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Annual Report 2012

Johann Radon Institute for Computational and Applied Mathematics

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Content

1. Mission Statement

The current mission statement of the Johann Radon Institute for Computational and Applied Mathematics (RICAM) is as follows:

The Johann Radon Institute for Computational and Applied Mathematics

1. does basic research in computational and applied mathematics according to highest international standards
2. obtains the motivation for its research topics also from challenges in other scientific fields and industry
3. emphasizes interdisciplinary cooperation between its workgroups and with institutions with similar scope and universities world-wide
4. cooperates with other disciplines in the framework of special semesters on topics of major current interest
5. wishes to attract gifted PostDocs from all over the world and to provide an environment preparing them for international careers in academia or industry
6. cooperates with universities by involving PhD-students into its research projects
7. promotes, through its work and reports about it, the role of mathematics in science, industry and society

2. Scientific Activity 2012

2.1. Zusammenfassung des wissenschaftlichen Berichts 2012

Das Institut verfügte 2012 über folgende Arbeitsgruppen:

- Arbeitsgruppe „Computational Methods for Direct Field Problems“, Gruppenleiter: Prof. Dr. Ulrich Langer
- Arbeitsgruppe „Inverse Problems“, Gruppenleiter: Prof. Dr. Otmar Scherzer
- Arbeitsgruppe „Symbolic Computation“, Gruppenleiter: Prof. Dr. Josef Schicho
- Arbeitsgruppe „Analysis for Partial Differential Equations“, Gruppenleiter: N.N.
- Arbeitsgruppe „Optimization and Optimal Control“, Gruppenleiter: Prof. Dr. Karl Kunisch
- Arbeitsgruppe „Mathematical Imaging“, Gruppenleiter: Prof. Dr. Otmar Scherzer
- Arbeitsgruppe „Mathematical Methods in Molecular and Systems Biology“, Gruppenleiter: Prof. Dr. Christian Schmeiser, Dr. Philipp Kügler
- Transfergruppe, Gruppenleiter: Prof. Dr. Ronny Ramlau
- Forschungsprojekt „Applied Discrete Mathematics and Cryptography“, Doz. Dr. Arne Winterhof
- START-Project "Sparse Approximation and Optimization in High Dimensions", Prof. Dr. Massimo Fornasier

Im Folgenden wird kurz über die wissenschaftliche Tätigkeit der einzelnen Arbeitsgruppen berichtet; Details und Informationen über die Zusammenarbeit zwischen den einzelnen Gruppen sowie über die sonstigen wissenschaftlichen Tätigkeiten sind dem Punkt 2.5. zu entnehmen.

Gruppe “Computational Methods for Direct Field Problems”

Die Forschungsarbeit dieser Gruppe konzentriert sich auf die Entwicklung, die Analyse sowie die Implementierung effizienter und robuster numerischer Methoden zur Lösung partieller Differentialgleichungen mit folgenden Schwerpunkten:

- Robuste geometrische und algebraische Mehrgitter-, Multilevel- und Multiskalenverfahren sowie Gebietszerlegungsmethoden zur numerischen Lösung und Simulation großdimensionierter technischer Probleme und Probleme in den Lebenswissenschaften.

- Isogeometrische Analysis.
- Das neue Forschungsgebiet “Isogeometrische Analysis” wurde mit einem FWF-Forschungsprojekt 2010 begonnen. 2011 wurde ein nationales Forschungsnetzwerk zum Thema „Geometrie + Simulation“ vom FWF bewilligt, welches am 1. März 2012 seine Arbeit aufgenommen hat. Die Gruppe ist mit einem Projekt zur Isogeometrische Analysis an diesem Forschungsnetzwerk beteiligt. Dieses neue Forschungsgebiet hat viele interessante praktische Anwendungen und wird weiter ausgebaut werden.

Gruppe „Inverse Problems“

Die Inverse Probleme Gruppe hat sich 2012 mit verschiedenen Aspekten der Regularisierungtheorie und Inversen Problemen bei Maxwellgleichungen beschäftigt.

Die Gruppe hat eine neuartige Konvergenzanalyse, basierend auf Stabilitätsabschätzungen, für iterative Verfahren zur Lösung von nichtlinearen inversen Problemen entwickelt. Diese Arbeiten haben bereits erheblichen Impact in der Regularisierungs-Community, wo sie nun zur Analyse von Multi-Level und Mehrskalen Methoden angewandt werden.

Ein weiteres Arbeitsgebiet ist die adaptive Wahl der Regularisierungsräume. Erste theoretische und numerische Resultate wurden in führenden Mathematik und Informatik Zeitschriften publiziert. Zu diesem Thema wurde von Prof. Dr. Sergei Pereverzyev erfolgreich das FWF-Projekt "Data-driven and problem oriented choice of the regularization space" eingeworben.

Eine mathematische Rechtfertigung der Faktorisierungsmethode für die Maxwellgleichungen war offen. Prof. Sini und seine Mitarbeiter erzielten Meyer-Groger L^p Abschätzungen für diese Gleichungen und konnten damit eine mathmatische Rechtfertigung für die Faktorisierunsgmethode erhalten. Darüberhinaus wurden Integralgleichungsmethoden verwendet um die Foldy-Lax Näherung für kleine Objekte mit beliebiger Geometrie zu beweisen.

Gruppe „Symbolic Computation“

Die wichtigsten Resultate dieser Gruppe können in zwei Themenbereichen zusammengefasst werden:

- Im Bereich der konstruktiven algebraischen Geometrie war die Gruppe an zwei FWF Projekten beteiligt; eines über die Auflösung von Singularitäten mit H. Hauser von der Universtät Wien, ein zweites über Wurzelparametrisierungen. Die Gruppe war auch am FWF finanzierten Doktoratskolleg (DK) "Computational Mathematics" beteiligt,

zusammen mit dem Research Institute for Symbolic Computation (RISC), dem Institut für Numerische Mathematik und dem Institut für Industriemathematik (alle Johannes Kepler Universtät Linz).

- Das zweite Thema ist die symbolische Funktionalanalysis. Das RICAM war von Beginn an, an der Entwicklung dieses neuen Gebietes beteiligt. In 2012 wurde diese Richtung durch die Rückkehr des Schrödingerstipendiaten (Regensburger) ans RICAM verstärkt; es wurde auch eine der ersten Doktorarbeiten in diesem Gebiet fertig gestellt.

Über diese zwei Themen hinaus gab es, in gewisser Weise auch unerwartet, wesentliche Fortschritte im Bereich der Kinematik, insbesondere im Bereich der Konstruktion und Analyse von Gelenkmechanismen. Dieses Thema ist auch der Schwerpunkt im neuen Abschnitt des RICAM-Teilprojekts im DK "Computational Mathematics".

Gruppe „Analysis for Partial Differential Equations“

Die Arbeitsgruppe fokussiert auf folgende Themen: Variationsrechnung und geometrische Masstheorie mit Betonung auf inverse freie Diskontinuitätsprobleme.

Existenz von Lösungen und numerischen Methoden wurden untersucht. Weiters haben wir Modelle von quasi-statischer Evolution für perfekte Plasizität untersucht.

Gruppe „Optimization and Optimal Control“

Die Forschung konzentrierte sich auf die Analysis und die Entwicklung numerischer Verfahren von Optimalen Steuererungsproblemen bei partiellen Differentialgleichungen. Da in den letzten Jahren große Forschritte bei Diffusionsgleichungen gemacht wurden, galt der optimalen Steuerung von Wellengleichungen besondere Aufmerksamkeit. Neu aufgenommen wurde die Forschung zum Thema der Bidomaingleichungen, welche als elektrokardio-graphisches Modell Anerkennung gefunden haben. Im Bereich der Optimalsteuerung bei Gleichungen in der Fluidmechanik wurden einerseits Kontrollierbarkeitsprobleme und andererseits Gebietoptimierungsprobleme analysiert. Hier galt es insbesondere geeignete Kostenfunktionale für die Quantifizierung von Vortizität zu finden.

Gruppe “Mathematical Imaging”

Die aktuellen Forschungsschwerpunkte dieser Gruppe sind photoakustisches Imaging und analytische und numerische Lösungsverfahren für ein Randwertproblem bei Wasserwellen. Bei der photoakustichen Bildgebung sind wir an der Berücksichtigung von dispersiven Eigenschaften des Materials interessiert. Weiters beschäftigen wir uns mit geometrischen Methoden für imaging Probleme. Dieses Forschungthema wird im Rahmen des FWF-NFN Projekts „Geometrie + Simulation“ behandelt, welches am 1. März 2012 begonnen hat.

Gruppe „Mathematical Methods in Molecular and Systems Biology“

Die Arbeitsgruppe arbeitet an interdisziplinären Projekten, die durch Fragestellungen aus der Zell- und Molekularbiologie angeregt werden. Interdisziplinäre Kooperationen mit Vertretern von IMP, IMBA, MFPL, der Universität Wien (Institut für Pharmakologie und Toxikologie, Department Molecular Systems Biology) und CzechGlobe (Tschechien) sind in verschiedenen Phasen der Realisierung. Eine davon ist derzeit im Rahmen eines WWTF-Projekts zum Thema Zytoskelettdynamik institutionalisiert. Die mathematische Methodenentwicklung und -anwendung konzentriert sich auf die Gebiete inverse Probleme, partielle Differentialgleichungen und Bildverarbeitung. Die derzeitigen biologischen Fragestellungen umfassen die Korrektur fehlerhafter Signalübertragung, die asymmetrische Zellteilung, das Schaltverhalten von Ionenkanälen, Chemotaxis, intrinsisches Rauschen in biochemischen Reaktionsnetzwerken und die Fortpflanzung des Meereswurms Platynereis dumerilii.

Transfergruppe

Ziel der 2011 gegründeten Gruppe ist der Transfer von aktuellen mathematischen Forschungsergebnissen in die Industrie. Daher erfolgen die Forschungsarbeiten der Mitarbeiter der Gruppe immer in Kooperation mit Unternehmen oder anderen außeruniversitären Einrichtungen. Im vergangenen Jahr wurden insbesondere Forschungskooperationen mit der Europäischen Südsternwarte ESO (Garching), der AVL List GmbH (Graz), der uni software plus GmbH (Linz), Siemens VAI, der MathConsult GmbH (Linz) sowie mit der Bachmann GmbH (Feldkirch) durchgeführt. Für die ESO wurden mathematische Algorithmen und Software für die Adaptive Optik – Systeme des derzeit in Planung befindlichen European Extremely Large Telescopes (E-ELT) entwickelt. Insbesondere wurden zwei Teilprojekte im Berichtszeitraum abgeschlossen und erfolgreich evaluiert. Mit der AVL werden Methoden zur Modellierung und Simulation von

Motorkomponenten entwickelt. Im Rahmen der Kooperation in der Finanzmathematik mit der MathConsult und der uni software plus werden schnelle Löser für stochastische Differentialgleichungen und für spezifische partielle Differentialgleichugnen sowie Methoden zur Identifikation von Parametern in diesen Differentialgleichungen entwickelt. Die Kooperation mit Siemens VAI hat zum Ziel, existierende Methoden zur Simulation von Sinterprozessen signifikant zu beschleunigen. Zusammen mit Bachmann wird derzeit an der Entwicklung von Methoden zur Unwuchtüberwachung in Windenergieanlagen gearbeitet. Die Vielfalt der bearbeiteten Probleme erfordert den Einsatz und die Entwicklung unterschiedlichster mathematischer Techniken. Der Schwerpunkt der entwickelten mathematischen Methoden lag im Bereich der Inversen Probleme sowie der Entwicklung von schnellen und stabilen Lösern für partielle Differentialgleichungen.

Forschungsprojekt „Applied Discrete Mathematics and Cryptography“

Das Forschungsprojekt hat seinen Schwerpunkt bei Anwendungen der Diskreten Mathematik

- in der Kryptografie
- bei der Erzeugung und Analyse von Pseudozufallszahlen
- bei der Erzeugung und Analyse gleichverteilter Punktmengen für quasi-Monte Carlo Methoden
- in der Kodierungstheorie

Ein Highlight war der internationale RICAM-Workshop zum Thema „Finite Fields and Their Applications“ in Strobl mit dem daraus resultierenden Proceedings-Band.

START Projekt Y432 „Sparse Approximation and Optimization in High Dimensions“

Die Arbeitsgruppe fokussiert auf das Thema: „sparse“ Optimierung und Anwendungen für die Dimensionsreduzierung in komplexen Problemen. Die Dimension von zu verarbeitenden Daten in Problemen unserer modernen Gesellschaft ist mittlerweile sehr groß geworden. Um aus dieser Menge von Daten, die in einer Vielzahl moderner Anwendungen (wie das Internet, physikalische Experimente, medizinische Diagnostik, um nur ein paar zu nennen) gesammelt werden, nur die wesentliche Information zu extrahieren und zu interpretieren, ist die Etablierung eines neuen Fachgebietes der Natur- und Ingenieurwissenschaften vonnöten. Die Durchführung numerischer Simulationen basierend auf diesen Daten (skaliert zu der jeweils geforderten Größenordnung) ist eine der wichtigsten Aufgaben des 21. Jahrhunderts. Kurz gesagt müssen wir imstandesein, Komplexität zu verstehen und zu organisieren. Die bemerkenswertesten Vorstöße in diese Richtung in der modernen Datenanalyse und in numerischen Simulationen basieren auf der Erkenntnis, dass in etlichen Situationen, sogar für sehr komplexe Phänomene, nur ein paar wenige führende Komponenten benötigt werden, um die Dynamik des ganzen Problems zu beschreiben. Eine Reduktion der Dimensionalität kann hierbei durch die Forderung, dass das Ergebnis dünn besetzt (englisch "sparse") bzw. komprimierbar ist, erreicht werden. Da die relevanten Freiheitsgrade des Ergebnisses nicht vorgeschrieben sind und von Problem zu Problem variieren können, brauchen wir effiziente Optimierungsmethoden, um das schwierige kombinatorische Problem der entsprechenden Identifizierung zu lösen.
Die Gruppe hat sich zuerst mit der Entwicklung effizienter Algorithmen beschäftigt, mit denen es möglich ist, auch in höherdimensionalen Fragestellungen optimale dünn besetzte Ergebnisse zu erhalten. In einem zweiten Schritt sollen die dadurch gewonnenen Werkzeuge für die Lösung partieller Differenzialgleichungen und Variationsprobleme, die auf Gebieten von großem Maßstab gelöst werden sollen, eingesetzt werden. Zuletzt sind wir daran interessiert, diese gesamte Maschinerie an interessanten Anwendungen in der Bildverarbeitung, in Problemen freier Unstetigkeiten und bei freien Randwertproblemen, wie z.B. der Erkennung von Korrossionsstellen und der Identifizierung von Brüchen, zu verwenden. Außerdem hat sich die Gruppe mit neuen Anwendungen in innovativen Gebieten, wie dem automatisierten Lernen und der optimalen Steuerung von hochdimensionalen dynamischen Systemen, beschäftigt.

2.2. Highlights 2012

Jede Arbeitsgruppe am RICAM hat interessante Highlights erzielt, die es verdient haben, hier extra genannt zu werden. Wir halten uns aber an die Vorgabe, höchstens zwei zu nennen:

- START-Projekt „Sparse Approximation and Optimization in High Dimensions“: Auf Basis eines - für einen Zwischenbericht eingeholten - sehr positiven Fachgutachtens hat das Kuratorium des FWF in seiner Sitzung am 7. Mai 2012 beschlossen, die Mittel für das 4.-6. Forschungsjahr des Projektes freizugeben. Das aktuell vorgemerkte Projektende ist der 30. Juni 2015. In der Zwischenzeit wurde ein Projektantrag „High Dimensional Sparse Optimal Control“ im Rahmen der letzten Ausschreibung des „ERC Starting Independent Researcher Grant“ eingereicht. Am 19. Juli 2012 wurde das Projekt von ERC mit sehr positiven Fachgutachten erfolgreich genehmigt. Nach dieser Bewilligung wurden die verbleibenden Förderungsmittel des START-Projektes bis auf eine Summe von EUR 100.000 EUR eingezogen. Die verbleibende Summe kann seit 1. Dezember 2012 - für das ERC-Projekt ergänzende Forschungstätigkeiten - verwendet werden.

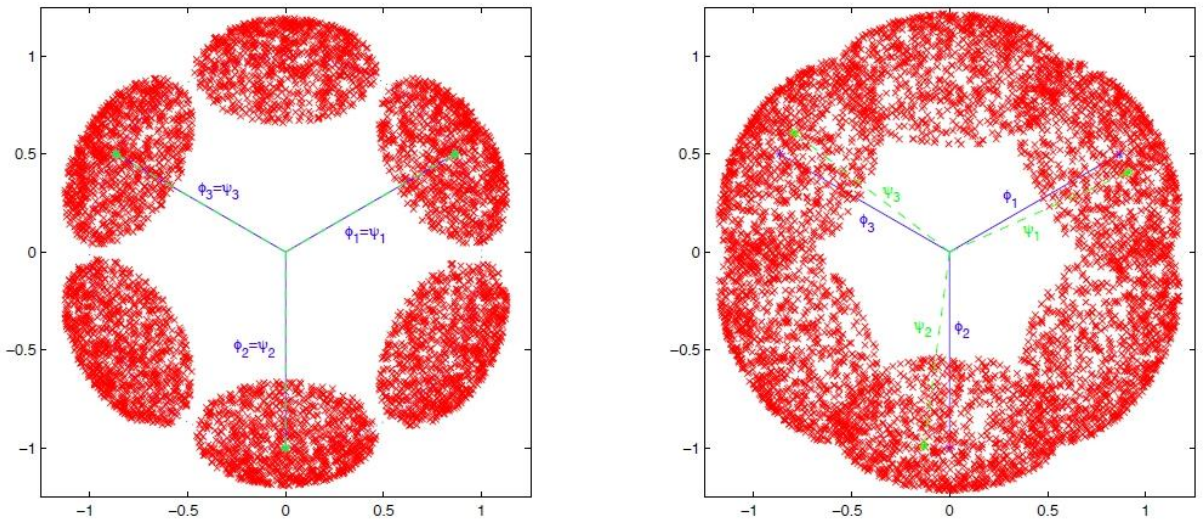

Figure 1: Die von einem Mercedes-Stern-Frame erzeugten Signale und die Koeffizienten mit verschieden Abklingverhalten zusammen mit entsprechenden Minimierer nach dem K-SVD Kriterium (Abbildung aus der Arbeit von K. Schnass, On the identifiability of overcomplete dictionaries via the minimisation principle underlying K-SVD, preprint, 2012).

