Structure Theorems of Compact Groups*
Tulane University, New Orleans

03/03/2016 *Approximating locally compact groups by groups of integers*
Tulane University, New Orleans

Christopher Hojny

11/05/2015 *Polyhedral Symmetry Handling via Symmetry Breaking Polytopes*
Optimization Seminar, TU Darmstadt

26/05/2015 *Symmetry Handling via Symmetry Breaking Polytopes*
Cologne Twente Workshop (CTW), Marmara University Istanbul

05/01/2016 *Polytopes Associated with Symmetry Handling*
Combinatorial Optimization Workshop (COW), Aussois

14/07/2016 *Symmetry Handling in Binary Programs via Polyhedral Methods*
International Conference on Mathematical Software (ICMS), Berlin

17/10/2016 *Symmetry Handling in Binary Programs via Polyhedral Methods*
Optimization Seminar, TU Darmstadt

Benjamin Horn

11/08/2016 *Shape optimization for contact problems based on isogeometric analysis and nonconvex bundle methods*
International Conference on Continuous Optimization (ICCOPT), Tokyo

Amru Hussein

01/03/2016 *On the primitive equations in* L^p
The 12th Japanese-German International Workshop on Mathematical Fluid Dynamics, Tokyo

18/05/2016 *Global strong* L^p *well-posedness of the 3D primitive equations*
International Conference on Evolutione Equations, Vanderbilt University, Nashville

12/09/2016 *Non-self-adjoint graphs*
Trilateral German-Russian-Ukrainian summer school Spectral Theory, Differential Equations Probability, Mainz

28/09/2016 *Global strong L^p well-posedness of the 3D primitive equations*
10th Euro-Maghrebian Workshop on Evolution Equations, Blaubeuren

01/12/2016 *Global strong L^p well-posedness of the 3D primitive equations*
The 13th Japanese-German International Workshop on Mathematical Fluid Dynamics, Darmstadt

Imke Joormann

05/07/2016 *Heuristics for Analyzing Infeasibility in Flow Networks*
European Conference on Operational Research (EURO), Poznań

12/05/2016 *Unzulässigkeitsanalyse in Fluss-Netzwerken*
AG Seminar, TU Braunschweig

26/01/2015 *Irreducible Infeasible Subsystems and their Covers in Flow Networks*
Optimization Seminar, TU Darmstadt

Klaus Keimel

23/09/2015 *Healthiness conditions for predicate transformers*
Conference on Mathematical Foundations of Programming Semantics (MFPS XXXI), Nijmegen, Netherlands

03/07/2015 *Healthiness conditions for predicate transformers*
Kyoto University, Japan

26/08/2015 *The Cuntz semigroup of a C^*-algebra and Domain Theory*
Workshop Domains XII, University College Cork, Ireland

27/10/2015 *Duality and Compactness*
Duality in Computer Science, Leibniz Zentrum, Schloß Dagstuhl

03/05/2016 *Elliott's topological enrichment of the Cuntz semigroup of a C^*-algebra*
31st Summer Conference on Topology and its Applications, Leicester University, UK

Ulrich Kohlenbach

24/05/2016 *Proof-theoreric metatheorems for metric structures and their relations to positive bounded logic*
ASL Annual Meeting, Storrs, Connecticut, USA

Philip Kolvenbach

16/07/2015 *Robust Geometry Optimization in Elastodynamics with Time-Dependent Uncertainties*
International Symposium on Mathematical Programming (ISMP), Pittsburgh

11/08/2016 *Nonlinear robust optimization using second-order approximations and an application to the shape optimization of hyperelastic load-carrying structures*
International Conference on Continuous Optimization (ICCOPT), Tokyo

13/09/2016 *Nonlinear robust optimization using second-order approximations and an application to the shape optimization of hyperelastic load-carrying structures*
European Conference on Computational Optimization (EUCCO), Leuven

07/11/2016 *Robuste Optimierung PDE-restringierter Probleme mittels quadratischer Approximationen*
Optimization Seminar, TU Darmstadt

Angeliki Koutsoukou-Argyraki

19/04/2016 *New effective bounds for the approximate common fixed points and asymptotic regularity of nonexpansive semigroups*
IRTG 1529 Seminar, TU Darmstadt, Germany.

29/11/2015 *New Applications of Proof Mining to Nonlinear Analysis*
General Proof Theory: Celebrating 50 Years of Dag Prawitz's "Natural Deduction", Tübingen, Germany.

08/10/2015 *Effective information for abstract Cauchy problems extracted via Proof Mining*
SPP 1506, IRTG 1529 and DFG-JSPS Joint International Conference and Autumn School, Darmstadt, Germany.

20/07/2015 *Approximate common fixed points and rates of asymptotic regularity for one-parameter nonexpansive semigroups*
11th International Conference on Fixed Point Theory and Applications, Istanbul, Turkey.

17/07/2015 *Approximate common fixed points and rates of asymptotic regularity for one-parameter nonexpansive semigroups*
Logic Seminar, TU Darmstadt, Germany.

15/06/2015 *Recent proof mining results for PDE theory and fixed point theory and other ongoing applications of proof theory to analysis*
Poster presentation, 10th Panhellenic Logic Symposium, Samos, Greece.

09/06/2015 *Proof mining and nonlinear semigroups*
IRTG 1529 Seminar, TU Darmstadt, Germany.

03/03/2015 *First application of proof mining to partial differential equations; rates of convergence and metastability for abstract Cauchy problems generated by accretive operators*
Constructivism and Computability, JAIST Logic Workshop Series, Kanazawa, Japan.

Thomas Kugler

14/04/2016 *Damped Waves on Networks*
Seminar der AG Numerik, TU Darmstadt

07/07/2016 *Structure Preserving Model Reduction for Damped Wave Propagation on Networks*
AANMPDE, Strobl

06/10/2016 *Structure Preserving Model Order Reduction for Damped Wave Propagation on Networks*
Mathematics of Gas Transport, Berlin

Anja Kuttich

25/03/2015 *Robust Optimization of Trusses under Dynamic Loads via Nonlinear Semidefinite Programming*
Annual Meeting of the International Association of Applied Mathematics and Mechanics (GAMM), Lecce

18/07/2015 *Robust Optimization of Trusses under Dynamic Loads via Nonlinear Semidefinite Programming*
International Symposium on Mathematical Programming (ISMP), Pittsburgh

19/11/2015 *Robust Truss Topology Design with Beam Elements via Mixed Integer Nonlinear Semidefinite Programming*
International Conference on Uncertainty in Mechanical Engineering (ICUME), Darmstadt

09/03/2016 *Nonlinear Semidefinite Programming with Application to Robust Truss Topology Design under Uncertain Dynamic Loads*
Joint Annual Meeting of GAMM and DMV, Braunschweig

11/08/2016 *Robust Topology Design of Mechanical Systems under Uncertain Dynamic Loads via Nonlinear Semidefinite Programming*
International Conference on Continuous Optimization (ICCOPT), Tokyo

Mads Kyed

03/06/2015 *Fundamental solution to the time-periodic Stokes equations*
Conference on “Asymptotic Problems: Elliptic and Parabolic Issues”, Vilnius, Lithuania

Jens Lang

07/09/2015 *On Global Error Estimation and Control for Stiff Initial Values Problems*
NUMDIFF 2015, Halle

15/09/2015 *Higher Order Time Integrators of PEER Type for Parabolic Problems*
ENUMATH 2015, Ankara, Turkey

Oliver Lass

15/06/2015 *Robust optimization of a permanent magnet synchronous motor geometry*
British-French-German Conference on Optimization, London

Francesco Ludovici

27/03/2015 *A priori error estimates for nonstationary optimal control problems with gradient state constraints*
Annual Meeting of the International Association of Applied Mathematics and Mechanics (GAMM), Lecce

15/07/2015 *A priori error estimates for nonstationary optimal control problems with gradient state constraints*
International Symposium on Mathematical Programming (ISMP), Pittsburgh

22/09/2015 *A priori error estimates for nonstationary optimal control problems with state constraints*
Jahrestagung der Deutschen Mathematiker-Vereinigung, Hamburg

07/12/2015 *Optimal control of parabolic PDEs with state constraints*
Optimization Seminar, TU Darmstadt

08/03/2016 *Nonstationary optimal control problems with state constraints*
Joint Annual Meeting of GAMM and DMV, Braunschweig

01/09/2016 *Optimal control of parabolic PDEs with state constraints*
Workshop in applied and industrial mathematics (WIAM16), Hamburg

Hendrik Lüthen

20/06/2016 *Optimierungsprobleme mit farbinduzierten Budget-Bedingungen*
Optimization Seminar, TU Darmstadt

04/08/2016 *Partitioning into Induced Connected Isomorphic Subgraphs*
Future Research in Combinatorial Optimization (FRICO), Osnabrück

Axel Ariaan Lukassen

16/06/2016 *Parameter estimation for chemical systems*
Seminar der AG Numerik, TU Darmstadt

04/10/2016 *Parameter estimation for chemical systems*
Reduced Basis Summer School 2016, Hedersleben

Matthias Meiners

02/03/2016 *Solutions to complex smoothing equations*
12th German Probability and Statistics Days, Bochum

Hannes Meinlschmidt

23/02/2015 *Quasilineare und nichtautonome parabolische Optimalsteueraufgaben und Kompaktheit für Steuerungen*
Chemnitzer Seminar zur Optimalsteuerung, Haus im Ennstal

01/07/2015 *PDAEs and Optimal Control*
IFIP TC7 Conference on System Modelling and Optimization, Sophia Antipolis

01/03/2016 *Hölder-Schranken für nichtautonome parabolische Probleme und Anwendung für quasilineare Probleme*
Chemnitzer Seminar zur Optimalsteuerung, Haus im Ennstal

11/04/2016 *Hölder-Schranken für nichtautonome parabolische Probleme und Anwendung für quasilineare Probleme*
Optimization Seminar, TU Darmstadt

Pascal Mindt

09/06/2016 *Finite Volume Methods on Networks*
Seminar der AG Numerik, TU Darmstadt

Sven Möller

02/03/2015 *Cyclic Orbifold Construction of Holomorphic Vertex Operator Algebras*
Winter Seminar of the Darmstadt Algebra Group, Manigod, France

08/03/2016 *BRST Construction of 10 Borcherds-Kac-Moody Algebras*
Winter Seminar of the Darmstadt Algebra Group, Manigod, France

Christian Mönch

30/07/2015 *Persistence of activity in critical scale free Boolean networks*
Oberwolfach Workshop "Interplay of Analysis and Probability in Applied Mathematics", MFO Oberwolfach

Christopher Müller

14/04/2015 *The stochastic Galerkin method*
5th Retreat of the GSC CE, Seeheim-Jugenheim