- Die Integration der RICAM Gruppe „Mathematical Methods in Molecular and Systems Biology“ in die Wiener Forschungslandschaft im Bereich der Lebenswissenschaften wurde im Jahr 2012 weiter vorangetrieben und ist etwa durch ein WWTF-Projekt (siehe 2.5.7) mit dem IMBA sowie die Veranstaltung eines Workshops (siehe 2.7.2) mit über 100 Teilnehmern in Kooperation mit dem CEMM belegt. Ein Forschungsschwerpunkt der Gruppe ist die Modellierung und Simulation von biochemischen Reaktionsnetzwerken im Zusammenhang mit biologischer Signalübertragung oder Stoffwechselprozessen. Zur Korrektur fehlerhafter Reaktionsmechanismen wurde ein Algorithmus entwickelt und im SIAM Journal on Applied Mathematics veröffentlicht (siehe key publications). Die Abbildung zeigt den mathematischen Graphen zu einem Teil des Reaktionsnetzwerks der intrinsischen Signalübetragung bei der Apoptose, deren Störung in Zusammenhang mit Krankheiten wie Krebs oder Alzheimer gebracht wird. Rot markiert sind jene Stellen, die vom Algorithmus als mögliche therapeutische Angriffspunkte identifiziert wurden. Auch in Folge dieser Arbeit hat Dr. Philipp Kügler einen Ruf auf die W3-Professur „Mathematik, insbesondere Modellierung komplexer biologischer Systeme“ an der Universität Hohenheim erhalten, wo er als geschäftsführender Direktor die Leitung des Instituts für angewandte Mathematik und Statistik übernehmen wird.

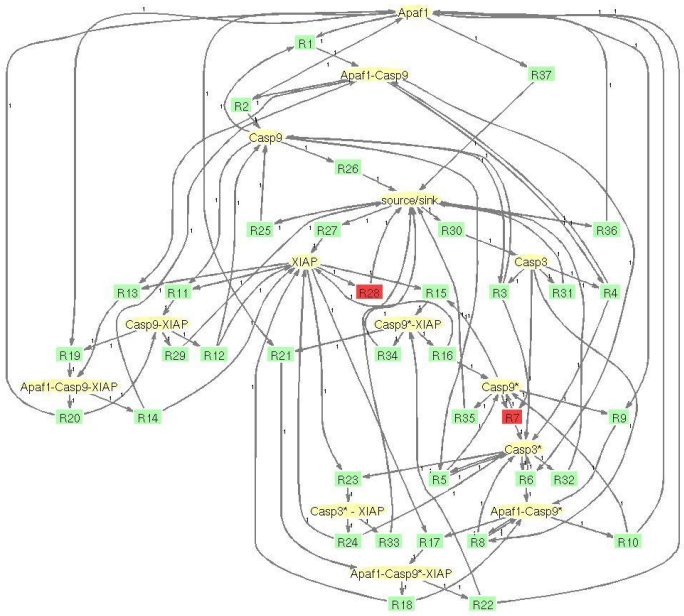

Figure 2: Bipartiter Graph zum Reaktionsnetzwerk der intrinsischen Signalübertragung bei der Apoptose. Gelbe Knoten bezeichnen Reaktanten und Produkte, während eckige Knoten biochemische Reaktionen bezeichnen.

Key Publications:

Wir nennen hier die **16** wichtigsten Publikationen aus den Forschungsgruppen und den Forschungsprojekten. Darunter sind **5** Publikationen, die wir in AkademIS als Highlights markiert haben:

1. S. W. Anzengruber, E. Klann, **R. Ramlau**, D. Tonova. Numerical methods for the design of gradient-index optical coatings. Applied Optics, v. 51 (2012), pp. 8277-8295.
2. P. Charpin, A. Pott, **A. Winterhof** (Hrsg.). Finite fields and applications: Character sums and polynomials. In Reihe: Radon Series on Computational and Applied Mathematics: de Gruyter.
3. **M. Emans:** Krylov-accelerated algebraic multigrid for semi-definite and nonsymmetric systems in computational fluid dynamics. Numerical Linear Algebra and Applications, v. 19, pp. 210-231, 2012.
4. **M. Fornasier**, Y. Kim, ***A. Langer***, C. Schönlieb. Wavelet decomposition method for L2/TV-minimization problems, SIAM Journal on Imaging Sciences 2012, Vol. 5, No. 3, pp. 857-885.
5. **M. Fornasier**, **K. Schnass, J.Vybiral**. Learning functions of few arbitrary linear parameters in high dimensions, Found. Comput. Math. 2012, Vol. 12, No. 2, pp. 229-262.
6. H. Hauser, **J. Schicho.** A game for the resolution of singularities. Proceedings of the LMS. (2012) 105(6): pp 1149-1182.
7. **H. Kasumba, K. Kunisch.** On free surface PDE constrained shape optimization problem. Applied Mathematics and Computation, 23 (2012), 11429–11450.
8. K. Kim, G. Nakamura, **M. Sini.** The Green function of the interior transmission problem and its applications. Inverse Problems and Imaging, v. 6 (2012), No. 3, pp. 487-521.
9. **S. Kleiss**, C. Pechstein, **B. Juettler, S. Tomar**. IETI – Isogeometric Tearing and Interconnecting. Computer Methods in Applied Mechanics and Engineering, v. 247-248 (2012), pp. 201-215.
10. **J. Kraus.** Additive Schur complement approximation and application to multilevel preconditioning. SIAM Journal on Scientific Computing, v. 34 (2012), No. 6, pp. A2872-A2895.
11. **P. Kügler**. A sparse update method for solving nonlinear underdetermined systems

applied to the manipulation of signalling pathways , SIAM Journal on Applied Mathematics, v. 72 (2012), 982-1001.

12. **S. Müller**, **G. Regensburger**. Generalized mass action systems: Complex balancing equilibria and sign vectors of the stochiometric and kinetic-order subspaces. SIAM Journal on Applied Mathematics. v. 72 (2012), pp 1926-1947.
13. **N. Chamakuri, K. Kunisch**, G. Plank. Optimal control approach to termination of re-entry waves in cardiac electrophysiology. Journal of Mathematical Biology, 2012, pp 1-30.
14. **V. Naumova**, **S. V. Pereverzyev, S. Sivananthan.** A meta-learning approach to the regularized learning – case study: Blood Glucose Prediction. Neural Networks, v. 33 (2012), pp. 181-183.
15. **H. Niederreiter.** Low-discrepancy simulation. In: J.-C. Duan, W.K. Härdle, J.E. Gentle (eds.), Handbook of Computational Finance; Berlin: Springer, p. 703–729.
16. M. Vinzenz, M. Nemethova, F. Schur, J. Mueller, A. Narita, E. Urban, **C. Winkler**, **C. Schmeiser**, S. Koestler, K. Rottner, G.P. Resch, Y. Maeda, J.V. Small. Actin branching in the initiation and maintenance of lamellipodia, J. Cell Sci. 125 (2012), pp. 2775-2785.

2.2.1. Personnel Development

In 2012 the founding director of the Johann Radon Institute for Computational and Applied Mathematics, Prof. Heinz W. Engl has received an Honorary Doctorate from Saarland University, Saarbrücken (Germany).

It is a principle at RICAM (see Mission Statement in Section 1) to hire PostDocs internationally and in most cases with limited time contracts. In 2012 our PostDocs have been successful in obtaining offers for permanent positions including professorial positions. **Dr. Daniel Wachsmuth** accepted a call of a professorial position from the University of Würzburg (Germany). **Dr. Sivananthan Sampath** joined the Indian Institute of Technology Delhi (India) as an assistant professor. **Dr. Philipp Kügler** received a call for a W3-professorship in "Mathematik, insbesondere Modellierung komplexer biologischer Systeme" at University Hohenheim (Germany). **Prof. Dr. Ronny Ramlau** received an offer of a full professorial position from the University of Linz.

It is on the one hand certainly a great success for people receiving offers for excellent positions worldwide, but also implies that we have to constantly hire new PostDocs. The financial constraints and the financial restrictions of the last two years have made this difficult, and we hope for an improvement in this context in order to remain competitive internationally.

2.3. Summary of the scientific report 2012

At the end of 2012, the Institute had the following group structure:

- Group “Computational Methods for Direct Field Problems”, group leader: Prof. Dr. Ulrich Langer
- Group “Inverse Problems”, group leader: Prof. Dr. Otmar Scherzer
- Group “Symbolic Computation”, group leader: Prof. Dr. Josef Schicho
- Group “Analysis of Partial Differential Equations”, group leader: N.N.
- Group “Optimization and Optimal Control”, group leader: Prof. Dr. Karl Kunisch
- Group “Mathematical Imaging”, group leader: Prof. Dr. Otmar Scherzer
- Group “Mathematical Methods in Molecular and Systems Biology”, group leaders: Prof. Dr. Christian Schmeiser, Dr. Philipp Kügler
- Transfer Group, group leader: Prof. Dr. Ronny Ramlau
- Research Project “Applied Discrete Mathematics and Cryptography“, Doz. Dr. Arne Winterhof
- START-Project "Sparse Approximation and Optimization in High Dimensions" led by Prof. Dr. Massimo Fornasier

In the following, we present an overview about the scientific activities of these groups. More details and information about their interaction and about further scientific activities follow in later sections.

Group “Computational Methods for Direct Field Problems“

The research of the Group has been focused on the development, analysis and implementation of efficient and robust computational methods for Partial Differential Equations with emphasis on the following topics:

- Robust geometric and algebraic Multigrid-, Multilevel- and Multiscale Methods as well as Domain Decomposition Methods for large-scale technical problems and problems in life sciences
- Isogeometric Analysis

The new research area “Isogeometric Analysis“ was started with a FWF research project in 2009. In December 2011 the FWF approved a national research network (NFN) on the topic “Geometry + Simulation” that was started on March 1 2012. The group participates in this NFN with one research project on Discontinous Galerkin Isogeometric Analysis. This research topic has many interesting practical applications, and will be strengthened in the future.

Group “Inverse Problems”

In 2012 we have been developing a novel convergence analysis for iterative methods for solving nonlinear inverse problems based on stability estimates. The work already has significant input in the community, and has led to further developments of multi-level and mulit-scale algorithms for solving nonlinear ill-posed problems.

In 2012 the members of the group contributed significantly to the issue of the adaptive choice of the regularization space. First theoretical and numerical results have been published in leading mathematical / computer science journals. Moreover, the application for the FWF-project that focuses on this direction has been successfully accepted and the new project “Data-driven and problem-oriented choice of the regularization space” begins on June 3 2013 under the supervision of Prof. Dr. Sergei Pereverzyev.

The justification of the enclosure method for the Maxwell system was left open in the literature. We derived the Meyers-Groger Lp estimates for this system and used it to answer this question. In addition, we used integral equation methods to justify the Foldy-Lax approximation for acoustic scattering by small obstacles with arbitrary shapes. To our best knowledge, this is the first result in this generality.

Group “Symbolic Computation”

The main results in this group can be grouped into two topics:

- In computational algebraic geometry, the group was running two FWF-projects, one on resolution of singularities together with H. Hauser from the University of Vienna. The other one on radical parametrization that was also part of the FWF-funded doctoral college “Computational Mathematics”, which is run by mathematicians from RISC, the Institute of Numerical Analysis, and the Institute for Industrial Mathematics (all at the University of Linz).

- The second topic is symbolic functional analysis. Despite the novelty of this field, it has been connected with RICAM from its very beginning. In 2012, the focus on this topic has increased by the return of Schrödinger fellow (Regensburger) to RICAM; in addition, one of the first PhD thesis in this field was completed.

Outside the two topics mentioned above, and somewhat unexpected, we also saw substantial progress in kinematics, in particular the design and analysis of linkages. This topic has also been made the main theme for the new phase of the RICAM subproject in the DK “Computational Mathematics”.

Group “Analysis for Partial Differential Equations”

The group focused on the topics Variational calculus and geometric measure theory with particular emphasis on inverse free-discontinuity problems.
Existence of solutions and numerical methods were investigated. We also addressed models of quasi-static evolution in perfect plasticity.

Group “Optimization and Optimal Control”

The research focused on the analysis and development of numerical methods for optimization with partial differential equations as constraints. While a significant amount of progress was made for diffusion type equations over the last years, relatively little progress was made for wave phenomena. This was one of the key points of research in the funding period. A new component of the group is optimal control of the bidomain equations which are the commonly accepted model for the electrical activity of the heart. In the area of fluid mechanics contributions were made to controllability problems as well as to the proper quantification of vortex reduction problems in the context of shape optimizaiton.

Group “Mathematical Imaging”

In 2012, we have been developing inversion formulas for photoacoustic imaging in dispersive media, which are modeled as causal equations in Fourier space. The analysis is based on an asymptotical analysis developed by Ammari et al.

We were also pursuing our modeling of photoacoustic sectional imaging by incorporating the propagation of the laser light into the model and derived reconstruction formulas for this quantitative photoacoustic imaging problem.

Recently, we have started working on free surface water waves. The analysis is based on a nonlinear domain transformation. For the first time, this problem was formulated as a variational optimization problem which we are analyzing with the goal to solve it with Augmented Lagrangian techniques.

Group “Mathematical Methods in Molecular and Systems Biology”

The group is working on interdisciplinary projects motivated by questions from cell and molecular biology. Interdisciplinary cooperation with groups from IMP, IMBA, MFPL, the University of Vienna (Institute for Pharmacology and Toxicology, Department Molecular Systems Biology) and CzechGlobe (Czech Republic) are in different stages of realization. One of them is currently institutionalized in the framework of a WWTF (Viennna Science and Technology Fund) funded project on cytoskeleton dynamics. The development and application of mathematical methods concentrates on the fields of inverse problems, partial differential equations and image processing. Biological fields under investigation include the correction of defective signal transduction, asymmetric cell division, the gating behavior of ion channels, chemotaxis, intrinsic noise in biochemical reaction networks and the reproduction of the marine bristle worm Platynereis dumerilii.

Transfer Group

The group, installed in 2011, aims at the transfer of modern mathematical methods to industry. Therefore the research is always done in close cooperation with industrial or other scientific partners. Within the last year we have in particular worked with the European Southern Observatory ESO (Garching), AVL List GmbH (Graz), Siemens VAI, uni software plus GmbH (Linz), MathConsult GmbH (Linz) and Bachmann GmbH (Feldkirch).
For ESO, we develop mathematical algorithms and software of adaptive optics systems for the European Extremely Large Telescope (E-ELT), which is currently planed. In particular, two subprojects have been finalized in 2012, and were succesfully evaluated. With AVL, methods for modeling and simulation of engine components are developed. In Finance, we cooperate with MathConsult and uni software plus in the development of fast numerical solvers for stochastic and specific partial differential equations and methods for the identification of parameters in these differential equations. The development of methods for condition monitoring of wind power plants is the topic of the cooperation with Bachmann. The

variety of the considered applications requires the use of a whole range of different mathematical techniques. The focus of our mathematical work was on the development of new reconstruction methods for Inverse Problems and on the development of fast and stable numerical solvers for partial differential equations.

Resarch Project “Applied Discrete Mathematics and Cryptography”

The research project focuses on applications of discrete mathematics

- in cryptography
- for the generation and analysis of pseudorandom numbers
- for the generation and analysis of uniformly distributed sequences for quasi-Monte Carlo methods
- in coding theory

A highlight was the international RICAM-Workshop on “Finite Fields and Their Applications” in Strobl and its proceedings.

START Projekt Y432 „Sparse Approximation and Optimization in High Dimensions“

The research group focused on the following topic: sparse optimization for dimensionality reduction in complex problems. The dimension scale of problems arising in our modern information society became very large. A new area of science and engineering is now urgently needed in order to extract and interpret significant information from the universe of data collected from a variety of modern sources (Internet, physics experiments, medical diagnostics, etc.). Numerical simulations at the required scale will be one of the great challenges of the 21st century. In short, we need to become capable of organizing and understanding complexity. The most notable recent advances in data analysis and numerical simulation are based on the observation that in several situations, even for very complex phenomena, only a few governing components are required to describe the whole dynamics; a dimensionality reduction can be achieved by demanding that the solution be "sparse" or "compressible". Since the relevant degrees of freedom are not prescribed and may depend on the particular solution, we need efficient optimization methods for solving the hard combinatorial problem of identifying them. Our group will first address the problem of designing efficient algorithms which allow us to achieve sparse optimization in high-dimensions. Secondly, the tools which we are developing for achieving adaptive

dimensionality reductions will subsequently be used as building blocks for solving large-scale partial differential equations or variational problems arising in various contexts. Finally, we will apply the whole machinery to interesting applications in image processing, numerical simulation, and we will explore new applications in innovative fields such as automatic learning of dynamical systems.

2.4. Highlights 2012

Each of these groups has produced very interesting highlights, but we follow the requirement to quote at most two:

- **START-Project „Sparse Approximation and Optimization in High Dimensions“:** On the basis of very positive evaluations on the mid-term Scientific Report, the Board of FWF in its session of May 7, 2012 has resolved to approve the funding for the 4th-6th years of research activity of the Project. The actual date of conclusion of the Project is set on the 30th of June 2015. In the meanwhile an application with the Project „High Dimensional Sparse Optimal Control” has been submitted in the framework of the „ERC Starting Independent Researcher Grant“. On July 19th, 2012 this Project has been approved by the ERC with very positive evaluations. As a consequence of this approval the funding of the START-Project has been reduced to an amount of 100.000 EUR which was complementing the activity of the ERC-Starting Grant since December 1st, 2012.

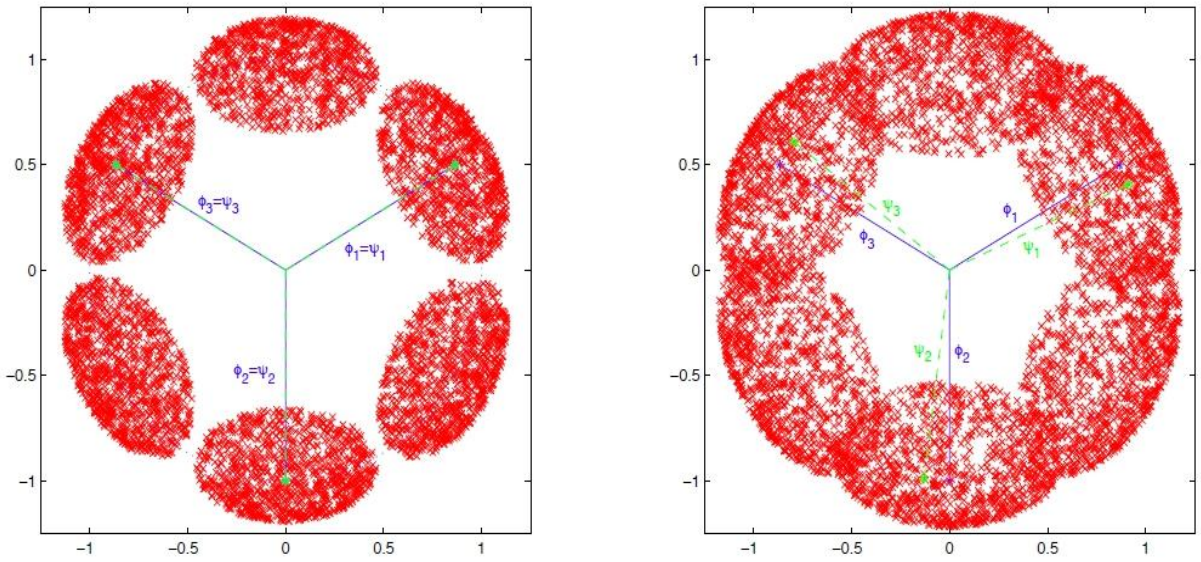

Figure 1: Signals created from the Mercedes star frame and coefficients with various decayproperties together with the corresponding minimizer of the K-SVD criterion (figure from the paper K. Schnass, On the identificability of overcomplete dictionaries via the minimisation principle underlying K-SVD, preprint, 2012).

- The integration of the RICAM group „**Mathematical Methods in Molecular and Systems Biology**“ into the Viennese research community in the field of life sciences has been continued in 2012 and is demonstrated by a WWTF-project (see 2.5.7) joint with IMBA as well as the organization of a workshop - joint with CEMM - (see 2.7.2) with more than 100 participants. One research emphasis of the group is on modelling and simulation of biochemical reaction networks in the context of biological signal transduction or metabolomic processes. For the correction of dysfunctional reaction mechanisms an algorithm has been developed and published in the SIAM Journal on Applied Mathematics (see key publications). The figure displays the mathematical graph of a part of the reaction network for intrinsic apoptotic signaling, whose dysfunction is linked to diseases such as cancer or Alzheimer's disease. Given in red are those knobs that have been identified by the algorithm as potential therapeutic intervention sites. Also, in consequence of this work Dr. Philipp Kügler received a call to the W3-professorship „mathematics, especially modelling of complex biological systems“ at the University of Hohenheim, where he will lead the institute of applied mathematics and statistics as acting director.

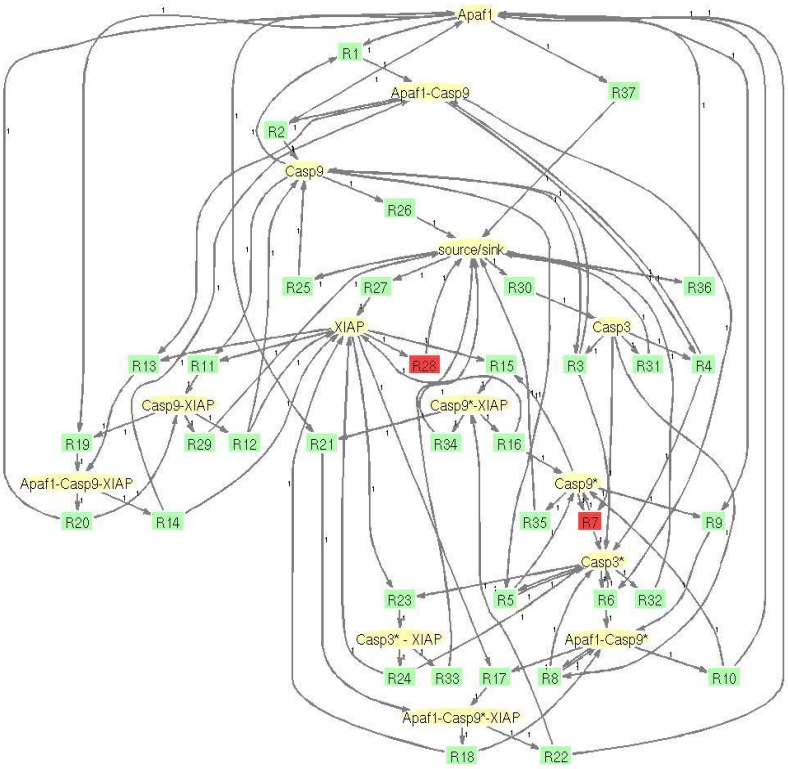

Figure 2: Bipartite graph of the reaction network for intrinsic apoptotic signalling. Yellow nodes denote reactants and products, while squared nodes refer to biochemischal reactions.

Key Publications:

We here quote **16** key publications of our research groups and projects, where **5** of which are highlighted in AkademIS:

1. S. W. Anzengruber, E. Klann, **R. Ramlau**, D. Tonova. Numerical methods for the design of gradient-index optical coatings. Applied Optics, v. 51 (2012), pp. 8277-8295.
2. P. Charpin, A. Pott, **A. Winterhof** (Hrsg.). Finite fields and applications: Character sums and polynomials. In Reihe: Radon Series on Computational and Applied Mathematics: de Gruyter.
3. **M. Emans**. Krylov-accelerated algebraic multigrid for semi-definite and nonsymmetric systems in computational fluid dynamics. Numerical Linear Algebra and Applications, v. 19, pp. 210-231, 2012.
4. **M. Fornasier**, Y. Kim, ***A. Langer***, C. Schönlieb. Wavelet decomposition method for L2/TV-minimization problems, SIAM Journal on Imaging Sciences 2012, Vol. 5, No. 3, pp. 857-885.
5. **M. Fornasier**, **K. Schnas, J.Vybiral**. Learning functions of few arbitrary linear parameters in high dimensions, Found. Comput. Math. 2012, Vol. 12, No. 2, pp. 229-262.
6. H. Hauser, **J. Schicho**. A game for the resolution of singularities. Proceedings of the LMS. (2012) 105(6): pp 1149-1182.
7. **H. Kasumba, K. Kunisch.** On free surface PDE constrained shape optimization problem. Applied ***Mathematics*** and Computation, 23 (2012), 11429–11450.
8. **K. Kim, G. Nakamura, M. Sini.** The Green function of the interior transmission problem and its applications. Inverse Problems and Imaging, v. 6 (2012), No. 3, pp. *487*-521.
9. **S. Kleiss**, C. Pechstein, **B. Juettler, S. Tomar**. IETI – Isogeometric Tearing and Interconnecting. Computer Methods in Applied Mechanics and Engineering, v. 247-248 (2012), pp. 201-215.
10. **J. Kraus.** Additive Schur complement approximation and application to multilevel preconditioning. SIAM Journal on Scientific Computing, v. 34 (2012), No. 6, pp. A2872-A2895.
11. **P. Kügler**. A sparse update method for solving nonlinear underdetermined systems applied to the manipulation of signalling pathways , SIAM Journal on Applied Mathe-

matics, v. 72 (2012), 982-1001.

12. **S. Müller, G. Regensburger**. Generalized mass action systems: Complex balancing equilibria and sign vectors of the stochiometric and kinetic-order subspaces. SIAM Journal on Applied Mathematics. v. 72 (2012), pp 1926-1947.

13. **N. Chamakuri, K. Kunisch**, G. Plank. Optimal control approach to termination of re-entry waves in cardiac electrophysiology. Journal of Mathematical Biology, 2012, pp 1-30.

14. **V. Naumova**, **S. V. Pereverzyev, S. Sivananthan.** A meta-learning approach to the regularized learning – case study: Blood Glucose Prediction. Neural Networks, v. 33 (2012), pp. 181-183.

15. **H. Niederreiter.** Low-discrepancy simulation. In: J.-C. Duan, W.K. Härdle, J.E. Gentle (eds.), Handbook of Computational Finance; Berlin: Springer, p. 703–729.

16. M. Vinzenz, M. Nemethova, F. Schur, J. Mueller, A. Narita, E. Urban, **C. Winkler**, **C. Schmeiser**, S. Koestler, K. Rottner, G.P. Resch, Y. Maeda, J.V. Small. Actin branching in the initiation and maintenance of lamellipodia, J. Cell Sci. 125 (2012), pp. 2775-2785.

2.5. Report on the scientific activity during 2012

2.5.1. Group „Computational Methods for Direct Field Problems"

Group Leaders:

Prof. Dr. Ulrich Langer

Prof. Dr. Bert Jüttler (Deputy Group Leader)

Researchers funded via ÖAW/Upper Austrian government funds:

Priv. Doz. Dr. Johannes Kraus

Dr. Angelos Mantzaflaris

Dr. Satyendra Tomar

Dr. Jörg Willems

Dr. Huidong Yang

Researchers externally funded:

MSc Nadir Bayramov

MSc Krishan Gahalaut

Dr. Ivan Georgiev

Dr. Qingguo Hong (employed since 01.12.2012)

Dipl.-Ing. Stefan Kleiss

Dipl.-Ing. Stephen Edward Moore (employed since 01.09.2012)

The "Computational Mathematics Group" (CMG) has focused on the development, analysis and implementation of novel fast computational methods for Partial Differential Equations (PDEs) or systems of PDEs arising in different fields of applications like diffusion in heterogeneous media, solid and fluid mechanics, fluid-structure interaction, electromagnetics, and others. We present the main scientific activities and the most important achievements and results obtained in 2012 following the target agreement (Zielvereinbarung) for the year 2012 where the following two major research topics were formulated:

1. **Robust Algebraic Multigrid, Multilevel, and Multiscale Methods.** The research work on this topic was organised in the following subprojects:

   (a) FWF-Research Project P22989 "*Subspace correction methods for nearly singular and indefinite problems with highly oscillatory coefficients*" (2010 – 2014) led by *J. Kraus* (2 Post-Docs: Q. Hong and I. Georgiev, and 1 PhD student: N. Bayramov). The main results for 2012 fall into three categories. Firstly, additive Schur complement

approximation was introduced as a key tool for robust multilevel preconditioning of high-frequency high-contrast problems **[20]**. Further this technique could be generalized to higher-order discretizations and also successfully applied in context of non-grid-aligned anisotropic diffusion **[21]**. Secondly, a convergence analysis was established for algebraic multilevel iteration (AMLI) methods for graph Laplacians **[5], [4]**. Finally, significant progress was made in the area of efficient solution of convection-diffusion processes driven by Stokes flow **[2]**. In December a new Post-Doc, Dr. Hong, has joined the team to strengthen our efforts in the area of discretization and optimal subspace correction methods for elasticity and Stokes problems.

(b) Collaborative Research Project on *"Robust Large-Scale Scientific Computing Methods and Scalable Algorithms"* with the Institute of Information and Communication Technologies (IICT) of the Bulgarian Academy of Sciences. Block-factorization preconditioners based on hierarchical decompositions **[23]** and semi-coarsening techniques **[22]** have been analyzed with a main emphasis on anisotropic elliptic problems. The robust algebraic multilevel methods (AMLI) developed by J. Kraus (RICAM) have been successfully used in time-periodic parabolic optimal control problems **[27]** as well as in time-periodic eddy current optimal control problems **[18]**. In connection with such optimal control problems, J. Kraus (RICAM) and M. Wolfmayr (DK W1214) have developed a new robust AMLI preconditioner that was presented at the European Multigrid Conference held in Schwetzingen (Germany), August 2012.

(c) Collaborative Research Project on *"Subgrid Discontinuous Galerkin Approximations of Brinkman Equation with Highly Heterogeneous Coefficients"* by J. Willems (RICAM) and R. Lazarov (TAMU) supported by mutual NSF project DMS-1016525. In cooperation with Y. Efendiev, J. Galvis, and R. Lazarov we developed robust two-level domain decomposition methods for general symmetric positive definite bilinear forms **[6]**. The emphasis in this research is on problems with highly varying coefficients that are not aligned with a coarse grid. Related to this we also pointed out some important relations to weighted Poincar´e inequalities **[7].**

(d) Domain Decomposition Methods in FSI. H. Yang and U. Langer are working on a joint project with T. Fitch (Vienna University) and C. Elemans (University of Southern Denmark) on computational modelling of Fluid-Structure Interaction (FSI) with

applications in life science. Figure 3 shows the FSI simulation of an aneurysm, and Figure 4 shows some flow simulation in a bird's syrinix, that is a first step towards vocal production simulation. The construction, analysis and Implementation of stable AMG preconditioned solvers are our main contributions to the efficient and reliable FSI simulation, see **[28, 32]** for our preparatory work. The results on FSI were also presented in an invited talk by U. Langer and H. Yang at the International Workshop on Efficient Solvers in Biomedical Applications (ESBA 2012), Mariatrost, Graz (Austria), July 2 - 5, 2012.

2. **Isogeometric Analysis (IGA).** This is a new research topic that was initiated by a FWF project led by S. Tomar and that is now integrated in the National Research Network NFN S117 on *"Geometry and Simulation"* led by B. Jüttler who is the speaker of the NFN S117 see http://www.gs.jku.at for more information about the NFN.

   (a) FWF-Research Project P21516 *"Isogeometric method for numerical solution of partial differential equations"* (2009 – 2013) led by S. Tomar (2 PhD students: K. Gahalaut and S. Kleiss). During 2012, we have completed two efficient approaches to solve the linear system of equations resulting from the isogeometric discretization, namely, isogeometric tearing and interconnecting method **[17]** and multigrid method **[10]**. We also concluded from our study of condition number of graph theory based preconditioners for isogeometric discretization of Poisson equation, which was continuing from 2011, that these preconditioners do not provide optimal order complexity **[11]**. We also completed the study of condition number estimates for matrices arising in the isogeometric discretization of elliptic PDEs **[12]**. Furthermore, with K. Gahalaut and J. Kraus we are investigating algebraic multilevel preconditioning for isogeometric matrices, and with S. Kleiss we are investigating guaranteed, sharp and robust a-posteriori error estimates for isogeometric discretization of elliptic PDEs.

   (b) NFN S117 *"Geometry and Simulation"* (2012 - 2016). U. Langer (PI) and S. Tomar (Co-PI) lead the sub-project S117-03 that is devoted to the construction and analysis of *"Discontinuous Galerkin Domain Decomposition Methods in IsoGeometric Analysis"* (2 PhD students: S. Moore and N.N.). The NFN was started with an international workshop organized by B. Jüttler and U. Langer in March 2012, see http://www.ag.jku.at/2012igaa/ and with a kick-off meeting in July 2012, see http://www.gs.jku.at/gs_kickoff.shtml. At the kick-off meeting, the main objectives have been discussed upon and short term and long-term goals have been set. Our

objectives are two-fold; theoretical advancements and efficient, collaborative software implementation of the results. During the last half of 2012 we initiated the C++ software implementation task coordinated by A. Mantzaflaris that aims to provide a robust library for Isogeometric analysis using hierarchical spline models **[16]**, innovative assembly techniques **[29]** and simulation over multipatch geometries. Moreover, S. Moore and Phd students from other partners of the Network have started implementations of IGA-based analysis techniques within the library framework.

The results obtained in the research projects described above have been disseminated not only via publications in journals and books, but also via invited and contributed talks which can be found in AkademIS. The highlights were certainly the invited talks by J. Kraus at the Fourth Conference of the Euro-American Consortium for Promoting the Application of Mathematics in Technical and Natural Sciences, in St. Constantine and Helena, Varna, Bulgaria, June 11-16, 2012, and at the Autumn School on Parallel Solution of Large Engineering Problems, Ostrava, November 19-20, 2012, and by U. Langer at the 5th International Conference on Computational Methods in Applied Mathematics (CMAM-5) in Berlin (Germany), July 30 - August 3, 2012, and at the International Workshop on Efficient Solvers in Biomedical Applications (ESBA 2012), Mariatrost, Graz (Austria), July 2 - 5, 2012. Furthermore, 7 invited minisymposium talks were presented at different minisymposia on several international conferences, see AkademIS.