17/08/2015 *Uncertainty Quantification for PDEs with random data – the stochastic Galerkin method*
CE Research Colloquium, TU Darmstadt

14/11/2016 *Stochastic Galerkin finite element discretization of Stokes flow with random viscosity – iterative solvers and preconditioning*
CE Research Colloquium, TU Darmstadt

24/11/2016 *Stochastic Galerkin finite element discretization of Stokes flow with random viscosity – iterative solvers and preconditioning*
Seminar der AG Numerik, TU Darmstadt

18/12/2016 *Conjugate gradient methods for stochastic Galerkin finite element matrices with saddle point structure*
FOMICS Winter School on Uncertainty Quantification, University of Lugano, Italy

Daniel Nowak

24/10/2016 *An Introduction to Game Theory and Nonconvexity in Hierarchical Games*
Graduate School CE Research Colloquium, TU Darmstadt

Martin Otto

02/02/2016 *Amalgamation and local-to-global in the finite with suitable groupoids*
New Pathways between Group Theory and Model Theory, Mülheim

29/09/2016 *Logics for bisimulation invariance*
Logical Structure Seminar, Simons Institute, Berkeley

08/11/2016 *Symmetry-preserving finite synthesis & amalgamation*
Symmetry, Logic and Computation workshop, Simons Institute, Berkeley

Raimondo Penta

07/04/2016 *The role of microvascular tortuosity in tumor transport phenomena*
BAMC2016, Oxford Mathematical Institute, UK

16/09/2015 *Investigation of multiphase composites via asymptotic homogenization and its application to the bone hierarchical structure*
XXII Italian Congress AIMETA2015, University of Genoa, Italy

17/06/2015 *Multiscale modeling and numerical simulations of multiphase elastic composites with discontinuous material properties*
EMI 2015 International Conference, Engineering Mechanics Institute, Stanford University, USA

15/03/2015 *The role of microvascular tortuosity in tumor transport phenomena*
GAMM 2015 International Conference, Lecce, Italy

Marc Pfetsch

16/07/2015 *Polyhedral Descriptions of Star Colorings*
International Symposium on Mathematical Programming (ISMP), Pittsburgh

08/03/2016 *Polytopes Associated With Symmetry Handling*
Joint Annual Meeting of GAMM and DMV, Braunschweig

Anna-Maria von Pippich

04/03/2015 *Regularized determinants and Kronecker limit type formulae*
Winter-Workshop of the Darmstadt Algebra Group, Chalet Giersch, Manigod

24/06/2015 *Kryptographie*
Beruflichen Schulzentrum Odenwaldkreis, Michelstadt

07/07/2015 *Primzahlen*
Four days Summer school course, Summer school *Faszination Mathematik* for mathematically talented pupils, Heidelberg

07/10/2015 *Moderne Kryptologie im Mathematikunterricht der Sekundarstufe II*
Lehrerfortbildungstagung der MNU-Hessen, TU Darmstadt

28/01/2016 *Summen natürlicher Zahlen – unendlich einfach oder einfach unendlich?*
Doktorandentag, Fachbereich Chemie, TU Darmstadt

08/03/2016 *On generalized Eisenstein series*
Winter-Workshop of the Darmstadt Algebra Group, Chalet Giersch, Manigod

22/04/2016 *Lauschen zwecklos!*
Lichtenbergschule, Darmstadt

22/04/2016 *Faszination Primzahlen*
Lichtenbergschule, Darmstadt

28/06/2016 *Kryptographie*
Four days Summer school course, Summer school *Faszination Mathematik* for mathematically talented pupils, Heidelberg

22/11/2016 *Lauschen zwecklos!*
Gymnasium Michelstadt, Michelstadt

Thomas Powell

11/06/2015 *Variations on learning: Relating the epsilon calculus to proof interpretations*
Epsilon 2015, University of Montpellier, France

02/07/2015 *On the computational content of termination proofs*
Computability in Europe (CiE 2015), Bucharest, Romania

16/12/2015 *Gödel's functional interpretation and the concept of learning*
Workshop on Efficient and Natural Proof Systems, University of Bath, UK

05/06/2016 *The computational content of Zorn's lemma*
Proof, Computation, Complexity (PCC 2016), LMU München, Germany

12/06/2016 *Gödel's functional interpretation and higher-order learning*
Mathematics for Computation (M4C), Niederaltaich, Germany

23/06/2016 *The computational content of Zorn's lemma*
Classical Logic and Computation (CL& C 2016), Porto, Portugal

05/07/2016 *Gödel's functional interpretation and the concept of learning*
Logic in Computer Science (LICS 2016), New York, USA

05/09/2016 *Complexity in higher types*
Logic, Complexity and Automation, Obergurgl, Austria

Martin Saal

02/12/2016 *The Primitive Equations with linearly growing initial data*
13th Japanese-German International Workshop on Mathematical Fluid Dynamics, TU Darmstadt

Werner Schindler

30/06/2015 *Exponent Blinding and Scalar Blinding in the Context of Side-Channel Analysis*
CryptArchi 2015, Leuven, Belgien

15/09/2015 *Exclusive Exponent Blinding May Not Suffice to Prevent Timing Attacks on RSA*
CHES 2015, Saint-Malo, Frankreich

19/05/2016 *Constructive Side-Channel Analysis*
Seminar Hardware Security, Dagstuhl

23/06/2016 *Tailored RNGs for Low-Cost Devices*
CryptArchi 2016, La Grande Motte, Frankreich

Johann Michael Schmitt

14/12/2015 *Optimal control of hyperbolic balance laws with state constraints*
Optimization Seminar, TU Darmstadt

01/03/2016 *Optimal control of hyperbolic balance laws with state constraints*
Chemnitzer-Seminar zur Optimalsteuerung, Haus im Ennstal

19/12/2016 *Optimalsteuerung von Systemen hyperbolischer Bilanzgleichungen am Beispiel verallgemeinerter Riemann Probleme*
Optimization Seminar, TU Darmstadt

Moritz Schneider

27/10/2016 *The Contour Method and its applications*
Seminar der AG Numerik, TU Darmstadt

Lucas Wilfried Schoebel-Kroehn

20/10/2016 *Stability and Galerkin Approximation for the Thermistor Problem with Mixed Boundary Conditions*
Seminar der AG Numerik, TU Darmstadt

Robert Schorr

30/06/2016 *Adaptive non-symmetric coupling of Finite Volume and Boundary Element Method*
Seminar der AG Numerik, TU Darmstadt

04/07/2016 *Adaptive non-symmetric coupling of Finite Volume and Boundary Element Method*
9th Workshop on Analysis and Advanced Numerical Methods for Partial Differential Equations (not only) for Junior Scientists (AANMPDE(JS)-9-16), Strobl

18/07/2016 *Adaptive non-symmetric coupling of Finite Volume and Boundary Element Method*
CE Research Colloquium, TU Darmstadt

Alexandra Schwartz

09/03/2016 *A Reformulation of Sparse Optimization Problems using Complementarity Constraints*
Joint Annual Meeting of GAMM and DMV, Braunschweig

04/05/2016 *A Reformulation of Sparse Optimization Problems using Complementarity Constraints*
International Conference on Bilevel Optimization and Related Topics, Dresden

02/07/2016 *A Reformulation of Sparse Optimization Problems using Complementarity Constraints*
EUROPT Workshop on Advances in Continuous Optimization, Warsaw

09/08/2016 *A Reformulation of Sparse Optimization Problems using Complementarity Constraints*
International Conference on Continuous Optimization (ICCOPT), Tokyo

Cedric Sehrt

09/08/2016 *Optimal Control of Scalar Transport in Incompressible Fluid Flow*
International Conference on Continuous Optimization (ICCOPT), Tokyo

28/11/2016 *Optimal Control of Scalar Transport in Incompressible Fluid Flow*
Optimization Seminar, TU Darmstadt

Tobias Seitz

02/02/2015 *Inverse problems for incompressible flow*
CE Research Colloquium, TU Darmstadt

26/02/2015 *Inverse problems for incompressible flow*
Research Group Workshop Kleinwalsertal, Hirschegg

12/03/2015 *Inverse problems for incompressible flow*
The 11th Japanese-German International Workshop on Mathematical Fluid Dynamics, Waseda University, Japan

14/04/2015 *Flow reconstruction from MRV measurements*
5th Retreat of the GSC CE, Seeheim-Jugenheim

23/05/2015 *Flow reconstruction from MRV measurements*
Mathematical Theory in Fluid Mechanics, Kácov, Czech Republic

23/10/2015 *Flow enhancement using fluiddynamic constraints*
Waseda University, Japan

17/12/2015 *Filtering distributed flow measurements using fluid-dynamic constraints*
Seminar der AG Numerik, TU Darmstadt

04/03/2016 *Filtering distributed flow measurements using fluid-dynamic constraints*
The 12th Japanese-German International Workshop on Mathematical Fluid Dynamics, Waseda University, Japan

15/03/2016 *Filtering distributed flow measurements using fluid-dynamic constraints*
OCIP 2016, TU München

06/06/2016 *An introduction to Lagrange-Galerkin schemes for fluid mechanics*
CE Research Colloquium, TU Darmstadt

30/10/2016 *Enhancement of flow measurements using fluid-dynamic constraints*
The 13th Japanese-German International Workshop on Mathematical Fluid Dynamics, TU Darmstadt

Christopher Spannring

14/04/2015 *The stochastic Galerkin method*
5th Retreat of the GSC CE, Seeheim-Jugenheim

07/09/2015 *Reduced Basis Method for Parametrized Partial Differential Equations*
CE Research Colloquium, TU Darmstadt

15/09/2016 *Reduced Basis Method for Parabolic Problems with Random Data*
SIMAI 2016, Polytechnic University of Milan, Italy

04/10/2016 *Reduced Basis Method for Parabolic Problems with Random Data*
Reduced Basis Summer School 2016, Hedersleben

17/10/2016 *Reduced Basis Method for Parabolic Problems with Random Data*
CE Research Colloquium, TU Darmstadt

01/12/2016 *Reduced Basis Method for Linear Parabolic Problems with Random Data*
Seminar der AG Numerik, TU Darmstadt

18/12/2016 *Reduced Basis Method for Linear Parabolic Problems with Random Data*
FOMICS Winter School on Uncertainty Quantification, University of Lugano, Italy

Florian Steinberg

03/03/2015 *Second-order representations for Lp-spaces*
Constructivism and Computability, Kanazawa

11/03/2015 *Second-order representations for Lp-spaces*
The 11th Japanese-German International Workshop on Mathematical Fluid Dynamics, Tokyo

14/07/2015 *Towards Computational Complexity Theory on Advanced Function Spaces in Analysis*
Twelfth International Conference on Computability and Complexity in Analysis, Tokyo