J. Kraus was co-editor of a collection of papers **[1]**, which evolved from the Special Semester on “Multiscale Simulation & Analysis in Energy and Environment”, held at Linz, October 3 - December 16, 2011. U. Langer was co-editor of two books **[25, 26]** and one special issue of the journal CMAM **[19].** The book **[25]** contains the major contributions from the SFB F013 (1998 – 2008) and the DK W1214 (2008 - 2014) as well as from cooperation partners to “Numerical and Symbolic Scientific Computation” that was and is an area where the Linz Mathematics plays in the first league worldwide. The book contains papers from our group **[14]** as well as from the group “Symbolic Computation”.

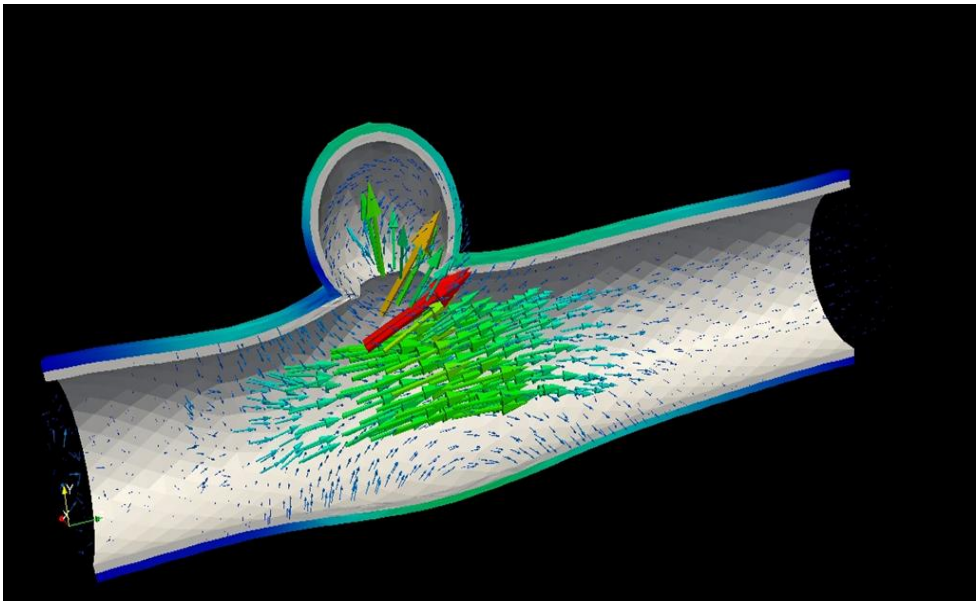

Figure 3: Aneurysm Simulation

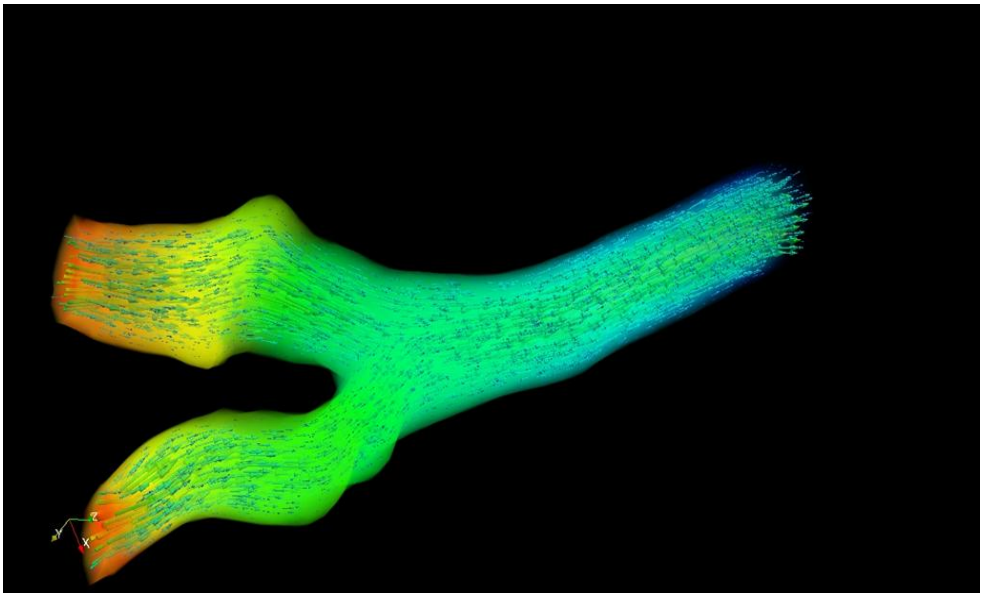

Figure 4: Flow Simulation in a Syrinix

Publications 2012 (boldface / *italic* = current / *former* members of CMG):

1. P. Bastian, **J. Kraus**, R. Scheichl, M. Wheeler, editors. Simulation of Flow in Porous Media, Radon Series Comp. Appl. Math., Walter de Gruyter, Berlin-New York, to appear.

2. **N. Bayramov, J. Kraus.** On the robust solution of convection-diffusion equation coupled with Stokes equation. RICAM-Report No. 2012-30.

3. *S. Beuchler,* V. Pillwein, and *J. Schöberl.* Sparicity Optimized High Order Finite Element Functions on Simplices. In U. Langer and P. Paule, editors, Numerical and Symbolic Scientific Computation: Progress and Prospects, Texts and Monographs in Symbolic Computation, pages 21–44. Springer-Verlag, Wien, 2012.

4. P. Boyanova, **I. Georgiev**, S. Margenov, L. Zikatanov. Multilevel Preconditioning of Graph-Laplacians: Polynomial Approximation of the Pivot Blocks Inverses, Mathematics and Computers in Simulation, v. 82 (2012), pp. 1964-1971.

5. J. Brannick, Y. Chen, **J. Kraus**, L. Zikatanov. Algebraic multilevel preconditioners for the graph Laplacian based on matching in graphs. RICAM-Report 2012-28.

6. Y. Efendiev, J. Galvis, R. Lazarov, and **J. Willems**. "Robust domain decomposition pre-conditioners for abstract symmetric positive definite bilinear forms". In: ESAIM Math. Model. Numer. Anal. v. 46 (2012), pp. 1175–1199.

7. Y. Efendiev, J. Galvis, R. Lazarov, and **J. Willems**. "Robust solvers for symmetric positive definite operators and weighted Poincar´ inequalities". In: Proceedings of the 8th international conference on Large-Scale Scientific Computing. LSSC'11. Sozopol, Bulgaria: Springer-Verlag, 2012, pp. 43–51.

8. I.Z. Emiris and **A. Mantzaflaris.** Multihomogeneous Resultant Formulae for Systems with Scaled Support. Special issue on symbolic and algebraic computation, methodology, applications, systems, v. 47 (2012), No. 7, pp. 820-842.

9. I.Z. Emiris, **A. Mantzaflaris** and B. Mourrain. Voronoi Diagrams of Algebraic Distance Fields. Computer-Aided Design, available online October 2012 from http://dx.doi.org/10.1016/j.cad.2012.10.043.

10. **K. Gahalaut**, **J. Kraus**, **S. Tomar**. Multigrid methods for isogeometric discretization. Computer Methods in Applied Mechanics and Engineering, 253 (2013), pp 413-425 (online since 16.11.2012).

11. **K. Gahalaut and S. Tomar**. Condition number study of graph theory based preconditioners for isogeometric discretization of Poisson equation. RICAM Report 2012-14.

12. **K. Gahalaut, S. Tomar**. Condition number estimates for matrices arising in the isogeometric discretizations of elliptic PDEs. RICAM Report 2012-23 (submitted).

13. **I. Georiev, J. Kraus**. Preconditioning of elasticity problems with discontinuous material parameters. In “Numerical Mathematics and Advanced Applications”, A. Cangiani et al. (eds.), Springer, 2012 (accepted).

14. P. G. Gruber, J. Kienesberger, **U. Langer**, J. Schöberl, J. Valdman. Fast solvers and a posteriori error estimates in elastoplasticity. In U. Langer and P. Paule, editors, Numerical and Symbolic Scientific Computation: Progress and Prospects, Texts and Monographs in Symbolic Computation, pages 45–63. Springer-Verlag, Wien, 2012.

15. *E. Karer*, **J. Kraus,** L. Zikatanov. A subspace correction method for nearly singular linear elasticity problems. In Proceedings of the 20th International Conference on Domain Decomposition Methods, UC San Diego, La Jolla, California, Lecture Notes in Computational Science and Engineering, Springer (to appear). [KKZ:DD20].

16. G. Kiss, C. Giannelli, **B. Jüttler**. Algorithms and Data Structures for Truncated Hierarchical B-splines, DK-Report 2012-14, www.dk-compmath.jku.at/publications.

17. S. **Kleiss**, C. Pechstein, **B. Juettler**, **S. Tomar**. Isogeometric tearing and interconnecting. Computer Methods in Applied Mechanics and Engineering, v. 247-248 (2012), pp 201-215.

18. M. Kolmbauer, **U. Langer**. A robust preconditioned-minres-solver for distributed time-periodic eddy current optimal control problems. SIAM Journal on Scientic Computing, v 34 (2012), No. 6, pp. B785-B809.

19. V. Korneev, Y. Kuznetsov, **U. Langer**, A. Matsokin. Editorial. Computational Methods in Applied Mathematics, 12(4):367–368, 2012. Special Issue dedicated to the blessed memory of Sergei Nepomnyaschikh - a poineer in domain decomposition methods.

20. **J. Kraus.** Additive Schur complement approximation and application to multilevel preconditioning. SIAM Journal on Scientific Computing, v. 34 (2012), No. 6, pp. A2872-A2895.

21. **J. Kraus**, M. Lymbery, S. Margenov. Robust multilevel methods for quadratic finite element anisotropic elliptic problems. RICAM-Report 2012-29 (submitted).

22. **J. Kraus**, M. Lymbery, S. Margenov. Semi-coarsening AMLI preconditioning of higher order elliptic problems. AIP conference proceedings (to appear).

23. **J. Kraus**, M. Lymbery, S. Margenov. On the robustness of two-level preconditioners for quadratic FE orthotropic elliptic problems. In Large-Scale Scientific Computing, I. Lirkov, S. Margenov, and J. Wasniewski, eds., Lecture Notes in Computer Science, vol. 7116, pp. 582-589, Springer, Berlin/Heidelberg, 2012.

24. **J. Kraus**, P. Vassilevski, L. Zikatanov. Polynomial of best uniform approximation to 1/x and smoothing in two-level methods. Computational Methods in Applied Mathematics, v. 12(2012), No. 4, pp. 448-468.

25. **U. Langer,** P. Paule, editors. Numerical and Symbolic Scientific Computation: Progress and Prospects, Texts and Monographs in Symbolic Computation. Springer-Verlag, Wien, 2012.

26. **U. Langer**, M. Schanz, O. Steinbach, W. L. Wendland, editors. Fast Boundary Element Methods in Engineering and Industrial Applications, volume 63 of Lecture Notes in Applied and Compuational Mechanics, Springer-Verlag, Berlin, Heidelberg, 2012.

27. **U. Langer,** M. Wolfmayr. Multiharmonic finite element analysis of a time-periodic parabolic optimal control problem. Proc. Appl. Math. Mech. (PAMM), v. 12 (2012), No. 1, pp. 687 – 688.

28. **U. Langer, H. Yang.** Domain decomposition solvers for some fluid-structure interaction problems. Proc. Appl. Math. Mech. (PAMM), v. 12 (2012), No. 1, pp. 375 – 376.

29. **A. Mantzaflaris**, **B. Jüttler**. Exploring Matrix Generation Strategies in Isogeometric Analysis. RICAM-Report 2012-31 (submitted).

30. **S. Tomar**. Algebraic multilevel preconditioning in H(curl). RICAM Report 2012-27.

31. **J. Willems**. Robust Multilevel Methods for General Symmetric Positive Definite Operators. RICAM-Report 2012-06 (submitted).

32. **H. Yang**. Partitioned solvers for the fluid-structure interaction problems with a nearly incompressible elasticity model. Computing and Visualization in Science, v 14 (2012), No. 5, pp. 227-247.

2.5.2. Group "Inverse Problems"

Group Leader:

Prof. Dr. Otmar Scherzer

Researchers funded via ÖAW/Upper Austrian government funds:

Dr. Ankik Giri (employed since 01.05.2012)
Dr. Valeriya Naumova (partially)
Dr. Thanh Nguyen (employed until 30.04.2012)
Prof. Dr. Sergei Pereverzyev
Dr. Sivananthan Sampath (partially employed until 30.06.2012)
Priv. Doz. Dr. Mourad Sini

Researchers externally funded:

M.Sc. M.Tech. Durga Prasad Challa
M.Sc. Manas Kar
Dr. Valeriya Naumova (partially)
Dr. Sivananthan Sampath (partially employed until 30.06.2012)

In 2012 we have been focusing on three research topics, which are

- Convergence analysis for iterative methods for solving nonlinear inverse problems based on stability estimates
- Inverse scattering
- Meta-Learning approach and its applications to Diabetes technology

The research work on these three topics is summarized as follows:

1. a) The work on convergence analysis of iterative methods for solving nonlinear inverse problems based on stability estimates has been very well received by the

community. It replaces technical conditions like standard source conditions of inverse problems, but very well investigated stability estimates. Moreover, this let to further developments of multi-level and mulit-scale algorithms for solving nonlinear ill-posed problems.

b) The work has been been performed jointly with M. de Hoop and L. Qui from Purdue University and E. Berretta from Rome University.

2. a) In collaboration with G. Hu (WIAS, Germany), we derived the exact models for scattering by point-like obstacles corresponding to the Lame and the Maxwell systems, **[9, 11]**.

b) In collaboration with G. Hu and A. Kirsch (KIT, Germany), **[7]**, and with D. Gintides (ATU, Greece), **[2]**, we studied the inverse elastic scattering problem using only one type of elastic waves (pressure or shear waves). In some applications, we have access only to one of these two waves. These results give an answer to the corresponding inverse problems in these situations.

c) In collaboration with A. Boumenir (Univ. west Georgia, USA), we derived asymptotic formulas to reconstruct both, the density and the sound speed of stratified waveguide from only one surface measurement, **[13]**.

d) In collaboration with N. Thanh (formerly at RICAM and now at North Carolina University, USA), we started the study of inverse scattering using multifrequency measurements, **[5]**.

Related to the FWF project “Electromagnetic Scattering by Complex Interfaces”, we have the following works:

e) Forward and Inverse scattering problems for point-like scatterers for Maxwell model, **[6]**, and Lame model, **[11]**, are studied.

f) A first result to justify the enclosure method for Maxwell is submitted early this year, **[10]**. A second work on the acoustic model is done in **[8]**. A third result for the Lame model is submitted in fall this year **[12]**.

3. a) The newly-developed meta-learning approach has received positive feedback not only from mathematicians, but also from the computer science community. This can be justified by the fact that the advanced blood glucose prediction technology based on meta-learning has been published by “Neural Networks,” which is among Top 10 Computer Science Journals with highest Impact Factor. Moreover, this algorithm has been also published by the “Recent Patents on Computer Science” Journal.

   b) This approach will be further developed and analyzed within the recently granted FWF project “Data-driven and problem-oriented choice of the regularization space” under the supervision of the Prof. Dr. Sergei V. Pereverzyev.

The results obtained in the research projects described above have been disseminated not only via publications in journals and books, but also via invited and contributed talks which can be found in AkademIS.

The highlights were certainly the invited talks at the Oberwolfach workshops “Learning Theory and Approximation” and “Computational Inverse Problems” (Germany), Dagstuhl seminar “Algorithms and Complexity for Continuous Problems” (Germany), Canberra Symposium on Regularization (Chemnitz Symposium on Inverse Problems on Tour, Australia), and ”Workshop on Mathematics for Life Sciences” (Ukraine). Furthermore, two invited minisymposium talks were presented at different minisymposia on several international conferences, see AkademIS.

Publications 2012:

1. D. Gintides, **T.T. Nguyen, M. Sini**. Detection of point-like scatterers using one type of scattered elastic waves. J. Comput. Appl. Math. 236 (2012), no. 8, 2137–2145.
2. D. Gintides, **M. Sini**. Identification of obstacles using only the pressure parts (or only the shear parts) of the elastic waves. Inverse Probl. Imaging 6 (2012), no. 1, 39–55.
3. **M. Sini,** K. Yoshida. On the reconstruction of interfaces using complex geometrical optics solutions. The acoustic case. Inverse Problems 28 (2012), no. 5, 055013.

4. K. Kim, G. Nakamura, **M. Sini**. The Green Function of the Interior Transmission Problem and its applications. Inverse Probl. Imaging 6 (2012), no. 3, 487 - 521.

5. **M. Sini, T.T. Nguyen**. Inverse acoustic obstacle scattering problems using multifrequency measurements. Inverse Probl. Imaging 6 (2012), no. 4, 749 - 773.

6. **D. P. Challa, M. Sini**. Inverse scattering by point-like scatterers in the Foldy regime. To appear in Inverse Problems.

7. G. Hu, A. Kirsch, **M. Sini**. Some inverse problems arising from elastic scattering by rigid obstacles. To appear in Inverse Problems.

8. **M. Kar, M. Sini**. Reconstructing obstacles by the enclosure method using in one step the farfield measurements. To appear in Applicable Analysis.

9. G. Hu, **M. Sini**. Elastic scattering by finitely many point-like obstacles. Submitted.

10. **M. Kar, M. Sini**. Reconstruction of interfaces using CGO solutions for the Maxwell equations. Submitted.

11. **D. P. Challa**, G. Hu, **M. Sini**. Multiple Scattering of Electromagnetic Waves by M Point-like Obstacles. Submitted.

12. **M. Kar, M. Sini**. Reconstruction of interfaces from the elastic farfield measurements using CGO solutions. Submitted.