17/09/2015 *Towards Computational Complexity Theory on Advanced Function Spaces in Analysis*
Continuity, Computability, Constructivity - From Logic to Algorithms, Kochel am See

01/03/2016 *Complexity Theory in Sobolev Spaces*
The 12th Japanese-German International Workshop on Mathematical Fluid Dynamics, Tokyo

16/06/2016 *Representations of analytic functions and Weihrauch degrees*
Thirteenth International Conference on Computability and Complexity in Analysis, Faro

12/09/2016 *Representations of spaces of integrable functions*
Colloquium Logicum 2016, Hamburg

Thomas Streicher

21/05/2016 *"Moral" Triposes giving rise to Grothendieck Toposes*
PSSL 100, Cambridge

Zhen Sun

15/03/2016 *Modelling and Stabilization for Low-Mach-Number Reactive Flow*
Seminar of the Platform - Flexible Energy Converters with Low CO_2 Emissions, Graduate School Energy Science and Engineering, TU Darmstadt

20/10/2016 *Adaptive Finite Element Methods for Low-Mach-Number Reactive Flow*
Seminar of the Platform - Flexible Energy Converters with Low CO_2 Emissions, Graduate School Energy Science and Engineering, TU Darmstadt

Gabriel Teschner

15/12/2016 *Finite Element Methods for the Primitve Equations*
Seminar der AG Numerik, TU Darmstadt

Sara Tiburtius

26/01/2015 *Homogenization for the multiple scale analysis of musculoskeletal mineralized tissues*
Seminar der AG Numerik, TU Darmstadt

Andreas Tillmann

18/01/2016 *Maschinelles Lernen zur Signalrekonstruktion aus phasenlosen Messdaten*
Optimization Seminar, TU Darmstadt

Patrick Tolksdorf

14/01/2015 *The interplay between $\mathcal{R}$-boundedness and weak reverse Hölder estimates*
Workshop on Harmonic Analysis, Partial Differential Equations and Geometric Measure Theory, ICMAT Madrid

28/02/2015 *Maximal regularity of the Stokes operator in bounded Lipschitz domains*
5th Ohio River Meeting, University of Cincinatti

10/03/2015 *Gradient estimates of the Stokes semigroup subject Neumann conditions on bounded convex domains*
Seminar Analysis, University of Kentucky

07/07/2015 *Gradient estimates for the Stokes resolvent in bounded Lipschitz domains*
Seminar Analysis, TU Darmstadt

16/11/2015 *Investigation of the Stokes resolvent on Lipschitz domains*
Oberseminar Analysis, Universität Düsseldorf

02/12/2015 *$\mathcal{R}$-sectoriality of higher-order elliptic systems in divergence-form subject to mixed boundary conditions*
PDE 2015 - Theory and Applications of Partial Differential Equations, WIAS Berlin

21/07/2016 *An L^p-approach to the Navier–Stokes equations in three dimensional bounded Lipschitz domains*
7th European Congress of Mathematics, Berlin

30/11/2016 *Recent results on the Stokes and Navier–Stokes equations in three-dimensional bounded Lipschitz domains*
13th Japanese-German International Workshop on Mathematical Fluid Dynamics, TU Darmstadt

Sebastian Ullmann

27/02/2015 *Research in uncertainty quantification*
Research Group Workshop Kleinwalsertal, Hirschegg

16/03/2015 *Uncertainty quantification for thermally driven flow (Poster)*
SIAM CSE, Salt Lake City, USA

13/04/2015 *Reduced-order modeling for UQ*
5th Retreat of the Graduate School CE, Seeheim-Jugenheim

26/05/2015 *Natural convection with random boundary conditions: a comparison of techniques*
UNCECOMP 2015, Crete, Greece

10/09/2015 *Space-adaptive POD for a Burgers problem with stochastic data (Poster)*
GAMM AGUQ Workshop on Uncertainty Quantification, Chemnitz

15/10/2015 *POD-Galerkin for finite elements with dynamic mesh adaptivity*
MoRePaS III, Triest, Italy

12/11/2015 *Adaptive finite element POD for uncertainty quantification*
Workshop Direct and Inverse Problems for PDEs with Random Coefficients, WIAS, Berlin

07/04/2016 *POD-Galerkin modeling with adaptive finite elements for stochastic sampling*
SIAM UQ 2016, Lausanne

17/11/2016 *POD-Galerkin reduced-order modeling with adaptive finite element snapshots*
KoMSO Challenge Workshop, Renningen

Fabian Völz

03/03/2015 *Hyperbolic and elliptic Eisenstein series*
Winter Seminar of the Darmstadt Algebra Group, Manigod, France

08/03/2016 *Elliptic and hyperbolic Eisenstein series as theta lifts*
Winter Seminar of the Darmstadt Algebra Group, Manigod, France

Miroslav Vrzina

13/02/2015 *Zylinder konstanter mittlerer Krümmung in homogenen 3-Mannigfaltigkeiten*
Research seminar DA-FF-MZ, Darmstadt

27/03/2015 *Zylinder konstanter mittlerer Krümmung in* Sol_3
AG-Seminar, Höchst

10/03/2016 *Kreisringe konstanter mittlerer Krümmung in homogenen Mannigfaltigkeiten*
AG-Seminar, Höchst

Lisa Wagner

14/09/2015 *Higher order time discretization for simulation and optimization of water supply networks*
ENUMATH, Ankara, Turkey

09/06/2016 *Second order implicit schemes for solving balance laws with applications to water supply networks*
Seminar der AG Numerik, TU Darmstadt

17/06/2016 *Second order implicit schemes for solving balance laws with applications to water supply networks*
ECMI, Santiago de Compostela, Spain

Mirjam Walloth

29/05/2015 *Adaptive finite element discretization methods for the numerical simulation of static and dynamic contact.*
IV. ICCCM, Hannover

13/06/2016 *Adaptive finite element discretization methods for the numerical simulation of static and dynamic contact.*
Seminar Lehrstuhl für Festkörpermechanik, Uni Siegen

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

Anna Walter

04/03/2016 *Simulation-based optimization methods for the deep drawing of branched structures*
Summer School, Geelong

Winnifried Wollner

11/03/2015 *Optimal Control for Fracture Propagation Modeled by a Phase-Field Approach*
Recent Trends and Future Developments in Computational Science and Engineering Workshop (CSE), Plön

19/03/2015 *Differentiability of Fluid-Structure Interaction Problems with Respect to the Data*
International Conference on High Performance Scientific Computing (HPSC), Hanoi

22/03/2015 *Optimal Control for Fracture Propagation Modeled by a Phase-Field Approach*
Chemnitzer Seminar zur Optimalsteuerung, Haus im Ennstal

24/03/2015 *Adaptive Optimal Control of the Obstacle Problem*
Annual Meeting of the International Association of Applied Mathematics and Mechanics (GAMM), Lecce

13/05/2015 *Optimal Control for Fracture Propagation Modeled by a Phase-Field Approach*
Viennese Workshop on Optimal Control and Dynamic Games, Wien

11/06/2015 *Optimization Problems subject to PDEs and Pointwise Constraints on the Gradient of the State*
IFIP TC7 Conference on System Modelling and Optimization, Sophia Antipolis

24/08/2015 *Discretization error analysis of optimal control problems with PDEs*
Workshop: Partial differential equations, optimal design and numerics, Benasque

15/09/2015 *Finite Element Error Analysis for Elliptic and Parabolic Optimization Problems with Gradient State Constraints*
European Conference on Numerical Mathematics and Advanced Applications (ENUMATH), Ankara

24/09/2015 *Adaptive Optimal Control of the Obstacle Problem*
Chinese-German Workshop on Computational and Applied Mathematics, Augsburg

28/02/2016 *Gradientenschranken in der Optimierung mit nicht-stationären PDGen*
Chemnitzer-Seminar zur Optimalsteuerung, Haus im Ennstal

09/03/2016 *Optimal Control for Fracture Propagation Modeled by a Phase-Field Approach*
Joint Annual Meeting of GAMM and DMV, Braunschweig

18/03/2016 *Optimal L^2-Error for a Modified Crouzeix-Raviart Stokes Element*
Variational Multiscale and Stabilized Finite Elements (VMS), Magdeburg

16/06/2016 *Discretization of Parabolic Optimization Problems with Constraints on the Spatial Gradient of the State*
The Mathematics of Finite Elements and Applications (MAFELAP), Brunel

15/06/2016 *Finite Element Approximation of Gradient Constraint Elliptic Optimization Problems on Non-Smooth Domains*
The Mathematics of Finite Elements and Applications (MAFELAP), Brunel

11/08/2016 *PDE Constrained Optimization with Pointwise Gradient Constraints*
International Conference on Continuous Optimization (ICCOPT), Tokyo

6.1.3 Visits

Herbert Egger, Waseda University, Tokyo, Japan, March 2015

Herbert Egger, FAU Erlangen, July 2015

Herbert Egger, ETH Zürich, March 2016

Herbert Egger, TU Chemnitz, June 2016

Herbert Egger, TU Berlin, December 2016

Kord Eickmeyer, TU Berlin, May 2015

Kord Eickmeyer, National Institute of Informatics, September 2015

Kord Eickmeyer, TU Berlin, July 2016

Kord Eickmeyer, National Institute of Informatics, Dezember 2016

Christoph Erath, TU Wien, August 2016

Christoph Erath, International Centre for Mathematical Sciences, Edinburgh, UK, March 2015

Reinhard Farwig, Universität Mainz, January 2015

Reinhard Farwig, Université de Lorraine, Nancy, February 2015

Reinhard Farwig, Tokyo University, Tokyo, February-March 2015

Reinhard Farwig, Shinshu University, Matsumoto, March 2015

Reinhard Farwig, Waseda University, Tokyo, March 2015

Reinhard Farwig, Vilnius University, Vilnius, May 2015

Reinhard Farwig, Waseda University, Tokyo, March 2016

Reinhard Farwig, Nagoya University, Nagoya, March 2016

Reinhard Farwig, National Institute for Mathematical Sciences (NIMS), Daejeon, South Korea, June 2016

Reinhard Farwig, Polish Academy of Sciences, Warsaw, September 2016

Reinhard Farwig, Centro di Recerca Matematica E. de Giorgi, Pisa, October 2016

Reinhard Farwig, Czech Academy of Sciences, Prague, December 2016

Tobias Fischer, Zuse-Institut Berlin, February 2015

Tobias Fischer, TU Ilmenau, April 2016

Tobias Fischer, Zuse-Institut Berlin, September 2016

Tristan Gally, Zuse-Institut Berlin, February 2015

Tristan Gally, Kyushu University, Fukuoka, March 2015

Tristan Gally, Zuse-Institut Berlin, May 2016

Tristan Gally, Zuse-Institut Berlin, September 2016

Alf Gerisch, Isaac Newton Institute for Mathematical Sciences, Cambridge, UK, July 2015