13. F. Al-Musallam, A. Boumenir, **M. Sini**. Detection of Multilayered Media in the Acoustic Waveguide. Submitted.

14. **V. Naumova, S. V. Pereverzyev, S. Sivananthan**. A meta-learning approach to the regularized learning – case study: Blood Glucose Prediction. Neural Networks 33 (2012), pp. 181-183.

15. **V. Naumova, S. V. Pereverzyev, S. Sivananthan**. Adaptive parameter choice for one-sided finite difference schemes and its application in diabetes technology. Journal of Complexity 28 (2012), pp. 524-538.

16. J. Randlov, S. Mckennoch, **S. V. Pereverzyev** and **S. Sivananthan**. Glucose Predictor based on Regularization Networks with Adaptively Chosen Kernels and Regularization Parameters. World Intellectual Property Organization, Patent Publication WO 2012/143505 A2, October 2012.

17. **V. Naumova, S. V. Pereverzyev.** Blood Glucose Predictors: an Overview on How Recent Developments Help to Unlock the Problem of Glucose Regulation. Recent Patents on Computer Science 5 (2012), pp. 1-11.

18. *S. Lu,* **V. Naumova, S. V. Pereverzyev**. Legendre polynomials as a recommended basis for numerical differentiation in the presence of stochastic white noise. Journal of Inverse and Ill-Posed Problems 20 (2012), pp. 1-22.

19. *S. Lu,* **V. Naumova, S. V. Pereverzyev**. Numerical differentiation by means of Legendre polynomials in the presence of square summable noise, RICAM Technical Report 2012-15 (2012).

20. **V. Naumova**. Numerical Methods for Diabetes Technology: Mathematical Algorithms for a Better Management of Type 1 Diabetes. LAP LAMBERT Academic Publishing (2012).

21. **S. V. Pereverzyev**, S. Solodky, E. A. Volynets. The balancing principle in solving semi-discrete inverse problems in Sobolev scales by Tikhonov method. Applicable Analysis 91 (2012), pp. 435-446.

22. **V. Naumova, S. V. Pereverzyev, S. Sivananthan**. Learning in Variable RKHSs with application to the Blood Glucose Reading. Oberwolfach Report 31/2012 (2012).

23. **V. Naumova, S. V. Pereverzyev, S. Sivananthan**. Regularization in Variable RKHSs with application to the Blood Glucose Reading. Oberwolfach Report 51/2012 (2012).

24. **V. Naumova, S. V. Pereverzyev, S. Sivananthan**: A Meta-Learning Approach to the Adaptive Regularization – Case Study: Blood Glucose Prediction. Oberwolfach Report 51/2012 (2012).

The submitted papers by M. Sini cited above can be read in the following webpage: http://people.ricam.oeaw.ac.at/m.sini/publications.html

2.5.3. Group “Symbolic Computation”

Group Leader:

Prof. Dr. Josef Schicho

Researchers funded via ÖAW/Upper Austrian government funds:

Dr. Gabor Hegedüs (employed until 30.04.2012)

Dr. Anja Korporal

Dr. Christoph Koutschan (employed since 01.09.2012)

Dr. Georg Regensburger (employed since 01.09.2012)

Dr. David Sevilla Gonzalez (employed until 17.08.2012)

Dr. Martin Weimann (employed until 31.08.2012)

Researchers externally funded:

Dr. Hamid Ahmadinezhad (employed since 01.05.2012)

MSc. Cevahir Demirkiran (employed until 15.02.2012)

Dr. Madalina Hodorog (employed until 15.02.2012)

MSc Zijia Li (employed since 01.03.2012)

Dr. Niels Lubbes (employed until 30.06.2012)

2012 was a very dramatic and successful year for the symbolic computation group: almost the whole group changed (except A. Korporal and J. Schicho). Most colleagues left to assume academic positions in various countries. David Sevilla has assumed a position as a „profesor ayudante“ at the University of Merida, Spain. Martin Weimann has assumed a position as a „maitre de conference“ at the University of Caen, France. Gabor Hegedüs has assumed a position as a docent at Kecskemet College, Hungary. Niels Lubbes has assumed a postdoctoral research position at the King Abdul University of Science and Technology, Saudiarabia. Madalina Hodorog has assumed a postdoctoral position at the Technical University of Berlin; she decided later to switch to an industrial career. Cevahir Demarkiran decided to leave Linz for private reasons; he plans to resume a PhD study on Mathematics in another place.

We present the main achievements obtained in 2012 following the target agreement, in which two topics have been formulated:

1. Computational Algebraic Geometry. The group has elaborated on two projects funded by FWF and a subproject of an FWF-funded doctoral college. Most results can be attributed to one of these projects.

(a) **Resolution of Singularities** (FWF project P21461-N23 together with the University of Vienna). Together with H. Hauser (University of Vienna), we formulated the problem of resolution of singularities in characteristic zero as a game **[1]**, for the purpose of clarifying the logical structure of the proof of the correctness of the resolution procedure. Previously, the existence result was one of the most complicated theorems in algebraic geometry, but the game-theoretic approach provides a substantial simplification. We also organised a Clay Mathematical Summer School in Obergurgl, with 80 participants from various countries, together with D. Ellwood (CMI), S. Mori (RIMS, Japan) and H. Hauser (University of Vienna); a proceedings volume for this summer school will appear this year.

(b) **Radical parametrisation** (FWF-Project P22766-N18): Together with J. Gonzalez and I. Polo-Blanco (both University of Cantabria) and M. Harrison (University of Sydney), we developed a parametrization algorithm for Del Pezzo surfaces of degree 5 **[2]**. Del Pezzo fibrations have been also analyzed in **[5]** and play a role in **[11]**, where we extended the technique to the parametrization of trigonal curves. The boundaries of parametrizability can be measured with the pliability concept; this has been done in **[13]**.

(c) **Symbolic-numeric algorithms**: in **[8]**, we gave a symbolic-numeric method for genus computation. This method is inspired by discussions with colleagues from the direct field group and the inverse problem group (both groups also gave projects in the doctoral college).

2. **Symbolic functional analysis**. The results of the PhD thesis of A. Korporal have lead to an implementation of a simplifier for symbolic expressions involving boundary problems **[6,12,19]**. This implementation won the “Distingished Software Award” at of ISSAC 2012. In some cases, this approach allows decomposing boundary problems into smaller boundary problems **[16]** or computing closed formulas for solutions **[17, 15]**. These methods also have been applied in cooperation with H. Albrecher (Univ. Lausanne) et al to give formulas and asymptotic results for insurance risk models **[3]**. In collaboration with S. Müller from the systems biology group, we give necessary and sufficient criteria for the existence of positive equilibria in generalized mass action systems.

Besides the FWF-funded projects, the group also obtained remarkable results in kinematics, more precisely the mathematics in the design and analysis of linkages, together with H.-P. Schröcker (University of Innsbruck). In **[10]**, we give a method for construction of overconstrained linkages based on factorization of polynomials with coefficients in the dual quaternions. Figure 5 shows 3 positions in a motion of a linkage that has been generated by this method. In **[9]**, we introduced bond theory as technique for analyzing linkages. To demonstrate the power of this technique, we gave a conceptual proof for the classification of closed 5R linkages. Up to now, there was only a proof by large computations using computers. The paper **[7]** is an offspring result which has been planned earlier.

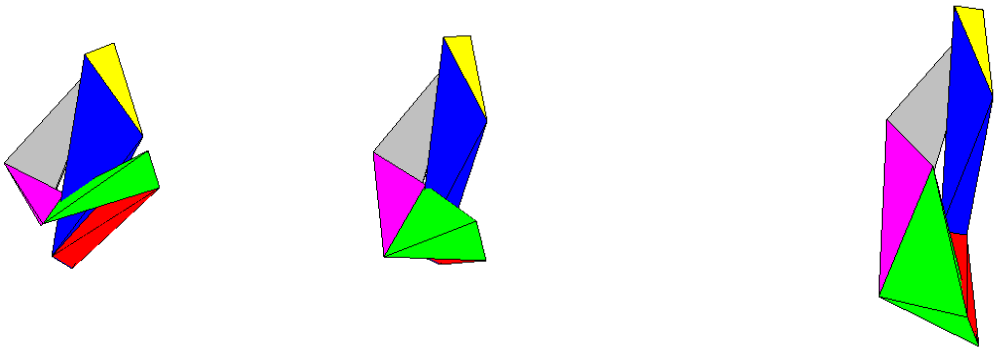

Figure 5: Three positions of a movable 6R linkage generated by factorisation of polynomials with quaternion coefficients.

Publications 2012:

1. H. Hauser, **J. Schicho.** A game for the resolution of singularities. Proceedings of the LMS. (2012) 105(6): pp 1149-1182.

2. ***M. Harrison***, J. Gonzalez, I. Polo-Blanco, **J. Schicho.** Algorithms for Del Pezzo Surfaces of Degree 5 (Construction, Parametrisation). Journal of Symbolic Computation, Bd. 47 (3), (2012, online: 2011), S. 342-353.

3. ***H. Albrecher,*** C. Constantinescu, Z. Palmowski, **G. Regensburger,** ***M. Rosenkranz***. Exact and asymptotic results for insurance risk models with surplus-dependent premiums. SIAM Journal on Applied Mathematics. (in press).

4. S. Müller, **G. Regensburger**. Generalized mass action systems; complex balancing equilibria and sign vectors of the stochiometric and kinetic-order subspaces. SIAM Journal on Applied Mathematics. (2012) 72(6), pp 1926-1947.

5. **H. Ahmadinezhad.** On del Pezzo fibrations that are not birationally rigid. Journal of London Mathematical Society, Bd. 86 (2), (2012), S. 36-62.

6. **A. Korporal, G. Regensburger,** ***M. Rosenkranz*** (in press). Symbolic Computation for Ordinary Boundary Problems in Maple. ACM Communications in Computer Algebra, Bd. 46; this contribution won the „Distinguished Software Award“ at ISSAC 2012, Grenoble.

7. **G. Hegedüs,** B. Moore. The Minkowskian planar 4R mechanism. International Electronic Journal of Geometry, Bd. 5 (1) (2012), S. 1-35.

8. **M. Hodorog**, **J. Schicho.** A Symbolic-Numeric Algorithm for Genus Computation, Numerical and Symbolic Scientific Computing. (2012).

9. **G. Hegedüs, J. Schicho,** H.-P. Schröcker. Bond theory and closed 5R linkages. In: Husty, Manfred; Lenarcic, Jadran (Hrsg.), Latest Advances in Robot Kinematics: Springer, 2012.

10. **G. Hegedüs, J. Schicho,** H.-P. Schröcker. Construction of overconstrained linkages by factorization of rational motions. In: Husty, Manfred; Lenarcic, Jadran (Hrsg.), Latest Advances in Robot Kinematics: Springer 2012.

11. **J. Schicho, D. Sevilla.** Effective Radical Parametrization of Trigonal Curves. In: Volcheck, M. Seppala and E. (Hrsg.), Computational Algebraic and Analytic Geometry of Low-dimensional Varieties: AMS, (in press), S. 10.

12. ***M. Rosenkranz,*** **A. Korporal.** A Noncommutative Mikusinski Calculus. Bericht-Nr. 546432, 2012.

13. **H. Ahmadinezhad.** Birational models of Mori fibre spaces, pliability and Cox rings. RICAM report, Linz 2012.

14. S. Müller, **G. Regensburger.** Generalized mass action systems: Complex balancing equilibria and sign vectors of the stoichiometric and kinetic-order subspaces. Bericht-Nr. 2012-21, Linz 2012.

15. L. Guo, **G. Regensburger,** ***M. Rosenkranz.*** On integro-differential algebras. Bericht-Nr. arXiv:1212.0266; Cornell University: Ithaca (2012).

16. **A. Korporal, G. Regensburger.** On the product of projectors and generalized inverses. Bericht-Nr. 2012-22; Johann Radon Institute for Computational and Applied Mathematics: Linz 2012.

17. A. Quadrat, **G. Regensburger.** Polynomial solutions and annihilators of ordinary integro-differential operators. Proceedings of the 5th IFAC Symposium on System Structure and Control (SSSC 2013): IFAC, (in press).

18. G. Ivanyos, L. Ronyai, **J. Schicho.** Splitting full matrix algebras over algebraic number fields. Journal of Algebra, Bd. 354, 2012, S. 15.

19. **M. Rosenkranz, G. Regensburger,** L. Tec, B. Buchberger. Symbolic Analysis for Boundary Problems: From Rewriting to Parametrized Groebner Bases. In: Langer, Ulrich; Paule, Peter (Hrsg.), Numerical and Symbolic Scientific Computing: Progress and Prospects; Vienna: SpringerWienNew York, 2012, S. 273-331.

2.5.4. Group "Analysis of Partial Differential Equations"

Group Leader:

N.N.

Researchers funded via ÖAW/Upper Austrian government funds:

Dr. Francesco Solombrino (employed until 05.10.2012)

The group focused on the following topics: Numerical methods for nonconvex and linearly constrained optimization. We also addressed models of quasi-static evolution in perfect plasticity.

Motivated by variational models in continuum mechanics, we introduced a novel algorithm for performing nonsmooth and nonconvex minimizations with linear constraints. We showed how this algorithm is actually a natural generalization of well-known non-stationary augmented Lagrangian methods for convex optimization. The relevant features of this approach are its applicability to a large variety of nonsmooth and nonconvex objective functions, its guaranteed global convergence to critical points of the objective energy, and its simplicity of implementation. In fact, the algorithm results in a nested double loop iteration, where in the inner loop an augmented Lagrangian algorithm performs an adaptive finite number of iterations on a fixed quadratic and strictly convex perturbation of the objective energy, while the external loop performs an adaptation of the quadratic perturbation. To show the versatility

of this new algorithm, we studied how it can be easily used for computing critical points in inverse free-discontinuity variational models, such as the Mumford-Shah functional, and, by doing so, we also derived and analyzed new iterative thresholding algorithms.

Inspired by some recent developments in the theory of small-strain heterogeneous elastoplasticity, we both revisited and generalized the formulation of the quasistatic evolutionary problem in perfect plasticity proposed by Francfort and Giacomini. We showed that their definition of the plastic dissipation measure is equivalent to an abstract one, where it is defined as the supremum of the dualities between the deviatoric parts of admissible stress fields and the plastic strains. By means of this abstract definition, a viscoplastic approximation and variational techniques from the theory of rate-independent processes give the existence of an evolution statisfying an energy-dissipation balance and consequently Hill's maximum plastic work principle for an abstract and very large class of yield conditions.

Publications 2012:

1. **M. Fornasier**, R. March, **F. Solombrino**: Existence of minimizers of the Mumford and Shah functional with singular operators and unbounded data, to appear in Annali Mat. Pura Appl.
2. **M. Fornasier**, **F. Solombrino**. Linearly constrained nonsmooth and nonconvex minimization, submitted to SIAM J. Opt. (2012).
3. **F. Solombrino**. Quasistatic evolution in perfect plasticity for generalized multiphase materials, submitted to Arch. Rat. Mech. Anal. (2012).

2.5.5. Group “Optimization and Optimal Control”

Group Leader:

Prof. Dr. Karl Kunisch

Researchers funded via ÖAW/Upper Austrian government funds:

Dr. Nagaiah Chamakuri (employed since 01.05.2012)
Dr. Henry Kasumba
Dr. Axel Kröner
Dr. Sergio Rodriues
Dr. Daniel Wachsmuth (employed until 29.02.2012)

Researchers externally funded:

M.Sc. Saheed Ojo Akindeinde (employed until 29.02.2012)

Optimal control of the wave equation (A. Kröner)

A. Kröner worked on adaptive finite element methods for optimal control problems governed by the dynamical Lamé system using the dual weighted residual approach (DWR), **[1]**. This method allows setting up an adaptive algorithm which leads to a reduction of the computational costs to solve these types of control problems. Further he worked on semi-smooth Newton methods for optimal control of the Lamé system with additional constraints on the control, see **[2]**. Different types of control settings were considered: distributed, Neumann boundary and Dirichlet boundary control. The convergence behaviour of the Newton method was analyzed and the results were confirmed by numerical examples. Besides this he has worked on a minimum effort control problem for the wave equation which includes L¥-control costs. The difficulty arising from the nondifferentiability of the problem formulation can be overcome by considering a regularized problem whose convergence with respect to the regularization parameter he analyzed. Moreover he has worked on optimal feedback control for the wave equation by solving the Hamilton-Jacobi-Bellman equation. These two last topics are still under ongoing research.

Optimal control of the Bidomain equations (N. Chamakuri)

The objective of this work is on the development and implementation of efficient numerical techniques to solve an optimal control problem related to a reaction-difusion system arising in cardiac electrophysiology. Cardiac arrhythmia is associated with abnormal initiation of caraic excitation wave front and during the cardiac arrhythmia the electrical potentials are irregular. A natural optimal control approach to an arrhythmia is to find an external stimulus which drives the system from arrhythmia pattern to a uniform pattern of the heart rhythm. We are developing optimal control techniques to such highly complex problem and studying the feasibility of such techniques is our primary interest. Existence of optimal control is established **[9]** and an optimal control approach for the termination of re-entry waves using high order numerical techniues in parallel environment is invetigated **[8,10]** for the simplified ionic model, namely Fitz-Hugh Nagumo model. Also, we are examining the lossy

compression techniques to write and read the solution trajectories, which is a bottleneck for the memory management, efficiently in optimal control of monodomain equations. Recently, we are working on more physiological models, in particularly Fenton-Karma ionic model, in our simulation study and this model involves the discontinuous source functions in state space solution. The derivative of such discontinuous source functions is required to solve the adjoint equations, which poses a lot of computational challenges. Developing the efficient numerical techniques for boundary control of the bidomain model as well as computational techniques to track the derivatives of discontinuous source functions in adjoint equations is in progress.

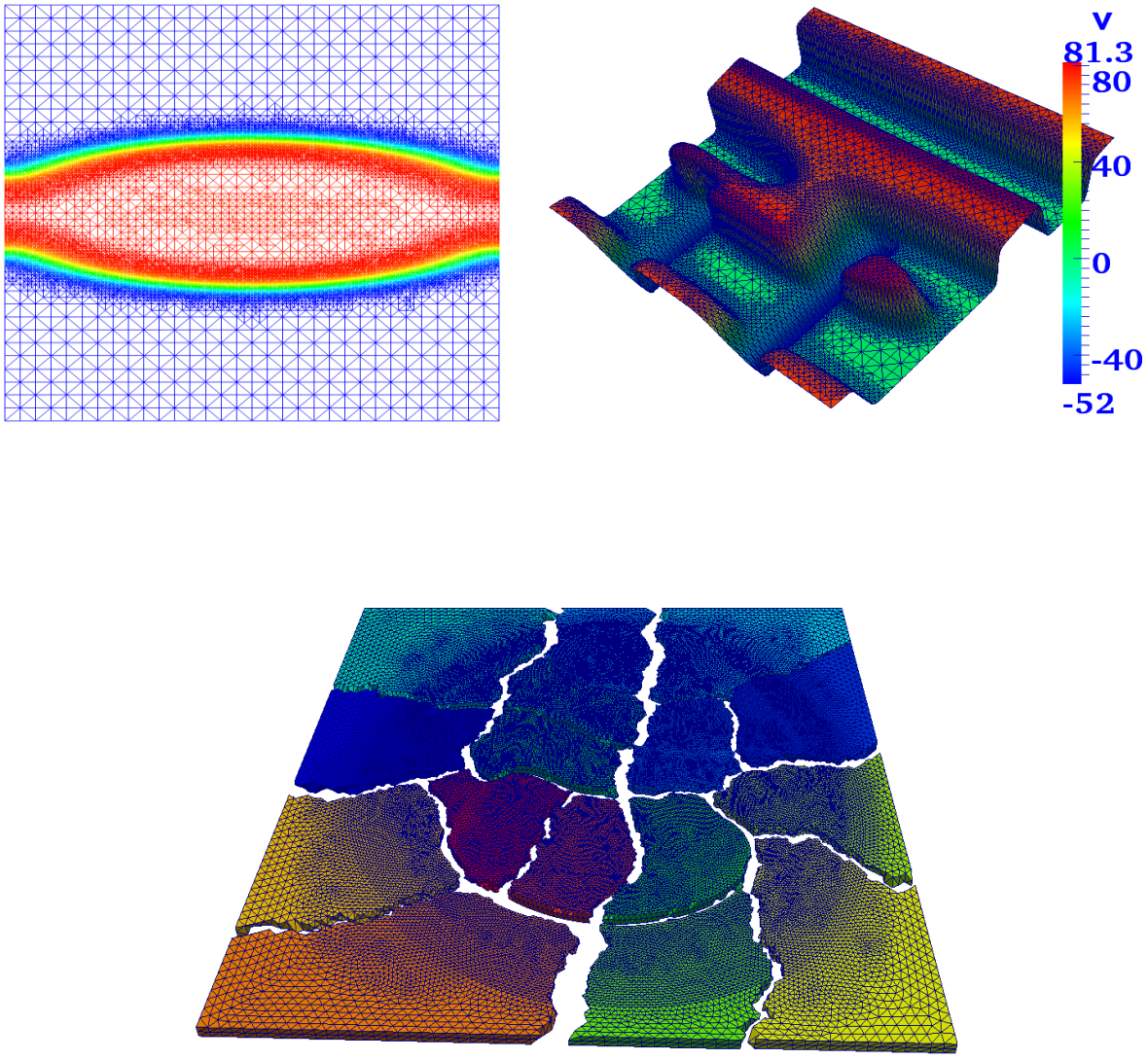

Figure 6: Optimal Control of Bidomain Equation: excitation wave front (at 8msec), controlled transmembrane potential (at 451 msec), and domain decomposition of 3D slab of cardiac tissue.

Boundary Stabilization of the Navier-Stokes equations (S. Rodrigues)

S. Rodrigues worked in the finite-dimensional feedback boundary stabilization to a given nonstationary solution for the (3D) Navier-Stokes system in a bounded domain. The controls are supposed to act on a given (small) open subset of the boundary, and that the admissible initial velocity field can have a normal component. This setting is more relevant for applications compared to the case of internal controls. We encounter new issues due to the tight relation between the control and state variables which is reflected in the assignement of these values along the boundary. Inspired by previous work for the case of internal controls, the procedure comprises the derivation of an appropriate observability inequality to deal with the admissible controls. In this direction, the exact null boundary controllability of the Oseen system was proved, with no constraint in the dimension of the control (included in **[11]**). From this result, a first boundary observability inequality was derived. It had to be improved (truncated) to suit the finite-dimensional control setting; this work is in progress **[12].** S. Rodrigues worked also in observer designing. For a system in a given class of linear systems with implicitly defined outputs, it is known that an observer can be constructed. The same can be done for any system that is equivalent, up to a change of coordinates, to one system in that class. A characterization of these equivalent systems is given in **[13,14]**.

Shape Optimization with pde constraints (H. Kasumba)

We continued our research on geometric vortex reduction in flows governed by instationary Navier-Stokes equations. In **[3]**, we report the results on the choice of an appropriate cost functional for vortex minimization. Another important topic we formally investigated in **[4]**, was the control of flows with free surfaces. Such types of problems give rise to bilevel optimizations which are complicated both from the theoretical and the numerical point of view. Several key issues arise in the study of this problem, for instance, how to construct fixed point methods for solving the free surface problem, and the rigorous sensitivity analysis of the bilevel optimization problem. The first issue requires a systematic study of the first and second order shape derivatives that we report in **[5]** and **[6]**, respectively. The second issue is currently an ongoing work under investigation in **[7]**. Furthermore, we are also currently focusing on extension of first order fixed domain approaches to second order methods with a goal of solving shape optimization problems without the necessity to involve shape derivatives and Hessians.

Publications 2012:

1. **Axel Kröner.** Adaptive finite element methods for optimal control of elastic waves. Proceedings of the 7th Vienna International Conference on Mathematical Modelling, accepted, 2012.
2. **Axel Kröner.** Semi-smooth Newton methods for optimal control of the dynamical Lamé system with control constraints. Submitted to Numerical Functional Analysis and Optimization, 2012.
3. **H. Kasumba, K. Kunisch.** Vortex control of instationary channel flows using translation invariant cost functionals. Comput Optim Appl. DOI.10.1007/s10589-012-9516-5.
4. **H. Kasumba, K. Kunisch.** On free surface PDE constrained shape optimization problem. Applied Mathematics and Computation, 23 (2012), 11429–11450.
5. **H. Kasumba, K. Kunisch.** On shape sensitivity analysis of the cost functional without shape sensitivity of the state variable. Control and Cybernectics Vol 40 (2011) No.4.
6. **H. Kasumba, K. Kunisch.** On computation of the shape Hessian of the cost functional without shape sensitivity of the state variable. RICAM report 2012-18. (submitted).
7. **H. Kasumba, K. Kunisch,** A. Laurain. A bilevel shape optimization problem for the exterior Bernoulli free boundary value problem. (under preparation).
8. **K. Kunisch, N. Chamakuri**, M. Wagner. A parallel newton-krylov method for optimal control of the monodomain model in cardiac electrophysiology. Computing and Visualization in Science, Volume 14(6),:257-269, 2011.
9. **N. Chamakuri, K. Kunisch** G. Plank. Numerical solution for optimal control of the reaction-diffusion equations in cardiac electrophysiology. Comput Optim Appl 49:149–178, 2011.
10. **N. Chamakuri, K. Kunisch**, G. Plank. Optimal control approach to termination of re-entry waves in cardiac electrophysiology. Journal of Mathematical Biology, pp 1-30. 2012.
11. **S. S. Rodrigues.** Local exact boundary controllability of 3D Navier-Stokes equations. (preparing for submission).

12. **S. S. Rodrigues.** Boundary observability inequalities for 3D Navier-Stokes equations. (in progress).
13. **S. S. Rodrigues,** A. P. Aguiar. On the linearization up to multi-output injection for a class of systems with implicitly defined outputs. (submitted).
14. **S. S. Rodrigues,** A. P. Aguiar. A new algorithm for linearization up to multi-output injection. (submitted).

2.5.6. Group "Mathematical Imaging"

Group Leader:

Prof. Dr. Otmar Scherzer

Researchers funded via ÖAW/Upper Austrian government funds:

Dr. Peter Elbau (employed until 30.09.2012)

Dr. Konstantinos Kalimeris

There has been research on three different subtopics.

1. The research on photoacustic inversion formulas has been performed jointly with R. Schulze and D. Meyer (Molecular Biology, University of Innsbruck). It provides novel reconstruction formulas for imaging and applications in cell biology.
2. We have been working on asymptotical methods for photoacoustic imaging in dispersive media. Thereby we developed novel mathematical expansion formulas and derived time reversal imaging functionals for acoustic attenuation models, which have been proposed recently. Asymptotic analysis provides reconstruction functionals from first and higher order corrections for the attenuating effect.
3. We are working on geometrical methods for solving variational problems on time dependent manifolds. This is also a topic of a subproject of the NFN project "Geometry and Simulation", funded by the FWF, which started this year.

The results obtained in the research projects described above have been disseminated not only via publications in journals and books, but also via invited and contributed talks which can be found in AkademIS. The highlights were certainly the invited talks at the Summer School at the Fields Institute in Toronto.

Publications 2012:

1. N. Thorstensen, **O. Scherzer.** Convergence of variational regularization methods for imaging on Riemannian manifolds, Inverse Problems 28 (2012) 015007.
2. A. De Cezaro, **O. Scherzer**, J.P.Zubelli. Convex Regularization of Local Volatility Models from Option Prices: Convergence Analysis and Rates, Nonlinear Analysis 75, 2398-2415 (2012).
3. L. Qiu, M. de Hoop, **O. Scherzer.** Local analysis of inverse problems: Hölder stability and iterative reconstruction, Inverse Problems 28, 045001 (2012).
4. **P. Elbau, O. Scherzer**, R. Schulze. Reconstruction Formulas for Photoacoustic Sectional Imaging, Inverse Problems 28, 045004 (2012).
5. T. Fidler, M.Grasmair, **O. Scherzer.** Shape Reconstruction with A Priori Knowledge Based on Integral Invariants, SIAM J. Imaging Sci., 5(2), 726–745 (2012).
6. T. Widlak, **O. Scherzer.** Hybrid Tomography for Conductivity Imaging, Inverse Problem 28, 084008 (2012).
7. A. Kirsch, **O. Scherzer.** Simultaneous Reconstructions of Absorption Density and Wave Speed with Photoacoustic Measurements, SIAM J. Appl. Math. 72 (5) 1508-1523 (2012).
8. R. Kowar, **O. Scherzer.** Photoacoustic Imaging Taking into Account Attenuation, pp. 85-130, in Mathematical Modeling in Biomedical Imaging II: Optical, Ultrasound, and Opto-Acoustic Tomographies.
9. H. Ammari ed. Lecture Notes in Mathematics, Mathematical Biosciences Subseries, Springer (2012).
10. C. Pontow, **O. Scherzer.** Analytical Evaluations of Double Integral Expressions Related to Total Variation. Pp. 193-218. in Numerical and Symbolic Scientific Computing: Progress and Prospects, ISBN 978-3-7091-0793-5, U. Langer and P. Paule (ed.), Springer Wien (2012).

2.5.7. Group “Mathematical Methods in Molecular and Systems Biology”

Group leader:

Dr. Philipp Kügler

Prof. Dr. Christian Schmeiser

Researchers funded via ÖAW/Upper Austrian government funds:

Dr. Philipp Kügler

Dr. Stefan Müller (partially employed since 01.06.2012)

Dr. Dietmar Ölz

Dr. Wei Yang

Msc. Clemens Zarzer (employed until 31.03.2012)

Researchers externally funded:

Mag. Stefanie Hirsch

Mag. Angelika Manhart

Msc. Christoph Winkler

The research work of the group mostly concentrates on Mathematical Cell Biology and can be grouped into the following parts:

Mathematical modelling of actin driven cell migration: This is the title of a grant project funded by WWTF and led by C. Schmeiser. It is based on a cooperation with the group of J.V. Small (IMBA, ÖAW). D. Ölz spent a substantial part of the year working on a model for actomyosin bundles like stress-fibers and cytokinesis constriction rings and submitted a preprint (D. Ölz, A viscous two-phase model for contractile actomyosin bundles). He also started to work on a grant proposal for a Schrödinger Grant (FWF) to continue that project with a strong focus on the application of the model and simulations. D. Ölz continued his work on an FE-method for cell movement together with N. Sfakianakis (University of Mainz) and A. Manhart. He also spent some time modifying and submitting an FWF-proposal which was not granted in the first place. Furthermore, he started to work with C. Winkler on an inverse problem to identify the force distribution along the leading edge of a lamellipodium. A further project of D. Ölz together with V. Milisic (University of Paris XIII) involves the stick/slip behavior of protein bonds. S. Hirsch works together with A. Manhart and C. Schmeiser on a model for a band shaped lamellipodium, based on the general lamellipodium model, derived earlier by Schmeiser and Ölz. One important new feature is the incorporation of myosin II. The model reduces to a system of ODEs, where a stability and bifurcation analysis has been

carried out, showing the dependence of the dynamics on myosin. S. Hirsch also started working on the mathematical analysis of the bundle model derived by Dietmar Ölz. C. Winkler mostly focuses on stochastic simulations of systems containing the cytoskeleton, especially actin filament meshworks. One main goal is an explanation of the relative thinness of lamellipodia. The approach combines geometric considerations and lamellipodium simulations with an effective description of the deformable cell membrane. Additionally C. Winkler deals with the shape of the cell membrane that is tethered to the cytoskeleton on a theoretical basis, as a modification of the obstacle problem. Apart from that, the Masters student Julia Pfanzelter works together with C. Winkler and C. Schmeiser on the movement of baculovirus.

Chemical reaction network theory: S. Müller continued his collaboration with Georg Regensburger (RICAM group "Symbolic Computation") on generalizing chemical reaction network theory to non mass-action kinetics. He is co-applicant in an EU grant proposal promoting an open software platform for symbolic analysis of biochemical networks. In collaboration with theoretical biologist Ralf Steuer (Humboldt University, Berlin), S. Müller investigated the evolutionary optimization of minimal metabolic pathways with respect to ressource assignment and temporal coordination. W. Yang works on the comparison between the dynamics of stochastic and deterministic models, and on the formulation of inverse problems in stochastic models. Deterministic models may show bistability and have a backward bifurcation under different conditions, which can be used to describe different states of the species or genes in the biochemical network corresponding to different treatments. When fluctuations and noise sources are introduced, stochastic biochemical models are proposed to mimic the reaction networks, which can be quite different from deterministic systems. By considering the higher moments of a stochastic model, it is possible to describe the dynamics, which would not be achieved by a deterministic model.

Service to the Life Science community:

- D. Ölz works with C. Cowan (IMP, Vienna) on the modeling of antisymmetric distribution of PIE-1 in C-elegans embryos. As a continuation of that he also started cooperations to gain a better understanding of that model together with Klemens Fellner (University of Graz). A related cooperation with Jan Haskovec (KAUST, Jeddah) is on the

mathematics of diffusion models with non-continuous diffusivity, motivated by the behavior of cytoplasmatic PIE-1, and, equally by the behavior of cockroach populations.

- P. Kügler collaborates with S. Hering (Department of Pharmacology and Toxicology, University of Vienna) on modeling of voltage gated ion channels.
- D. Ölz and C. Schmeiser work with Jeroen Dobbelaere (IMBA, ÖAW) on the modeling of the PCM-network (Pericentriolar Material).
- A. Manhart and C. Schmeiser work on a Boltzmann-like equation describing the group dynamics of Myxobacteria. They derived an equation capable of capturing alignment and reversal processes observed in nature, which lead to wave formation on a macroscopic level. The analysis of this equation is still ongoing.
- P. Kügler collaborates with G. Köhler (Department of Structural and Computational Biology, Max F. Perutz Laboratories) on modelling of glucocorticoid mediated feedback mechanisms in the hypothalamus-pituitary-adrenal axis.
- S. Müller's work with geneticist Leonie Ringrose (IMBA) on Polycomb binding kinetics has been completed, and a new project on epigentic switches, mediated by Polycomb proteins and non-coding RNA, was initiated.
- P. Kügler and W. Yang collaborate with W. Weckwerth (Molecular Systems Biology, University of Vienna) on the identification of perturbation sites in metabolomic reaction networks.
- In S. Müller's work with bioengineer Jan Cerveny (CzechGlobe), a quantitative model of carbonate chemistry in photobioreactors was developed to determine the carbon exchange rates of cyanobacteria cultures with the medium.

Publications 2012:

1. **P. Kügler**. A sparse update method for solving nonlinear underdetermined systems applied to the manipulation of signalling pathways 72,4, (2012), SIAM Journal on Applied Mathematics, 982-1001.
2. H. Freistühler, **C. Schmeiser**, N. Sfakianakis. Stable length distributions in co-localized polymerizing and depolymerizing protein filaments, SIAM J. Appl. Math. 72 (2012), pp. 1428-1448.

3. **S. Müller**, G. Regensburger. Generalized mass action systems: Complex balancing equilibria and sign vectors of the stoichiometric and kinetic-order subspaces, SIAM Journal on Applied Mathematics 72 (2012), pp. 1926-1947.

4. **P. Kügler**. Moment fitting for parameter inference in repeatedly and partially observed stochastic biological models (2012), PLoS ONE 7(8):e43001.