Alf Gerisch, Isaac Newton Institute for Mathematical Sciences, Cambridge, UK, November - December 2015

Karsten Grosse-Brauckmann, University of Warwick, July 2016

Matthias Hieber, MFO Oberwolfach, February 2015

Matthias Hieber, Waseda University, Tokyo, Japan, March 2015

Matthias Hieber, GAMM, Budapest, Hungary, May 2015

Matthias Hieber, Uni Düsseldorf, Düsseldorf, July 2015

Matthias Hieber, University of Parma, Parma, Italy, July 2015

Matthias Hieber, TULKA, Ulm, June 2016

Matthias Hieber, Sapporo, Japan, August 2015

Matthias Hieber, Porquerolles, France, September 2015

Matthias Hieber, VIASM, Hanoi, Vietnam, November 2015

Matthias Hieber, University of Tokyo, Tokyo, Japan, November 2015

Matthias Hieber, Bordeaux, France, January 2016

Matthias Hieber, Courant Institute, New York, USA, February 2016

Matthias Hieber, Nagoya, Japan, March 2016

Matthias Hieber, Princeton, USA, March 2016

Matthias Hieber, Vanderbuilt University, Nashville, USA, May 2016

Matthias Hieber, Banff, Canada, June 2016

Matthias Hieber, Waseda University, Tokyo, Japan, June 2016

Matthias Hieber, Prague, Czech Republic, August 2016

Matthias Hieber, Universität Hannover, Hanover, October 2016

Matthias Hieber, Waseda University, Tokyo, Japan, November 2016

Matthias Hieber, RIMS, Kyoto, Japan, November 2016

Karl H. Hofmann, Tulane University, March and September 2015, March and September 2016

Christopher Hojny, TU Braunschweig, June 2016

Christopher Hojny, Zuse-Institut Berlin, September 2016

Amru Hussein, Universität Hagen, May 2016

Amru Hussein, University of Tokyo, July 2016

Amru Hussein, Universität Bern, September 2016

Klaus Keimel, Kyoto University, Japan, July 2015

Klaus Keimel, Beihang University, Beijing, ChinaInstitution, September 2015

Klaus Keimel, Research visit, Leibniz Zentrum, Dagstuhl, February 2016

Klaus Keimel, University of Ljubljana, Slovenia, May 2016

Klaus Keimel, SFB 878, Universität Münster, June 2016

Ulrich Kohlenbach, Universidad de Sevilla, April-May 2015

Ulrich Kohlenbach, Institute for Mathematical Sciences, National University of Singapore, January 2016

Mads Kyed, University of Pittsburgh, September 2015

Jens Lang, CWI Amsterdam, The Netherlands, March 2015

Hendrik Lüthen, RWTH Aachen, March 2015

Hannes Meinlschmidt, Weierstraß Institut für Analysis und Stochastik (WIAS), Berlin, January 2015

Hannes Meinlschmidt, TU München, August 2015

Hannes Meinlschmidt, Weierstraß Institut für Analysis und Stochastik (WIAS), Berlin, January 2016

Hannes Meinlschmidt, Weierstraß Institut für Analysis und Stochastik (WIAS), Berlin, July 2016

Hannes Meinlschmidt, TU Dortmund, December 2016

Jens-Henning Moeller, Ajou University, Suwon, Korea, February 2016 - March 2016

Jens-Henning Moeller, Waseda University, Tokyo, Japan, April 2016 - May 2016

Martin Otto, Visiting scholar (Logical Structures in Computation Program), Simons Institute for the Theory of Computing, Berkeley, August-October 2016

Martin Otto, University of Cambridge, November 2015

Martin Otto, University of Leeds, November 2015

Martin Otto, University of Amsterdam, December 2015

Martin Otto, RWTH Aachen, December 2015

Andreas Paffenholz, Universität Magdeburg, March 2016

Marc Pfetsch, Kyushu University, Fukuoka, March 2015

Marc Pfetsch, RWTH Aachen, February 2016

Thomas Powell, University of Bologna, Italy, May 2015

Thomas Powell, LMU München, Germany, May 2016

Thomas Powell, University of Verona, Italy, July 2016

Steffen Roch, IPN Mexico-City, September 2016

Martin Saal, Waseda University, Tokio, March 2015

Martin Saal, Universität Konstanz, July 2015

Martin Saal, University of Bío-Bío, Concepcion, September 2015

Martin Saal, LNCC, Petropolis, September 2015

Martin Saal, Leibniz Universität Hannover, September 2015

Martin Saal, Universität Konstanz, December 2015

Martin Saal, Vanderbilt University, Nashville, May 2016

Martin Saal, Universität Konstanz, August 2016

Martin Saal, LNCC, Petropolis, September 2016

Martin Saal, University of Bío-Bío, Concepcion, September 2016

Martin Saal, Heinrich-Fabri-Institute, Blaubeuren, September 2016

Nils Scheithauer, National Research University HSE, Moscow, November 2015

Nils Scheithauer, Sapienza University, Rome, January 2016

Nils Scheithauer, Stony Brook, March 2016

Nils Scheithauer, ETH Zürich, May 2016

Nils Scheithauer, Universität Hamburg, Juni 2016

Johann Michael Schmitt, FAU Erlangen-Nürnberg, July 2016

Tobias Seitz, Waseda University, Tokyo, Japan, October 2015 – March 2016

Florian Steinberg, KAIST, April 2016

Florian Steinberg, Todai, August 2015

Florian Steinberg, JAIST, July 2015

Thomas Streicher, Max Planck Institut, February 2016

Thomas Streicher, Universities of Verona and Padova, April 2016

Thomas Streicher, University of Marseille, September 2016

Andreas Tillmann, INRIA Grenoble Rhône-Alpes, Grenoble, May 2015

Andreas Tillmann, TU Ilmenau, April 2016

Patrick Tolksdorf, University of Kentucky, February 2015 - June 2015

Patrick Tolksdorf, University of Kentucky, December 2016

Stefan Ulbrich, INP ENSEEIHT, Toulouse, October 2016

Stefan Ulbrich, Rice University, Houston, September 2016

Stefan Ulbrich, FAU Erlangen-Nürnberg, June 2016

Stefan Ulbrich, Rice University, Houston, May 2016

Stefan Ulbrich, TU München, September 2015

Fabian Völz, ETH Zürich, September - December 2016

Mirjam Walloth, Università della Svizzera italiana, Lugano, Italy, April 2016

Mirjam Walloth, Università degli Studi di Milano, Italy, April 2016

David Wegmann, Waseda University, Tokyo, Japan, February 2015 - March 2015

David Wegmann, Waseda University, Tokyo, Japan, February 2016 - March 2016

David Wegmann, Steklov Mathematical Institut, St. Petersburg, Russia, April 2016 - May 2016

Winnifried Wollner, FAU Erlangen-Nürnberg, December 2016

Winnifried Wollner, Universität Bochum, December 2016

Winnifried Wollner, Universität Heidelberg, November 2016

Winnifried Wollner, TU München, September 2016

Winnifried Wollner, Weierstraß Institut für Analysis und Stochastik (WIAS), Berlin, July 2016

Winnifried Wollner, Universität Bonn, June 2016

Winnifried Wollner, CAU Kiel, May 2016

Winnifried Wollner, Weierstraß Institut für Analysis und Stochastik (WIAS), Berlin, April 2016

Winnifried Wollner, Universität Bonn, February 2016

Winnifried Wollner, TU München, September 2015

Winnifried Wollner, Universität der Bundeswehr, München, June 2015

Winnifried Wollner, EPN, Quito, January–February 2015

Martin Ziegler, KAIST, May 2015

6.2 Organization and Program Commitees of Conferences and Workshops

Frank Aurzada

– Workshop on Lévy processes and their applications, 28-29 May 2015, Mannheim

Volker Betz

– Winterschool on Stochastic Analysis of Spatially Extended Models, Darmstadt, March 2015 (jointly with Matthias Meiners)

– Geometric Models in Probability, Darmstadt, April 2016 (jointly with Frank Aurzada, Matthias Meiners)

– Interplay of Analysis and Probability in Applied Mathematics, Mathematisches Forschungsinstitut Oberwolfach, July 2015

Dieter Bothe

– ICMF2016, Florence, Scientific Committee

Jan H. Bruinier

– AKLS-Seminar on *Automorphic Forms* (jointly with K. Bringmann, V. Gritsenko, A. Krieg, G. Nebe, N.-P. Skoruppa, D. Zagier), 11.03.15 Köln, 24.04.15 Utrecht, 02.10.15 Aachen, 01.03.16 Bonn, 30.11.16 Aachen

– Workshop *Moduli spaces and modular forms* (jointly with G. van der Geer and V. Gritsenko), Mathematisches Forschungsinstitut Oberwolfach, 24.04.16–30.04.16

– Conference *L-functions and Automorphic Forms* (jointly with W. Kohnen), Universität Heidelberg, 22.02.16–26.02.16

Yann Disser

– Member of program committee, International Conference on Algorithms and Complexity (CIAC), 2015, Paris

– Member of program committee, European Symposium on Algorithms (ESA), 2016, Aarhus

Reinhard Farwig

– 11th Japanese-German International Workshop on Mathematical Fluid Dynamics, Waseda University, Tokyo, 10.-13.03.2015 (jointly with Matthias Hieber, Hideo Kozono and Yoshihiro Shibata)

– Special Session “Navier-Stokes Equations and Other Models of Fluid Mechanics”, International Conference: Asymptotic Problems: Elliptic and Parabolic Issues, 01.-05.06.2015, Vilnius

– SPP 1506 Transport Processes at Fluidic Interfaces and IRTG 1529 Mathematical Fluid Dynamics, and JSPS Program of The Japanese-German Graduate Externship “athematical Fluid Dynamics”Darmstadt-Waseda (DFG-JSPS), TU Darmstadt, Darmstadt, 05.-08.10.2015. (jointly with Dieter Bothe, Hideo Kozono, Arnold Reusken)

– 12th Japanese-German International Workshop on Mathematical Fluid Dynamics, Waseda University, Tokyo, 01.-04.03.2016 (jointly with Matthias Hieber, Hideo Kozono and Yoshihiro Shibata)

– 13th Japanese-German International Workshop on Mathematical Fluid Dynamics, TU Darmstadt, Darmstadt, 30.11.-02.12.2016. (jointly with Matthias Hieber, Hideo Kozono and Yoshihiro Shibata)