5. **S. Müller**, D.B. Murray, R. Machne. A new dynamic model for highly efficient mass transfer in aerated bioreactors and consequences for kLa identification, Biotechnology & Bioengineering 109 (2012), pp. 2997-3006.

6. **D. Ölz, C. Schmeiser**. Simulation of lamellipodial fragments, J. Math. Biol. 64 (2012), pp. 513-528.

7. M.G. Puchinger, **C. Zarzer, P. Kügler**, E. Gaubitzer, G. Köhler. In vitro detection of adrenocorticotropic hormone levels by fluorescence correlation spectroscopy immunoassay for mathematical modelling of glucocorticoid- mediated feedback mechanisms (2012), EURASIP Journal on Bioinformatics and Systems Biology 2012:17.

8. J.P. Fonseca, P.A. Steffen, **S. Müller**, J. Lu, A. Sawicka, C. Seiser, L. Ringrose. In vivo Polycomb kinetics and mitotic chromatin binding distinguish stem cells from differentiated cells. Genes & Development 26 (2012), pp. 857-71.

9. C. Sun, **W. Yang**. Vaccinations. Procedures, Types and Controversy (Immunology and Immune System Disorders), Chapter V: Impact of Vaccination on Disease Prevention and Control, Nova Science Publishers Inc, 2012. (BOOK CHAPTER)

10. M. Vinzenz, M. Nemethova, F. Schur, J. Mueller, A. Narita, E. Urban, **C. Winkler**, **C. Schmeiser**, S. Koestler, K. Rottner, G.P. Resch, Y. Maeda, J.V. Small. Actin branching in the initiation and maintenance of lamellipodia, J. Cell Sci. 125 (2012), pp. 2775-2785.

11. **C. Winkler**, M. Vinzenz, J.V. Small, **C. Schmeiser.** Actin filament tracking by the localized Radon transform in three-dimensional electron microscope tomograms of lamellipodia, J. Structural Biol. 178 (2012), pp. 19-28.

12. **P.Kügler**, W. Windsteiger. Algorithmische Methoden Band 2: Funktionen, Matrizen, multivariate Polynome, Lehrbuchreihe Mathematik Kompakt (2012), Birkhäuser.

13. **P. Kügler, W. Yang**. Identification of alterations in the Jacobian of biochemical reaction networks from steady state covariance data at two conditions, J. Math. Bio, submitted.

14. **A. Manhart, C. Schmeiser.** A kinetic transport model for actin-myosin interaction, submitted.

15. **D. Ölz.** A viscous two-phase model for contractile actomyosin bundles, submitted.

16. A.U. Göppert, S.S. Sans, S. Reiter, **D. Ölz**, C.R. Cowan. Reciprocal anterior-posterior cytoplasmic gradients control asymmetric segregation of the fate determinant PIE-1 in C. Elegans, preprint.

17. S. Beyl, **P. Kügler**, A. Hohaus, K. Depil, S. Hering, E. Timin. Crosstalk between voltage sensor and pore in CaV1.2: An algorithm to estimate gating parameters from current kinetics, preprint.

2.5.8. Transfer Group

Group leader:

Prof. Dr. Ronny Ramlau

The funding model of the transfer group differs from the other groups, as all group members are at least partially funded by external cooperation partners.

Researchers funded via ÖAW/Upper Austrian government funds:

Dr. Michael Aichinger (75% until 30.09.2012, 50% since 01.10.2012)
Dr. Maximilian Emans (50%)
Dipl.-Ing. Johannes Fürst (50%)
Dipl.-Ing. Josef Haslinger (50%)
Dr. Roman Heinzle (50%)
DI Diana Hufnagl (50% employed since 01.12.2012)
Dipl.-Ing. Christian Kletzmayr (50% employed until 30.06.2012)
Dipl.-Ing. Norbert Lorenz (50%)
Dr. Stefan Janecek (63%)
Dr. Jenny Niebsch (partially)

Researchers externally funded:

Dr. Jenny Niebsch (partially)

Dipl.-Ing. Mykhaylo Yudytskiy
Dr. Sergiy Pereverzyev (employed since 01.04.2012)

The group focuses on the transfer of mathematical methods and numerical techniques to industrial and other scientific partners and develops algorithms and software prototypes for mathematical problems motivated from specific applications of the partners. Mathematically, the transfer group deals with the following fields:

- Fast and stable methods for stochastic or partial differential equations arising from industrial applications
- Inverse problems and optimisation of systems described by integral and differentital equations
- Model reduction and surrogate models

In 2012, the group was in particular active in the fields of Adaptive Optics, Automotive, Finance and Energy. The following results were achieved:

Mathematical Algorithms and Software for E-ELT Adaptive Optics

Images from ground based telescopes suffer from atmospheric turbulences, which lead to serious image degradation. Adaptive Optics (AO) is a hardware-based technique for the correction of the phase of the incoming light. The correction is based on reconstruction of the turbulence in the atmosphere from guide star measurements. For each correction step, several subproblems have to be solved, where the essential subproblem is the severely ill-posed atmospheric tomography. The subproblem resembles limited angle tomography, as the solution approach requires reconstructing the atmospheric turbulence layers from data measured by the wavefront sensors aimed at the sky in different directions.

The project is carried out in close cooperation between RICAM, the Industrial Mathematics Institute of the Kepler University Linz and MathConsult GmbH. At RICAM, the work was carried out by S. Pereverzyev Jr., R. Ramlau and M. Yudytskiy. The aim of the project is the development of mathematical reconstruction methods for different types of adaptive optics systems for the European Extremely Large Telescope (E-ELT). The algorithms have to achieve a certain quality of reconstruction and the reconstructions have to be carried out in real time.

In October 2012, two of the four suprojects have been successfully completed. Both subprojects passed the Final Review with excellent recommendation from the review board of the European Southern Observatory. To quote the board report, “The Board unanimously recognized the excellent overall quality of the work carried out by the Project Team. The Board has acknowledged that the project deliverables fully comply with the technical specifications and the statement of work. The originality of the work performed by the Project Team has also been recognized.”

In April 2012 the third and only still running subproject has successfully passed the MidTerm Review by the European Southern Observatory.

In 2012 the research has been focused on three AO systems: Single Conjugate Adaptive Optics (SCAO) and Multi Conjugate Adaptive Optics (MCAO), for which the subprojects have been concluded, as well as the Multi Object Adaptive Optics (MOAO). At RICAM the emphasis has been placed on the development of fast and efficient algorithms for the atmospheric tomography subproblem, which plays a key role for MCAO and MOAO systems. During this year several methods have been considered and improved at RICAM. Amongst them are the Kaczmarz reconstructor and a wavelet-based method.

The Kaczmarz method is used to reconstruct turbulence layers at high altitudes from the incoming wavefronts. It turns out that the reconstruction can be achieved at a very high speed and does not require any matrix-vector multiplications. A real-time computing (RTC) prototype of the algorithms shows that the method allows a computation of the mirror correction in about 750 microseconds, which is well below the available time span of 1 millisecond.

The wavelet method is based on using local properties of compactly supported wavelets, both in the spatial and frequency domain. The reconstruction in the atmospheric tomography problem is obtained by solving the Bayesian maximum a-posteriori estimator with a preconditioned conjugated gradient algorithm. Incorporating the statistical information on the measurement noise as well as the turbulence profiles of the atmosphere into the reconstruction make it possible for the method to perform well above the standard matrix-vector multiply (MVM) algorithm in quality even in the presence of high measurement noise. Dramatic improvement were made this year, when the idea of using two discretization techniques, the piecewise bilinear basis and the wavelet basis, as well as the Discrete Wavelet Transform as the coupling between the two, was implemented. Sparse

representation of the underlying operators of the regularized atmospheric tomography problem led to a significant improvement in the computational cost of the method.

Figure 7: The proposed European Extremely Large Telescope (E-ELT) and the St. Stephen's Cathedral, Vienna

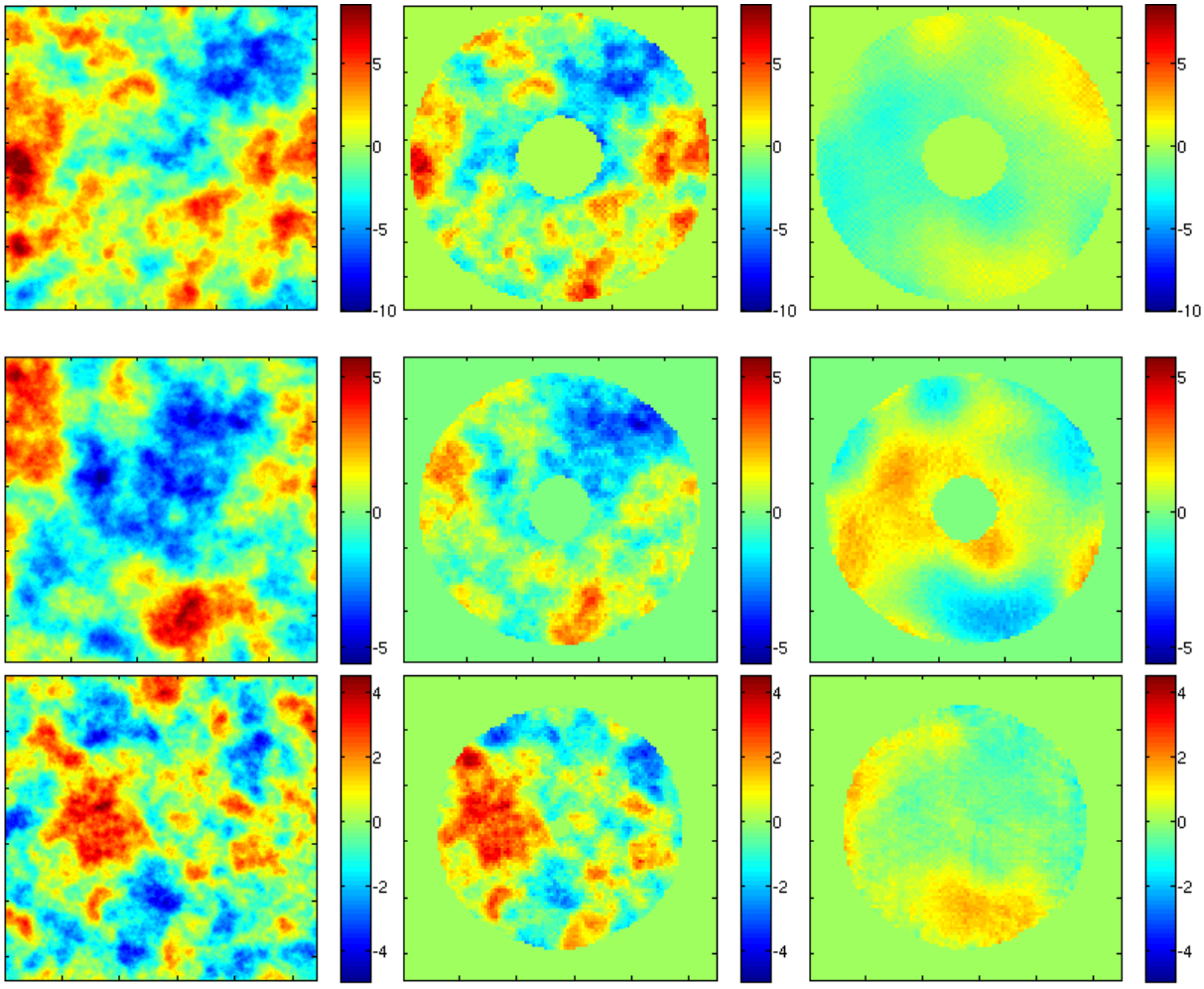

Figure 8: MCAO system: 3 simulated turbulence layers (left); 3 deformable mirrors, reconstruction using the wavelet-based method (middle); the residuals (right). Layer altitudes: 0 km (top), 4 km (middle) and 12.7 km (bottom).

Computational Finance

The research of the computational finance group has been focused on the development, analysis and implementation of fast and stable computational methods for the valuation, calibration and risk management of financial instruments.

The following topics were covered:

- Calibration and Valuation methods for short rate models: Fast methods for the valuation of interest rate instruments on the GPU have been developed. Using the results from advanced equity models, the relevant parts for the valuation of interest rate instruments (random number generation, transformation of random numbers, valuation) using Monte Carlo and Quasi Monte Carlo algorithms have been optimized using the GPU. The calibration methods have been refactored and improved in terms of parameter stability and efficiency.
- Random Number Generation and Transformation: The speed of several random number generators has been compared and the transformation of uniform random numbers to distributions used in financial models have been studied and implemented.
- Calibration of Commodity Models: An efficient and stable calibration method for a lognormal mean reverting commodity model to the time series of future and spot prices has been developed. For the valuation of complex instruments under the commodity model, Monte Carlo and Quasi Monte Carlo methods are used.
- Model Risk in Computational Finance: Especially when interest rates are on a low level, the fair prices of complex interest rate instruments under different models, which are based on different distribution assumptions, show a remarkable difference. The model risk has been studied using a time series of real market data from August 2011 to August 2012.
- Valuation of basket credit-linked instruments including issuer risk. For basket credit-linked instruments and Collaterized Debt Obligations (CDOs), efficient numerical methods for Gaussian and Student-T copulas have been studied and implemented. The valuation methods have been extended to include the risk of issuer default.

Automotive

Within this area, the group has worked on several projects:

GPU-computing: A Krylov-accelerated algebraic multigrid solver has been ported to graphics boards. In cooperation with the University of Graz, the matrix-vector multiplications have been implemented in an efficient manner on the GPU deploying the ICRS format. The entire solution phase of the algorithm can be run on the GPU now. Moreover, it is possible to use several graphics boards to speed up the calculation by additional parallelisation. We have developed a mechanism which allows to exchange the data between the graphics boards and to carry out the computations simultaneously. This way similar parallel efficiency as for conventional CPU calculations is obtained. The speed up of the solution phase is characterised by a factor of around 10; the entire linear solver runs up to four times faster on a GPU (compared to the same number of cores of a CPU).

Stabilisation of Velocity-Pressure Coupling: During the reporting period the velocity-pressure coupled solver for the Navier-Stokes equations has been stabilised in a manner that it is now suited for the industrial development process. It was particularly important to modify it in such way that it is robust enough to be accepted by those engineers and scientists who are used to deploy the segregated SIMPLE method. For this purpose a number of industrial compute cases covering a broad range of application cases of different sizes have been selected, and the behaviour of the solver has been examined. A particular result was that with regard to the AMG-based solver of the linear system, it was indispensible to deploy a stronger smoother compared to the standard smoother (Gauss-Seidel). Since the GPU-accelerated AMG algorithm is now available, it is reasonable to use it for the coupled algorithm since the time spent on the solution of linear systems within this algorithm is 50% or more.

Adaptive Grid Refinement: The spatial discretisation error of a calculation depends on the spatial resolution, i.e. it depends directly on the number of finite volumes by which the computational domain is covered. But in regions of the computational domain where, roughly speaking, the unknown functions are smooth it is possible to obtain results with reasonable accuracy by a discretisation with only a small number of finite volumes. However, in regions where these functions are characterised by e.g. strong gradients it is necessary to place a large number of finite volumes in order to obtain a solution with the desired accuracy. Since in time dependent calculations in many situations the regions with large and small gradients

do not stay at the same place, one has to find a compromise between high resolution and high accuracy (and high computational cost as a consequence) on the one side and low resolution and low accuracy (and fast calculation) on the other side. By means of an adaptive grid, one tries to find the appropriate grid for each time step. These grids are defined automatically, dependent on the current solution. The criteria for the definition of the grids, i.e. for the refinement at certain regions can be various. In the reporting period a literature survey has been undertaken and a number of appropriate criteria for the grid refinement have been compiled. The implementaiton of these criteria has been started and will be continued in the next year.

AVL-EXCITE: EXITE is a simulation software of AVL. In 2012, new algorithms were developed for the modeling of automotive parts. E.g, we have worked on the simulation of the temperature distribution in the oil film lubricated contacts in a combustion engine. The original model developed in 2011 has been extended to non stationary heat boundary conditions (e.g. rotating shaft – lubrication area). Furthermore, new body types were incorporated into the AVL multi body dynamics environment EXCITE PU. For some simplified body types (components with limited mobility) the equations of motion were reduced and simplified. We also contributed to the “Kinetostatic” project: For a time dependent flexible multi-body dynamic simulation it is necessary to have an appropriate initial state which represents the preloaded conditions at the starting time point. The model for the initial preloaded condition is introduced by a so called “kinetostatic model”, where the time dependent equations of momentum and angular momentum of a multi-body system are reformulated to a steady state system of equations with predetermined loads, velocities and accelerations.

We also worked on an efficient approach for the dynamic simulation of valve springs within a multi-body system framework. The possibility of the spring coils coming into contact significantly influences the dynamical properties of the valve spring system. The approach was chosen such that this coil-to-coil contact is modelled by means of non-smooth mechanics, more precisely by Signorini’s law. The equations of motion together with the contact constraints are solved by applying a BDF scheme. Due to the non-smooth contact constraints, a semi-smooth Newton method is applied for the solution of the resulting nonlinear systems in each time step. The approach was evaluated on a progressive spring.

Another subproject is concerned with the modal analysis of assemblies. The goal is to perform a modal analysis for an assembly of bodies within a multi-body system. Currently modal analysis is just possible for separate bodies without connections to other bodies. But eigenmodes and eigenfrequencies change significantly if bodies are connected. The system of equations of motion of the multi-body system is linearized and the according “modal matrices” are generated. Finally, the resulting quadratic eigenvalue problem has to be solved numerically. In a first step modal analysis of an assembly of rigid bodies was finished. Next is the extension of modal analysis to assemblies of flexible bodies.