Matthias Hieber

- Workshop Mathematical Fluid Dynamics, Waseda University, Tokyo, March 2015 (IRTG 1529, jointly with H. Kozono)
- Workshop Mathematical Fluid Dynamics, Waseda University, Tokyo, March 2016 (IRTG 1529, jointly with H. Kozono)
- Euro-Maghreb-Workshop, Blaubeuren, September 2016 (jointly with A. Rhandi, R. Schnaubelt)
- Int. Conference on Fluid Mechanics, Waseda University, Tokyo, Oktober 2016 (jointly with G.P. Galdi and Y. Shibata)

Klaus Keimel

- Workshop Domains XII, August 25 to 28, 2015, University College Cork, Ireland (Member of the programme committee)
- International Conference on Logical Algebras and Semirings, September 09 to 13, 2015, Beihang University, Peking, China (Member of the programme committee)

Ulrich Kohlenbach

- Workshop 'Classical Logic and Computation', June 23, Porto 2016 as part of FSCD 2016 (PC Chair)
- Oberwolfach Workshop on Mathematical Logic: Proof Theory, Constructive Mathematics, Nov. 5-11, 2017 (Organizer jointly with Sam Buss, Rosalie Iemhoff, Michael Rathjen)

Burkhard Kümmerer

- Exhibition: Dem Bauplan Gottes auf der Spur/On the Trail of God's Blueprint, Ehemals Reichsstädtische Bibliothek Lindau, March 24 – October 18, 2015, and June 19 – July 10, 2016 (on the occasion of the Lindau Nobel Laureate Meeting 2016)

Marc Pfetsch

- Session "Polyhedral Methods in Geometry and Optimization" at the International Congress on Mathematical Software (ICMS), 2016, Berlin
- A Frankfurt-Darmstadt Afternoon on Discrete Mathematics (jointly with Thorsten Theobald), July 3, 2015, Frankfurt

Anna-Maria von Pippich

- Winter-Workshop of the Darmstadt Algebra Group (jointly with C. Alfes, J. Bruinier, S. Möller, N. Scheithauer), Chalet Giersch, Manigod, 01.03.15–08.03.15
- Summer school *Faszination Mathematik* for mathematically talented pupils, Heidelberg, 07.07.15–10.07.15
- Winter-Workshop of the Darmstadt Algebra Group" (jointly with J. Bruinier, S. Möller, S. Opitz), Chalet Giersch, Manigod, 06.03.16–13.03.16

- Conference Moduli and Automorphic Forms: a meeting for women in mathematics, (jointly with A. Ortega), HU Berlin, 12.05.16–14.05.16
- Conference Arakelov theory and automorphic forms: a conference at the occasion of Jürg Kramer's 60th birthday (jointly with G. Farkas, U. Kühn, G. Wüstholz), HU Berlin, 06.06.16–09.06.16
- Summer school *Faszination Mathematik* for mathematically talented pupils, Heidelberg, 28.06.16–01.07.16

Thomas Powell

- Workshop on Logic, Complexity and Automation, Obergurgl, Austria, 5-7 September 2016 (Organized jointly with Georg Moser)

Ulrich Reif

- Subdivision, Refinability, Signals, and Approximation (jointly with T. Sauer et.al.)

Alexandra Schwartz

- Section "Optimization" (jointly with Anton Schiela) at the Joint Annual Meeting of GAMM and DMV, 2016, Braunschweig
- Session "Solutions of Equilibrium Problems: Computation and Stability" at the International Conference on Continuous Optimization (ICCOPT), 2016, Tokyo

Andreas Tillmann

- Session "(Co)Sparsity in Tomography and Inverse Problems" at the International Symposium on Mathematical Programming (ISMP), 2015, Pittsburgh

Stefan Ulbrich

- Session "Recent Advances in PDE-Constrained Optimization" at the International Symposium on Mathematical Programming (ISMP), 2015, Pittsburgh
- Session "Recent Developments in PDE-constrained Optimization I and II" at the Iternational Conference on Continuous Optimization (ICCOPT), 2016, Tokyo

Winnifried Wollner

- Minisymposium "Numerical Analysis and Methods for Problems with Singularities" at the European Conference on Numerical Mathematics and Advanced Applications (ENUMATH), 2015, Ankara
- Young-Researchers Minisymposium "Discretization aspects in PDE constrained optimization" at the Annual Meeting of the International Association of Applied Mathematics and Mechanics (GAMM), 2015, Lecce

7 Workshops and Visitors at the Department

7.1 The Colloquium

Winter term 2014/2015

15/10/2014 Prof. Dr. Mads Kyed (TU Darmstadt), *Bewegungsgleichungen eines umströmten Körpers: Kann eine Hummel fliegen?*

22/10/2014 Prof. emer. Dr. Adrian R. D. Mathias (Université de la Réunion, z. Zt. Universität Freiburg), *Hilbert, Bourbaki and the Scorning of Logic*

29/10/2014 Prof. emer. Dr. Alexander Wynands (Universität Bonn), *Basiskompetenzen Mathematik: (Un-)Verzichtbares Wissen und Können am Ende der Sek. I, Probleme einer "Allgemeinbildung" in der Sek. II*

05/11/2014 Prof. Dr. Britta Peis (RWTH Aachen), *Nash-Gleichgewichte und Polymatroide*

12/11/2014 Prof. Dr. Stefan Turek (TU Dortmund), *Finite Elemente mit fiktiven Rändern zur numerischen Lösung von komplexen Partikelströmungen*

19/11/2014 Prof. Dr. Frank Heinrich (TU Braunschweig), *"Strategiefehler" beim Bearbeiten mathematischer Probleme*

26/11/2014 Prof. Dr. Gerold Alsmeyer (Universität Münster), *Zum stationären Tail-Index kontraktiver iterierter Funktionensysteme*

03/12/2014 Prof. Dr. David Masser (Universität Basel), *On zeroes of exponential polynomials*

10/12/2014 Dr. habil. Andreas Paffenholz (TU Darmstadt), *Gitterpunkte, Polytope und torische Geometrie*

17/12/2014 Prof. Dr. Marko Lindner (TU Hamburg-Harburg), *Wo ist die Hauptdiagonale einer unendlichen Matrix?*

14/01/2015 Prof. Dr. Ben Schweizer (TU Dortmund), *Dispersionseffekte von Wellen in heterogenen Medien*

21/01/2015 Prof. Dr. Nina Gantert (TU München), *Einsteinrelation und Homogenisierung zufälliger Medien*

28/01/2015 Prof. Dr. Harald A. Helfgott (École Normale Supérieure, Paris), *The ternary Goldbach conjecture*

04/02/2015 Prof. Dr. Barbara Kaltenbacher (Universität Klagenfurt), *Regularisierung in Banachräumen*

11/02/2015 Prof. Dr. Alexandra Schwartz (TU Darmstadt), *Rigging the Game: Spieltheorie und Wettbewerbsdesign*

Summer term 2015

15/04/2015 Prof. Dr. Gerlind Plonka-Hoch (Universität Göttingen), *Sparse FFT: Läßt sich die schnelle Fourier-Transformation noch schneller machen?*

22/04/2015 Celebration colloquium on the occasion of 60th Birthday of Prof. Dr. Reinhard Farwig: Prof. Dr. Helmut Abels (Universität Regensburg), *The Navier-Stokes Equations – Some Old and New Challenges*

29/04/2015 Prof. Dr. Marc Levine (Universität Duisburg-Essen), *Topologische Methoden in der algebraischen Geometrie und umgekehrt*

06/05/2015 Prof. Dr. Erwin Bolthausen (Kyoto University and Universität Zürich), *Random Polymers*

13/05/2015 Prof. Dr. Michael Winkler (Universität Paderborn), *Analysis dynamischer Effekte von Chemotaxis-Fluid-Interaktionen*

27/05/2015 Prof. Dr. Peter Selinger (Dalhousie University, Halifax), *Efficient optimal approximation in unitary groups*

03/06/2015 Prof. Dr. Günter Leugering (Universität Erlangen-Nürnberg), *Materialdesign und Prozessoptimierung: Mathematische Konzepte und Ergebnisse im Anwendungskontext*

12/06/2015 Graduation Ceremony for summer term 2014 and winter term 2014/2015: Prof. Dr. Rainer Nagel (Universität Tübingen), *Die Einheit der Mathematik: Vision oder Fiktion?*

17/06/2015 Prof. Dr. Andreas Büchter (Universität Duisburg-Essen), *(Neue) Orientierung für den Analysisunterricht in der gymnasialen Oberstufe*

25/06/2015 Priv.-Doz. Dr. Orsola Tommasi (Universität Hannover, currently TU Darmstadt), *Kohomologie von Modulräumen algebraischer Kurven und die Gorenstein-Vermutung*

01/07/2015 Prof. Dr. Dirk Praetorius (TU Wien), *Optimale Konvergenz adaptiver FEM*

08/07/2015 Prof. Dr. Andreas Greven (Universität Erlangen-Nürnberg), *Evolution von Genealogien in Populationsmodellen*

15/07/2015 Prof. Dr. Anna Marciniak-Czochra (Universität Heidelberg), *Mathematische Modellierung der Musterbildung: Wie Konzepte und Verfahren aus der Mathematik helfen, Biologie besser zu verstehen*

Winter term 2015

14/10/2015 Prof. Dr. Christoph Erath (TU Darmstadt), *Koppeln auf unstrukturierten Gittern - adaptive FVM-BEM*

21/10/2015 Prof. Dr. Luigi C. Berselli (University of Pisa), *On averaged equations for turbulent flows*

28/10/2015 Prof. Dr. Alexander Ostermann (Universität Innsbruck), *Splitting-Verfahren: Stärken und Schwächen*

04/11/2015 Prof. Dr. Bernd Siebert (Universität Hamburg), *Theta functions – old and new*

11/11/2015 Prof. Dr. Hans Daduna (Universität Hamburg), *Stochastische Netzwerke: Gleichgewichtsanalyse und asymptotisches Verhalten*

18/11/2015 Prof. emer. Dr. Jürg Fröhlich (ETH Zürich), *Der Zufall in der Quantenmechanik*

25/11/2015 Prof. Dr. Tobias Weth (Universität Frankfurt), *Nichtlokale Effekte in Analysis und Geometrie*

02/12/2015 Prof. Dr. Josef Málek (Charles University in Prague), *Implicitly constitutive material models: modeling and analysis*

09/12/2015 Prof. Dr. Andreas Neuenkirch (Universität Mannheim), *Young Integrale, Rough Paths und Stochastische Differentialgleichungen*

16/12/2015 Prof. Dr. Sebastian Sager (Universität Magdeburg), *Entscheidungsunterstützung für den Weihnachtsmann – Über die ganzzahlige Optimierung dynamischer Prozesse*

13/01/2016 Prof. Dr. Joachim Hilgert (Universität Paderborn), *Resonanzen*

20/01/2016 Prof. Dr. Volker John (WIAS Berlin, FU Berlin), *Analysis und numerische Analysis von Turbulenzmodellen*

27/01/2016 Prof. Dr. Don Zagier (MPI Bonn), *Partitionen und Modulformen*

03/02/2016 Prof. Dr. Hans-Dieter Sill (Universität Rostock), *Zugänge zum Grundlegenden*

10/02/2016 Prof. Dr. Winnifried Wollner (TU Darmstadt), *Optimierungsprobleme mit partiellen Differentialgleichungen unter Restriktionen an den Gradienten*

Summer term 2016

13/04/2016 Prof. Dr. Genaro López-Acedo (University of Sevilla), *The Fixed Point Property for continuous mappings*

20/04/2016 Prof. Dr. Gavril Farkas (HU Berlin), *Was sind abelsche Varietäten der Dimension sechs?*

27/04/2016 Prof. Dr. Sylvie Roelly (Universität Potsdam), *Packing of Brownian balls in interaction*

04/05/2016 Prof. Dr. Arnold Reusken (RWTH Aachen), *Raum-Zeit-Finite-Elemente auf nicht-angepassten Gittern für Probleme mit sich bewegenden Unstetigkeiten*

11/05/2016 Prof. Dr. Annette Huber (Universität Freiburg), *Perioden und Nori-Motive*

18/05/2016 Prof. Dr. Christian Spannagel (PH Heidelberg), *Mathematik mit Videos lernen? Didaktische und methodische Möglichkeiten und Grenzen*

25/05/2016 Prof. Dr. Christoph Ortner (University of Warwick), *Atomistische und mehrskalige Materialmodellierung*

03/06/2016 Graduation Ceremony for summer term 2015 and winter term 2015/2016: Prof. Dr. Peter Paule (Research Institute for Symbolic Computation, Universität Linz), *Mathematik: Verstand und Gefühl - Reflexionen über eine Schlüsseltechnologie*

08/06/2016 Prof. Dr. Vadim Kostrykin (Universität Mainz), *Über den Tarnkappe-Operator*

15/06/2016 Prof. Dr. Peter Pfaffelhuber (Universität Freiburg), *Effekte natürlicher Selektion in der Mathematischen Populationsgenetik*

22/06/2016 Prof. Dr. Andreas Rieder (Karlsruher Institut für Technologie (KIT)), *Seismische Tomographie ist lokal schlecht-gestellt*

29/06/2016 Prof. Dr. Christoph Schnörr (Universität Heidelberg), *Variational image segmentation – a brief historical account and a new geometric approach*

06/07/2016 Prof. Dr. Mária Lukáčová (Universität Mainz), *Asymptotic preserving numerical schemes for singular limits of weakly compressible flows*

13/07/2016 Prof. Dr. Torsten Wedhorn (TU Darmstadt), *Dreieckszahlen und das Langlandsprogramm*

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*

7.2 Guest Talks at the Department

13/01/2015 Dr. Matthew Krauel (Universität Köln), *Multivariable trace functions for regular vertex operator algebras* (Nils Scheithauer)

13/01/2015 Prof. Alexander Lorz (UPMC, France), *On mathematical models of mutation selection* (Jan Pietschmann)

16/01/2015 Hugo Férée (Laboratoire lorrain de recherche en informatique et ses application, Loria, Nancy), *Understanding the complexity of real norms* (Martin Ziegler)

21/01/2015 Prof. Dr. Nina Gantert (TU München), *Einsteinrelation und Homogenisierung zufälliger Medien* (Matthias Meiners)

22/01/2015 Dr. Renato dos Santos (WIAS Berlin), *Random walk on a dynamic random environment consisting of a system of independent simple symmetric random walks* (Research Group Stochastics)

29/01/2015 Prof. Dr. Alex Novikov (UTS Sydney), *First passage time problems: martingale approach revisted* (Frank Aurzada)

29/01/2015 Prof. Dr. Vitali Wachtel (Universität Augsburg), *Asymptotics of invariant measures of recurrent Markov chains with asymptotically zero drift* (Frank Aurzada)

30/01/2015 Hugo Férée (Laboratoire lorrain de recherche en informatique et ses application, Loria, Nancy), *Game semantics approach to higher order complexity* (Martin Ziegler)

05/02/2015 Prof. Dr. Thomas Richthammer (Universität Hildesheim), *Estimating the variance of particle positions in the hard disk model* (Volker Betz)

06/02/2015 Prof. Dr. Victor L. Selivanov (Ershov Institute of Informatics Systems, Novosibirsk), *Towards the effective descriptive set theory* (Martin Ziegler)

12/02/2015 Prof. Dr. Sabine Jansen (Ruhr-Universität Bochum), *Random partitions in statistical mechanics* (Volker Betz)

13/02/2015 Prof. Dr. Peter Selinger (Dalhousie University, Halifax), *Number-theoretic Methods in Quantum Circuit Synthesis* (Thomas Streicher)

22/02/2015 Prof. Dr. Günther Of (TU Graz), *Coupling of discontinuous Galerkin finite element and boundary element methods* (Herbert Egger)

13/05/2015 Prof. Dr. Michael Winkler (Universität Paderborn), *Analysis dynamischer Effekte von Chemotaxis-Fluid-Interaktionen* (Mads Kyed)

11/06/2015 Dr. Stefan Grosskinsky (University of Warwick), *Metastability in condensing zero-range processes* (Volker Betz)

12/06/2015 Prof. Dr. Russell G. Miller (Queens College, City University of New York), *Functors and Effective Interpretations in Model Theory* (Martin Ziegler)

16/06/2015 Erkal Selman (RWTH Aachen), *Graphs Identified by Two-Variable Logic with Counting* (Martin Otto)

19/06/2015 Prof. Dr. Peter Cholak (Notre Dame University, Indiana), *Friedberg Splits* (Ulrich Kohlenbach)

24/06/2015 Prof. Dr. Gernot Alber (TU Darmstadt, Institute of Applied Physics), *Asymptotic properties of quantum Markov chains* (Burkhard Kümmerer)

26/06/2015 Prof. Dr. Catherine Meusburger (Universität Erlangen), *Hopf algebra gauge theory from Kitaev lattice models* (Nils Scheithauer)

26/06/2015 Prof. Dr. Christoph Schweigert (Universität Hamburg), *Representations of mapping class groups and invariants from finite ribbon categories* (Nils Scheithauer)

01/07/2015 Vanda Farsad (University of Hamburg), *Hopfalgebren und Quantengruppen* (Burkhard Kümmerer)

06/07/2015 Prof. Ilaria Perugia, PhD (Universität Wien), *A Plane Wave Virtual Element Method for the Helmholtz Problem* (Christoph Erath)

09/07/2015 Prof. Dr. Hans-Peter Künzi (University of Cape Town), *A construction of the B-completion of a T_0-quasi-metric space* (Martin Ziegler)

10/07/2015 Prof. Dr. Loïc Chaumont (Université Angers), *Time change in multitype branching processes with application to mutations* (Frank Aurzada)

10/07/2015 Prof. Dr. Ron Doney (Manchester University), *A NASC for the strong renewal theorem via local large deviations* (Frank Aurzada)

14/07/2015 Ricardo Pena Hoepner (Universität Mannheim), *Solutions of the Sinh-Gordon Equation of Spectral Genus Two* (Jens Lang)

29/07/2015 Prof. Dr. Franz-Viktor Kuhlmann (University of Saskatchewan, Saskatoon), *Modelltheorie bewerteter Körper und Desingularisierung: gemeinsame offene Probleme* (René Bartsch)

11/09/2015 Dr. Makoto Fujiwara (Japan Advanced Institute of Science and Technology), *Classical uniform provability and intuitionistic provability for existence statements* (Ulrich Kohlenbach)

13/10/2015 Facundo Carreiro (Institute for Logic, Language and Computation, University of Amsterdam), *Fragments of Fixpoint Logics: Automata and Expressiveness* (Martin Otto)

06/11/2015 Silvia Steila (University of Turin), *Terminating via Ramsey's Theorem* (Ulrich Kohlenbach)

11/11/2015 Prof. Dr. Hans Daduna (Universität Hamburg), *Stochastische Netzwerke, Gleichgewichtsanalyse und asymptotisches Verhalten* (Cornelia Wichelhaus)

27/11/2015 Dr. Ferdinand Ihringer (Justus-Liebig-Universität Gießen), *Colloquium in memory of Thomas Ihringer: Erdös-Ko-Rado sets in finite geometries* (Christian Herrmann and Klaus Keimel)

27/11/2015 Prof. Dr. Hans Peter Gumm (Philipps-Universität Marburg), *Colloquium in memory of Thomas Ihringer: A weak pullback preservation property of weakly monadic set functors* (Christian Herrmann and Klaus Keimel)

27/11/2015 Prof. Dr. Jiri Tuma (Charles University Prague), *Colloquium in memory of Thomas Ihringer: Antichains and business intelligence* (Christian Herrmann and Klaus Keimel)

03/12/2015 Prof. Dr. Marcel Ortgiese (Universität Münster), *A scaling limit for branching random walk in random environment* (Frank Aurzada)

04/12/2015 Dr. Ulrik Buchholtz (Carnegie Mellon University, Pittsburg), *Towards Primitive Recursive Homotopy Type Theory* (Ulrich Kohlenbach)

17/12/2015 Tobias Seitz (University of Tokyo, Japan), *Filtering distributed flow measurements using fluid dynamic constraints* (Herbert Egger)

15/01/2016 Dr. Arno Pauly (Clare College, Cambridge), *Representations of analytic functions and Weihrauch reductions* (Florian Steinberg)

21/01/2016 Prof. Dr. Ira Neitzel (Universität Bonn), *Finite element error estimates for elliptic Dirichlet-boundary control problems with pointwise state constraints* (Winnifried Wollner)

26/01/2016 Prof. Dr. Delio Mugnolo (Universität Hagen), *Isoperimetric inequalities and smoothing properties of the discrete p-Laplacian* (Amru Hussein)

05/02/2016 Prof. Dr. Jean Bertoin (Universität Zürich), *Compensated Fragmentations* (Frank Aurzada)

05/02/2016 Prof. Dr. René Schilling (Universität Dresden), *Level sets of Feller processes* (Frank Aurzada)

21/04/2016 Fabian Buckmann (Universität Münster), *Fluctuation Theory of Markov Random Walks* (Matthias Meiners)

22/04/2016 Ivano Ciardelli (University of Amsterdam), *Questions in Logic* (Martin Otto)

27/04/2016 Prof. Dr. Sylvie Roelly (Universität Potsdam), *Packing of Brownian balls in interaction* (Matthias Meiners)

11/05/2016 Dr. Rolf Gohmm (Aberystwyth University), *Streutheorie für Quanten-Markov-Prozesse* (Burkhard Kümmerer)

31/05/2016 Prof. Dr. David Krejcirik (Academy of Sciences of the Czech Republic), *The Hardy inequality and the heat equation with magnetic field* (Amru Hussein)

02/06/2016 Dr. Adriano De Cezaro (Federal University of Rio Grande, Brasil), *Regularization Approaches for Photo-Acoustic Tomography* (Herbert Egger)

03/06/2016 Dr. Vassilios Gregoriades (University of Turin), *Recursive-theoretic characterizations of the Topological Vaught Conjecture* (Ulrich Kohlenbach)

15/06/2016 Prof. Dr. Malte Braack (Universität Kiel), *Outflow boundary conditions for the Navier-Stokes equations* (Jens Lang)

15/06/2016 Prof. Dr. Peter Pfaffelhuber (Universität Freiburg), *Effekte natürlicher Selektion in der Mathematischen Populationsgenetik* (Matthias Meiners)

21/06/2016 Dr. Christian Seis (Universität Bonn), *New quantitative estimates for continuity equations* (Amru Hussein)

07/07/2016 Prof. Dr. Andreas Veeser (University of Milan), *Oscillation in a posteriori error estimation* (Winnifried Wollner)

11/07/2016 Prof. Dr. Weizhang Huang (University of Kansas, USA), *A new implementation of the MMPDE moving mesh method and applications* (Jens Lang)

06/09/2016 Prof. Dr. Jan Dusek (University of Strasbourg), *Rise path of freely rising bubbles and especially also oil drops (in water)* (Dieter Bothe)

07/09/2016 Dr. Rolf Gohmm (Aberystwyth University), *Quantensytemstheorie* (Burkhard Kümmerer)

16/09/2016 Prof. Dr. Martin Ziegler (KAIST School of Computing), *Computational Complexity of (Functions on) Compact Metric Spaces* (Thomas Streicher)

19/09/2016 Dr. Christina Burt (The University of Melbourne), *Little Missed Opportunities* (Johann Michael Schmitt)

19/09/2016 Dr. Christina Burt (The University of Melbourne), *The power-p Steiner tree problem: leveraging geometric properties to aid a math programming approach* (Johann Michael Schmitt)

28/09/2016 Prof. Shuichi Iwata (Nagoya Institute of Technology, Japan), *A sessile droplet shape on a vertically vibrating plate* (Dieter Bothe)

19/10/2016 Prof. Dr. Christoph Ortner (University of Warwick), *Atomistische und mehrskalige Materialmodellierung* (Winnifried Wollner)

02/11/2016 Prof. Dr. Ralph Neininger (Universität Frankfurt), *Pólya-Urnen* (Matthias Meiners)

03/11/2016 Prof. Dr. Bülent Karasözen (Middle East Technical University, Turkey), *Energy stable model order reduction for the Allen-Cahn equation* (Jens Lang)

04/11/2016 Prof. Dr. Martin Ziegler (KAIST School of Computing), *On Computability and Well-Posedness in Shape Optimization* (Thomas Streicher)

10/11/2016 Dr. Elfriede Friedmann (Universität Heidelberg), *PDE based tools for mathematical models in Cell Biology* (Mads Kyed)

10/11/2016 Prof. Dr. Hans Maassen (University of Nijmegen), *Permutationsinvariante verschränkte Zustände* (Burkhard Kümmerer)

10/11/2016 Prof. Dr. Illia Horenko (USI Lugano), *On a direct data-driven reduction of Bayesian models: where applied mathematics meets data* (Jens Lang)

11/11/2016 Andrei Sipoş (IMAR, University of Bucharest), *Proof mining in L^p spaces* (Ulrich Kohlenbach)

17/11/2016 Ben Lees (University of Warwick), *Néel order using a random loop model* (Volker Betz)

24/11/2016 Dirk Zeindler (Lancaster University), *The order of large random permutations with cycle weights* (Volker Betz)

25/11/2016 Alexandre Stauffer (University of Bath), *Multi-particle diffusion limited aggregation* (Volker Betz)

08/12/2016 Prof. Dr. Karsten Urban (Universität Ulm), *Space-Time-Varitionsformulierung für Reduzierte Basis Methoden (RBMs)* (Jens Lang)

09/12/2016 Prof. Dr. Andreas Neuenkirch (Universität Mannheim), *Young Integrale, Rough Paths und Stochastische Differentialgleichungen* (Frank Aurzada)

20/12/2016 Prof. Dr. Keita Yokoyama (Japan Advanced Institute of Science and Technology), *On the Proof-Theoretic Strength of Ramsey's Theorem for Pairs* (Ulrich Kohlenbach)

7.3 Visitors at the Department

Prof. Dr. Franz-Viktor Kuhlmann (University of Saskatchewan, Saskatoon), July 2015.

Prof. Dr. Franz-Viktor Kuhlmann (University of Silesia at Katowice), July 2016.

Prof. Dr. Josef Malek (Charles University Prague), December 2015.

Dr. Matthias Köhne (Universität Düsseldorf), Febuary 2016.

Dr. Masahiro Kunimoto (Waseda University, Japan), August 2016.

Prof. Dr. Jan Dusek (University of Strasbourg), September 2016.

Professor Shuichi Iwata (Nagoya Institute of Technology, Japan), September 2016.

Gast (Institution), Monat(e).

Prof. Dr. Vince Geiger (Catholic University of Brisbane, Queensland, Australia), November 2016.

Jeroen Stolwijk (TU Berlin), January 2015.

Dr. Dumitru Trucu (University of Dundee, UK), August 2015.

Jeroen Stolwijk (TU Berlin), August 2015.

Jeroen Stolwijk (TU Berlin), March 2016.

Oliver Kolb (University of Mannheim), June 2016.

Dr. Chenyin Qian (Zhejiang Normal University, Jinhua, China), September 2016 - September 2017.

Prof. Timofei Shilkin (St. Petersburg Department of V.A. Steklov Institute of Mathematics, Russian Acad December 2016.

Prof. Dr. Hideo Kozono (Waseda University), April 2015.

Prof. Dr. Gregery Seregin (University of Oxford), April 2015.

Prof. Dr. Senjo Shimizu (Shizuoka University), April 2015.

Prof. Dr. Agnieszka Swierczewska (University of Warsaw), April 2015.

Prof. Dr. Herbert Amann (University of Zurich), April 2015.

Prof. Dr. Josef Bemelmans (RWTH Aachen), April 2015.

Prof. Dr. Paolo Maremonti (University of Naples), April 2015.

Prof. Dr. Marius Tuscnak (University of Nancy), April 2015.

Prof. Dr. Yoshikazu Giga (University of Tokyo), June 2015.

Prof. Dr. Giovanni P. Galdi (University of Pittsburgh), June 2015.

Prof. Dr. Jürgen Saal (Heinrich-Heine-Universität Düsseldorf), June 2015.

Dr. Karoline Disser (Heinrich-Heine-Universität Düsseldorf), June 2015.

Prof. Dr. Jerry Goldstein (University of Memphis), July 2015.

Prof. Dr. Gisele Goldstein (University of Memphis), July 2015.

Prof. Dr. Hideo Kozono (Waseda University), January 2016.

Prof. Dr. Okihiro Sawada (Gifu University), April 2016.

Prof. Dr. Takayoshi Ogawa (Tohoku University), November 2016.

Prof. Dr. Raphael Danchin (University of Paris), November 2016.

Prof. Dr. Robert Denk (Universität Konstanz), November 2016.

Prof. Dr. Toshiaki Hishida (Nagoya University), November 2016.

Prof. Dr. Tsukasa Iwabuchi (Tohoku University), November 2016.

Prof. Dr. Jan Prüss (Martin-Luther-Universität Halle-Wittenberg), November 2016.

Prof. Dr. Hans Knüpfer (University Heidelberg), November 2016.

Prof. Dr. Paolo Maremonti (Second University of Naples), November 2016.

Prof. Dr. Piotr Mucha (University of Warsaw), November 2016.

Dr. Camilla Nobili (Universität Basel), November 2016.

Dr. Hirokazu Saito (Waseda University), November 2016.

Prof. Dr. Toshiaki Hishida (University of Nagoya), November 2016.

Dr. Christian Seis (Universität Bonn), November 2016.

Prof. Dr. Gieri Simmonett (Nashville University), November 2016.

Prof. Dr. Ryo Takada (Sendai University), November 2016.

Prof. Dr. Werner Varnhorn (Universität Kassel University), November 2016.

Dr. Mathias Wilke (Universität Regensburg), November 2016.

Prof. Dr. Ewelina Zatorska (Imperial College London), November 2016.

Professor Sidney A. Morris (LaTrobe University, Melbourne), May 2015, August 2016.

Dr. Alexis Bernadet (Laboratoire d'Informatique de l'Ecole polytechnique - LIX, Palaiseau), January to July 2016.

Xiaoning Bian (Dalhousie University, Halifax), February to August 2016.

Prof. Dr. Sara Faridi (Dalhousie University, Halifax), January to August 2015.

Prof. Dr. Sara Faridi (Dalhousie University, Halifax), January to July 2016.

Hugo Férée (Laboratoire lorrain de recherche en informatique et ses application, Loria, Nancy), January to July 2015.

Makoto Fujiwara (Waseda University, Tokyo), March 2016.

Dr. Takayuki Kihara (University of California, Berkeley), December 2015.

Dr. Takayuki Kihara (University of California, Berkeley), January and February 2016.

Prof. Dr. Hans-Peter Künzi (University of Cape Town), June to July 2015.

Prof. Dr. Genaro López Acedo (University of Seville), April 2016.

Pierre Pradic (ENS Lyon), September 2015 to January 2016.

Francisco Rios (Dalhousie University, Halifax), January to July 2015.

Francisco Rios (Dalhousie University, Halifax), January to July 2016.

Julien Ross (Dalhousie University, Halifax), March to July.

Prof. Dr. Peter Selinger (Dalhousie University, Halifax), January to August 2015.

Prof. Dr. Peter Selinger (Dalhousie University, Halifax), January to July 2016.

Andrei Sipoş (IMAR, University of Bucharest), November 2016.

Yasuyuki Tsukamoto (Kyoto University), January to March 2015.

Prof. Dr. Hans Maassen (University of Nijmegen), January 2015.

Prof. Dr. Hans Maassen (University of Nijmegen), March 2015.

Prof. Dr. Hans Maassen (University of Nijmegen), April 2015.

Prof. Dr. Hans Maassen (University of Nijmegen), October 2015.

Prof. Dr. Hans Maassen (University of Nijmegen), November 2015.

Prof. Dr. Hans Maassen (University of Nijmegen), January 2016.

Prof. Dr. Hans Maassen (University of Nijmegen), November 2016.

Prof. Dr. Rolf Gohm (Aberystwyth University), April to May 2016.

Prof. Dr. Rolf Gohm (Aberystwyth University), September 2016.

Prof. Giovanni P. Galdi (University of Pittsburgh), October 2016.

Dr. Sebastian Mentemeier (University of Wroclaw), December 2013.

Prof. Dr. Alexander Iksanov (Taras Shevchenko National University of Kyiv), July 2014.

Pierre Pradic (ENS Lyon), November 2015 to January 2016.

Prof. Dr. Günter Leugering (FAU Erlangen-Nürnberg), June 2015.

Dr. Pawel Lorek (University of Wroclaw), February 2015.

Prof. Dr. Hans Daduna (Universität Hamburg), November 2015.

Prof. Dr. Ira Neitzel (Universität Bonn), January 2016.

Prof. Dr. Andreas Veeser (University of Milan), July 2016.

Prof. Dr. Christoph Ortner (University of Warwick), October 2016.

Dr. Hugo Férée (LORIA/Nancy), January to June 2015.

7.4 Workshops and Conferences at the Department

- Spring School Geometric Models in Probability, 4-8 April 2016 (organized by Frank Aurzada, Volker Betz, Matthias Meiners)
- International Conference on Transport Processes at Fluidic Interfaces, 05.-07.10.16 (organized by Dieter Bothe)
- International Workshop M3TB2015 – Multiscale Models in Mechano and Tumor Biology: Modeling, Homogenization, and Applications, September 28-30, 2015 (organized by Alf Gerisch, Raimondo Penta, Jens Lang)
- Workshop on the Navier-Stokes Equations, Darmstadt, April 22-23, 2015 (organized by Matthias Hieber)
- Young Researchers in Fluid Dynamics, Darmstadt, June 18-19, 2015 (organized by the International Research Training Group 1529)
- Mathematical Fluid Dynamics, Darmstadt, October 5-8, 2015 (organized by the International Research Training Group 1529)
- Mathematical Fluid Dynamics, Darmstadt, November 30-December 2, 2016 (organized by the International Research Training Group 1529)
- 2nd International Conference on Uncertainty in Mechanical Engineering at the TU Darmstadt, Session on Uncertainty Quantification, November 19 to 20, 2015 (organized by Michael Kohler)
- PhDs in Logic VIII, 9-11 May 2016 (organized by Julian Bitterlich, Felix Canavoi, Daniel Körnlein Angeliki Koutsoukou-Argyraki and Florian Steinberg))
- Schur-Multipliers, September 01-04, 2015 (organized by Burkhard Kümmerer)
- Streutheorie f̈ur Markov-Prozesse, September 12-15, 2016 (organized by Burkhard Kümmerer)
- Stochastic Analysis of Spatially Extended Models, March 23-27, 2015 (organized by Volker Betz and Matthias Meiners)
- A Darmstadt–Frankfurt Afternoon on Optimization, June 10, 2016 (organized by Marc E. Pfetsch, Thorsten Theobald, and Stefan Ulbrich)
- Seminar on Conformal Field Theory, June 26, 2015 (organized by Peter Fiebig, Nils Scheithauer and Katrin Wendland)
- German-Japanese Workshop on Theory and Practice of Real Computation, 12.07.2015 (organized by Akitoshi Kawamura and Martin Ziegler)

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

- Advisory Board of ProcessNet technical committee on Computational Fluid Dynamics
- Advisory Board of ProcessNet technical committee on Multiphase Flows

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

Jan H. Bruinier

- Associate Member of the Pohang Mathematics Institute (PMI), Postech, Pohang, Korea

Karl Heinrich Hofmann

- Fellow of the American Mathematical Society

Ulrich Kohlenbach

- Corresponding member of 'Wissenschaftliche Gesellschaft an der J.W.Goethe-Universität zu Frankfurt am Main'
- President of 'Association for Symbolic Logic (ASL)', since January 2016
- Member of Expert Panel for Mathematics of the 'Research Foundation - FLanders (FWO)'
- Member of Steering Committee of the series 'Workshop on Logic, Language, Information and Computation (WoLLIC)'
- Member of Steering Committee of 'Logic and Computational Complexity (LCC)'
- Member of Advisory Board of Springer book series 'Theory and Applications of Computability'

Jens Lang

– Member of Board of Deans of the DFG Graduate School of Excellence Computational Engineering, TU Darmstadt, since 2008

Marc Pfetsch

– BMBF-Gutachterausschuss "Mathematik für Innovationen in Industrie und Dienstleistungen"

– Forschungsrat der Rhein-Main Universitäten

Steffen Roch

– Auswahlausschuss Bundeswettbewerb Mathematik

Stefan Ulbrich

– Member of the IFIP Technical Committee TC 7, WG 7.2 "Computational Techniques in Distributed Systems", since 2003

– Universitätsversammlung TU Darmstadt

– Senat TU Darmstadt

Winnifried Wollner

– Vice Speaker of GAMM Activity Group on "Optimization with Partial Differential Equations"

Martin Ziegler

– Steering Committee of DVMLG (Deutsche Vereinigung für Mathematische Logik und für Grundlagenforschung der Exakten Wissenschaften)

– Council Member of ACiE (Association Computability in Europe)

8.2 Awards and Offers

Awards

Yann Disser: Best Paper Award, DFG Priority Program "Algorithms for Big Data" (2016)

Imke Joormann: EURO Excellence in Practice Award 2016 (Association of European Operational Research Societies), July 6, 2016

Marc Pfetsch: EURO Excellence in Practice Award 2016 (Association of European Operational Research Societies), July 6, 2016

Ulrich Reif: Athene-Preis für gute Lehre 2015

Martin Saal: Airbus-Group-Forschungspreis Claude Dornier

Marcel Schaub together with Johannes Konert and Henrik Bellhäuser: Best E-Teaching Award 2016

Stefan Ulbrich: Athene Award for Excellent Teaching 2016, TU Darmstadt

Offers of Appointments

Winnifried Wollner: Professorship (W3) for Scientific Computing, Universität Hannover

Martin Ziegler: Professor of Theoretical Computer Science, KAIST

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 are clearly structured and provide quick links for several target groups as well as links leading to specific topics in research and teaching at the department.

In the year 2015, the department has re-worked its publications geared towards prospective students. They now consist of:

- A comprehensive study guide ("Mathematik studieren an der TU Darmstadt"). This guide has two distinct parts. The first part now gives a focused overview over the department's programmes and its profile with respect to teaching and learning of mathematics. The second part consists of the article "Mathematik — Warum? Was? Wozu? Wer? Wie? Wo? Weiteres?" (formerly published separately), authored by Prof. Kümmerer which gives general insight in the different facets of mathematics as a subject of study and as a career.
- Programme-specific leaflets for the Bachelor programme (separately for the two variants "Mathematics" and "Mathematics with Economics"), the bilingual Bachelor programme and the Teaching Degree programme. These leaflets are provided by the university's central student counselling service (ZSB) and provide a detailed overview over the courses taught in each programme.

Math on demand

In April 2015, the mathematics department of TU Darmstadt launched the program *Math on Demand* for mathematically interested secondary school students and mathematics teachers. The purpose of this program 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 mathematical research. Moreover, we aim to inform the secondary school students about the tremendous opportunities for careers in mathematics and about the mathematics program at TU Darmstadt.

By now eight scientists (F. Aurzada, P. Domschke, B. Kümmerer, M. Otto, A.-M. v. Pippich, U. Reif, A. Schwartz, B. Seyfferth) offer thirteen lectures covering a wide variety of topics. In 2015 and 2016, around 20 lectures or workshops were held for a variety of audiences from the Rhein-Main metropolitan area and its surroundings. Further information is available on the webpage http://www.mathematik.tu-darmstadt.de/math-on-demand/

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 accessible for questions and discussions during the whole summer school.

The project summer school *Faszination Mathematik* is lead by A.-M. v. Pippich. In 2015, the summer school took place from July 7 to July 11 in Heidelberg and was organized by A.-M. v. Pippich and C. Alfes. Nine scientists (C. Alfes, A. Kuttich, Y. Li, M. Meiners, Ch. Mönch, A.-M. v. Pippich, C. Sehrt, I. Schreiber, F. Völz) and 24 selected students from 14 secondary schools from Hesse participated and worked together on topics ranging from stochastics, cryptography, and number theory to optimization. In 2016, the summer school took place from June 28 to July 1 in Heidelberg and was organized by A.-M. v. Pippich and F. Völz. Six scientists (K. Große-Brauckmann, L.-B. Maier, I. Schreiber, M. Schwagenscheidt, A.-M. v. Pippich, F. Völz) and 24 selected students from 13 secondary schools from Hesse participated and worked together on topics ranging from analysis, geometry, and cryptography to number theory. The summer schools 2015 and 2016 were financially supported by the *TÜV SÜD Stiftung*. Further information is available on the webpage

http://www.mathematik.tu-darmstadt.de/sommerschule-faszination-mathematik/

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 Geometry, Logic, and Stochastics in 2015 and from the fields of Algebra, Numerical Analysis and Optimization in 2016.

- 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 Logic and Optimization in 2015 and from the fields of Geometry and Stochastics in 2016).

- Annual organization of an afternoon with several talks about mathematics for secondary school students , "Darmstädter Schülerinnen- und Schülernachmittag zur Mathematik" (organization: Prof. Kohler; in 2015 with talks from the fields of Stochastics, Algebra, and Didactics and in 2016 with talks in Algebra, Geometry, 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 (organization: Dr. Alfes in 2015 and Dr. Wagner in 2016; lectures from the field of Algebra in 2015 and from the field of Numerical Analysis in 2016).
- 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. Aurzada (2015) and Prof. Kiehl and Prof. Scheithauer (2016).
- 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).
- Annual Summer School "Faszination Mathematik" with about 25 participants from regional secondary schools and topics from Algebra, Optimization and Stochastics in 2015 and topics from Algebra, Geometry, and Logic in 2016 (organized by Prof. v. Pippich and Dr. Alfes in 2015 and Prof. v. Pippich and Mr. Völz in 2016).
- In connection with the project course "Teaching in Mathematics: Problem Solving" (Prof. Bruder, StR Krauth, OStR Klein and participating students, winter semesters 2015/16 and 2016/17), diverse mathematical "Knobelstraßen" for secondary schools were developed and conducted at several schools in Darmstadt and Frankfurt.

Other activities

- Annual Graduation Event: celebration with friends and family of the graduated students (organisation: Prof. Kohlenbach 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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