Simulation of a Sinter Plant

The cooperation with Siemens VAI has been started in 2012. The primary focus of this project is the optimization and parallelization of the existing sinter plant simulation (goal is a speedup by a factor of at least four). A detailed analysis and runtime profile showed that a significant refactoring of the code will be required to this end. The code was first adapted to compile and run on current versions of Windows. A general code optimization resulted in a speedup of almost a factor of 2. We implemented a tool to visualize the reaction equations, which are assembled dynamically at runtime by the simulation, in graphs. On the basis of these graphs, we devised a code refactoring strategy for further optimization and to make the code amenable to parallelization. In coordination with Siemens VAI it was decided to employ this strategy first to the Ergun equation, and decide the further course of action based on the findings there. Furthermore, a model of four new reaction equations was developed, implemented and tested. Additionally, an analysis of H_2O and CO in the offgas was conducted.

Imbalance reconstruction for wind power plants

The FFG project 818098/16630 „Modellbasierte Unwuchtbestimmung in Windenergie-anlagen“ aimed at the reconstruction of imbalances in the rotor of a WEC (Wind Energy Converter). Rotor imbalances are cause by inhomogeneous mass distributions of the blades, the mass imbalances, and/or by disproportionate aerodynamic forces at the blades,

aerodynamic imbalances. The imbalances have to be reconstructed from vibration measurements in the nacelle of a WEC.

The reconstruction of pure mass imbalances was already realized in a previous project. Since 2009 the new project focused on the simultaneous reconstruction of mass and aerodynamic imbalances. In case of the latter, only imbalances caused by pitch angle deviations of the three blades were considered. They cover 80 % of all aerodynamic imbalances, and the forces from pitch angle deviations can be modeled quantitatively. The resulting reconstruction algorithms used Matlab implemented routines for the minimization of the Tikhonov functional and were very slow.

In 2012, the project was finalized. The numerical algorithms were accelerated using gradient based minimization routines. This implied a change of the problem formulation as well as its numerical realization.

The description of the forces arising from pitch angle deviation requires the knowledge of the blade profiles and the aerodynamics of the WEC. This presents a problem since those data are often confidential. So far, we were only able to aquire data for a NTK500 converter. The test computations, based on the NTK500 data, showed good reconstruction results.

An implementation of the simpler reconstruction algorithms for pure mass imbalances into the control system of the project partner company Bachman Monitoring GmbH was also part of this years work. The developed routines were converted from Matlab to C and inserted into the Bachman system. Test computations are still going on. This is an important first step to develop a prototype of an imbalance reconstruction toolbox for condition monitoring systems.

Publications 2012:

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2. S. W. Anzengruber, E. Klann, **R. Ramlau.** D. Tonova. Numerical methods for the design of gradient-index optical coatings. Applied Optics, v. 51 (2012), pp. 8277-8295.

3. B. Basara, **M. Emans**, S. Frolov, B. Lidskii, V. Posvyanskii. SIMPLE-H: A finite-volume pressure-enthalpy coupling scheme. Journal for Numerical Methods in Fluids, v. 69, pp. 206-225, 2012.

4. C. Brandt, A. Krause, **J. Niebsch**, J. Vehmeyer, E. Brinksmeier, P. Maass, **R. Ramlau**. Surface Generation Process with Consideration of the Balancing State in Diamond Machining. Process Machine Interactions Predicition and Manipulation of Interactions between Manufacturing Processes and Machine Tool Structures: Springer, pp. 329-360, 2012.

5. **M. Emans.** Aggregation schemes for k-cycle AMG. In: Slovak University of Technology in Bratislava, Publishing House of STU (Hrsg.), Proceedings of ALGORITMY 2012; Bratislava, 2012.

6. **M. Emans**. Combining Smoother and Residual Calculation in v-cycle AMG for Symmetric Problems. In: R. Wyrzykowski, Jack Dongarra, Konrad Karczewski and Jerzy Wasniewski (Hrsg.), PAMM 2011, Part I; Berlin Heidelberg: Springer-Verlag, pp. 651-660, 2012.

7. **M. Emans**. Krylov-accelerated algebraic multigrid for semi-definite and nonsymmetric systems in computational fluid dynamics. Numerical Linear Algebra and Applications, v. 19, pp. 210-231, 2012.

8. **M. Emans**. Parallel Coarse-Grid Treatment in AMG for Coupled Systems. In: Wasniewski, R. Wyrzykowski and Jack Dongarra and Konrad Karczewski and Jerzy (Hrsg.), PAMM 2011, Part II; Berlin Heidelberg: Springer-Verlag, pp. 361-370, 2012.

9. **M. Emans**, M. Liebmann, B. Basara. Steps Towards GPU accelerated AMG. In: M. Bader, H.J. Bungartz, D. Grigoras, M. Mehl, R.P. Mundani and R. Potolea (Hrsg.), ISPDC 2012, pp. 79-86, 2012.

10. **M. Emans**, Z. Žunič, B. Basara, S. Frolov. A Novel SIMPLE-Based Pressure-Enthalpy Coupling Scheme for Engine Flow Problems. Mathematical Modelling and Analysis, v. 17, pp. 1-20, 2012.

11. T. Katrašnik, **R. Heinzle**, J. C. Wurzenberger. Detailed Engine and Vehicle Plant Model to Support ECU Calibration. (International Conference on Powertrain Modelling and Control), 2012.

12. T. Katrašnik, **R. Heinzle**, J. C. Wurzenberger. Tailored Cylinder Models for System Level Engine Modelling (Poster). ECOSM 12, 2012.

13. S. Kindermann, A. Neubauer, **R. Ramlau**. A singular value decomposition for the Shack-Hartmann based wavefront reconstruction. J. Comput. Appl. Math., v. 236 (2012), pp. 2186-2199.

14. K. Lettmann, N. Riedinger, **R. Ramlau**, N. Knab, M. Böttcher, A. Khalili, J.-O. Wolff, B. Jorgensen. Estimation of biogeochemical rates from concentration profiles: a novel inverse method. Estuarine, Coastal and Shelf Science, v. 100, p. 26-37, 2012.

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16. G. Offner, **N. Lorenz**, O. Knaus. Piston clearance optimization using thermo-elasto hydrodynamic simulation to reduce piston slap excitation and friction loss. (7th. International Styrian Noise, Vibration & Harshness Congress); Graz, 2012.

17. **R. Ramlau,** M. Rosensteiner. A Kaczmarz type reconstructor for MCAO data. Inverse Problems, v. 28 (2012), pp. 8277-8287.

18. **R. Ramlau,** C. Zarzer. On the optimization of a Tikhonov functional with non-convex sparsity constraints. ETNA, v. 39 (2012), pp. 476-507.

19. M. Sopouch, G. Offner, C. Barchanski, H. Petrin, **J. Haslinger**. Simulation of Gearbox Structure Borne Noise Using a Detailed Multi-body Dynamics Gear Contact Model., Getriebe in Fahrzeugen 2012 (Getriebe in Fahrzeugen 2012) In Reihe: VDI-Berichte (2158); Düsseldorf: VDI Verlag GmbH, p. 425-442, 2012.

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22. A. Macia, **D. Hufnagl**, F. Mazzanti, J. Boronat, R. E. Zillich. Excitations and Stripe Phase Formation in a Two-Dimensional Dipolar Bose Gas with Tilted Polarization. Phys. Rev. Lett. v. 109 (2012), pp. 235-307.

2.5.9. Research Project "Applied Discrete Mathematics and Cryptography"

Researcher funded via ÖAW/Upper Austrian government funds:

Univ. Doz. Dr. Arne Winterhof

Researcher externally funded:

Prof. Dr. Harald Niederreiter

The research project DM focused on the analysis of cryptographic functions and sequences as well as pseudorandom numbers and low-discrepancy sequences for (quasi-)Monte Carlo methods. It also studied mathematical problems coming from coding theory.

A highlight was the international RICAM-Workshop on "Finite Fields and Their Applications" in Strobl and its proceedings **[2]**.

Cryptographic and pseudorandom sequences and functions: Besides continuing the study of promising candidates of sequences **[1,4,9,14]** and functions **[3,5,20]** the relations between different quality measurs for sequences and functions were studied **[12,18]**. For example, in **[18]** it is showed that Boolean functions derived from pseudorandom sequences with small correlation measure have nice cryptographic features as a high nonlinearity. For getting benchmarks of cryptographic figures of merit as the linear complexity for a 'good' sequence one needs results on a typical sequence. Such a result for the linear complexity of multi-sequences was obtained in **[15]**. Moreover, results suitable for constructing covering codes were given in **[16]**.

Surveys: DM contributed with a survey on low-discrepancy simulation **[11]** to the Handbook of Computational Finance, with a survey on applications of character sums to cryptography,

wireless communication, coding theory and numerical integration **[21]** for the International Mathematical Notes, and with surveys on finite fields and applications to the proceedings of the RICAM-Workshop in Strobl **[8]** and the Handbook of Finite Fields **[6,7,10,13,17,19]**.

Talks and university courses: DM gave 7 invited talks, 4 contributed talks, 3 university courses and 1 seminar.

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2. P. Charpin, A. Pott, **A. Winterhof** (Hrsg.). Finite fields and applications: Character sums and polynomials. In Reihe: Radon Series on Computational and Applied Mathematics: de Gruyter.
3. Z. Chen, **A. Winterhof.** Additive character sums of polynomial quotients, Finite Fields and Applications, S. 67-73.
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2.5.10. START-Project Y432 „Sparse Approximation and Optimization in High Dimensions“

Group Leader:

Prof. Dr. Massimo Fornasier

Researchers funded via ÖAW/Upper Austrian government funds:

Prof. Dr. Massimo Fornasier

Researchers externally funded:

Dr. Jan Haskovec (employed until 16.04.2012)
Dr. Karin Schnass (employed until 30.06.2012)
MSc Juliane Sigl (employed 01.09.2012 – 15.12.2012)
Dr. Jan Vybiral (employed until 31.03.2012)

In connection with the state of the art research in the field, we report below also the most recent work of the research team (http://hdsparse.ricam.oeaw.ac.at/index.php/members), formed by Jan Haskovec, Andreas Langer, Karin Schnass, Jan Vybiral, and myself, as its Leader.

The dimension scale of problems arising in our modern and extremely interconnected society became very large, producing significant challenges in prediction of trends and policy making. New mathematical tools and concepts are now urgently needed in order to extract and interpret significant information from this fast dynamical-in-time flow. Numerical simulations at the required scale will be one of the great challenges of the 21st century. In short, we need to become capable of organizing and understanding complexity. The most notable recent advances in data analysis and numerical simulation are based on the observation that in several situations, even for very complex phenomena, the intrinsic dimensionality is significantly lower than the ambient dimension and, when the number of agents involved is very large, that a “mean field approximation” holds.

Quasi-isometrical embeddings of high-dimensional point clouds in lower dimension and recovery. Remarkable mathematical progresses have been made in theoretical modelling of data compression, processing, and acquisition. We mention, for instance, the use of *diffusion maps* for data clouds and graphs in high dimension in order to define low-dimensional local

representations of data with small distance distortion, and meaningful automatic clustering properties. In this setting the embedding of data is performed by a *highly nonlinear* procedure, obtained by computing the eigenfunctions of suitable normalized diffusion kernels, measuring the probability of transition from one data point to another over the graph. Quasi-isometrical *linear* embeddings of high-dimensional point clouds into low-dimensional spaces of parameters are provided by the well-known Johnson-Lindenstrauss Lemma.

This embedding strategy is simpler than the use of diffusion maps, as it is linear and universal (it does not depend on the data), however it is "blind" to the specific geometry and local dimensionality of the data, as the embedding dimension depends exclusively on the number of points in the cloud. In many applications, this is sufficient, as the number of points is supposed to be a power of the dimension. The Johnson-Lindenstrauss Lemma is also at the basis of the possibility of performing optimal compressed and nonadaptive acquisition of high-dimensional data. In *compressed sensing*, theory introduced by Candès, Romberg, and Tao and, independently, by Donoho, a vector is encoded in another low-dimensional vector, by applying a random projection with appropriate distribution, which is modeling a linear acquisition device with random sensors. From the lower dimensional representation it is possible to recover the high dimensional vector by using appropriate *sparse optimization algorithms*.

In fact the design of further measurement methods and efficient recovery algorithms for more general data structures is at the core of the latest developments towards applying compressive sensing for problems in numerical simulation, beyond the sole coding-decoding of compressible digital signals, which has been so far the more "traditional" application.

We contributed significantly to the development of novel theoretical advances and new algorithms, precisely with the intention to "clear through customs" the theory of sparse recovery towards new applications; we give below an essential description of some of our most relevant contributions:

New measurements matrices: the work **[7]** gives theoretical insights on the performance of K-SVD, a dictionary learning algorithm that has gained significant popularity in practical applications. The particular question studied here is when a dictionary A can be recovered as local minimum of the minimisation criterion underlying K-SVD from a set of training signals yi = A xi. A theoretical analysis of the problem leads to the following identificability result in the

limiting case. Assuming the training signals are generated from a tight frame with coefficients drawn from a random symmetric distribution, then in expectation the generating dictionary can be recovered as a local minimum of the K-SVD criterion if the coefficient distribution exhibits sufficient decay. This decay can be characterised by the coherence of the dictionary and the $\ell 1$-norm of the coefficients. Further it is demonstrated that a similar result holds also assuming small bounded white noise on the training signals.

New definitions of randomized sparse vectors: in **[11]** we defined the average best K-term approximation widths, and studied these quantities for both classical and new measures on the unit sphere of the ℓp sequence spaces for $p < 1$ (ℓp-balls are in fact a good model for compressible vectors). This work combines the geometry of (nonconvex) ℓp spaces together with probabilistic techniques and introduces a new very realistic model of random sparse vectors, which can be used to analyze the average behavior of algorithms performing on sparse vectors.

As an example of new developments of uses of compressive sensing as a powerful tool beyond coding-decoding of digital signals we report, for instance, the efficient approximation of high-dimensional functions, as we will describe below.

Learning functions in high-dimension: in large scale data analysis and learning, several real-life problems can be formulated as capturing or approximating a function defined on high dimensional domains, from relatively few given samples or queries. The usual assumption on the class of functions to be recovered is smoothness.

The more regular a function is, the more accurately and the more efficiently it can be numerically approximated. In the field of *information based complexity* it has been clarified that such a problem is in general *intractable*, i.e., it does not have polynomial complexity, as in the recent work by Novak and Wozniakowski. However, by assuming additional structures which combine both sparsity and smoothness, *tractable* models can be provided. In the paper **[3]** we showed the tractability of certain approximation problems, involving functions depending on few linear parameters, and we provided efficient algorithms with polynomial complexity with respect to the ambient dimension. Our approach uses tools taken from the compressed sensing framework before mentioned, recent Chernoff bounds for sums of positive-semidefinite matrices, and classical stability bounds for invariant subspaces of singular value decompositions.

High-dimensional dynamical systems: besides these relevant results in compressing and coding-decoding high-dimensional "stationary" data, dimensionality reduction of complex dynamical systems and high-dimensional partial differential equations is a subject of recent intensive research. One of the natural directions, where dimensionality reduction is desirable, is the simulation of dynamical systems with many particle interactions. In particular, we are interested in studying models for multiagent interactions in social dynamics. Everyone at some point in his life was surprised and astonished by the observation of beautiful swinging movements of certain animals such as birds (starlings, geese, etc.), fishes (tuna, capelin, etc.), insects (locusts, ants, bees, termites, etc.) or certain mammals (wildebeasts, sheep, etc.). These coherent and synchronized structures are ruled by "social forces", for instance *alignment, attraction, repulsion, aggregation, self-drive*, and apparently produced without the active role of a leader in the grouping, i.e., phenomena denominated *self-organization*. Most of the basic models proposed in the literature are based on discrete particle systems incorporating these "social first principles". When the number of agents is large, the use of continuum models for the evolution of the density of individuals becomes essential. Some continuum models were derived phenomenologically, directly incorporating "social forces", in other situations the models are based on hydrodynamic descriptions derived by studying the fluctuations or the mean-field particle limits. The essence of the kinetic or mean field equations is that they connect the microscopic world, expressed in terms of particle models, to the macroscopic one, written in terms of continuum mechanics. In this field we contributed with several advances: we introduced new models of social interactions and analyzed their behavior **[1,4]**.

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6. H. Kempka, **J. Vybiral.** Spaces of variable smoothness and integrability: Characterizations by local means and ball means of differences, J. Four. Anal., Appl. 2012, Vol. 18, No. 4, pp. 852-891.

7. **K. Schnass.** On the identificability of overcomplete dictionaries via the minimisation principle underlying K-SVD, preprint, 2012.

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9. C. Schneider, **J. Vybiral.** Homogeneity property of Besov and Triebel-Lizorkin spaces, to appear J. Funct. Spaces Appl.

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2.6. Publications/talks/poster presentations 2012

The complete AkademIs report is attached as DVD.

17. Wissenschaftliche Publikationen

	gesamt
A) Bücher / Monographien oder **Editionen**	4
A) Peer-reviewte Beiträge in Fachzeitschriften oder Sammelwerken	120
· davon in indizierten Fachzeitschriften	89
B) Herausgeberschaften	2
B) längere Beiträge ohne Peer-Review in Fachzeitschriften oder Sammelwerken	1
C) Sonstige wissenschaftliche Publikationen	37
Veröffentlichungen von Nachwuchswissenschafter(inne)n/Habilitationen (diese Publikationen wurden z.T. bereits in oben angeführten Kennzahlen miterfasst)	
· Diplomarbeiten	0
· Dissertationen	3
· Habilitationen	0
Lexikonartikel	0
Kurze Lexikonbeiträge, summarisch	0

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Müller, S.; Regensburger, G. (2012) Generalized mass action systems: Complex balancing equilibria and sign vectors of the stoichiometric and kinetic-order subspaces. Bericht-Nr. 2012-21; Linz . [Regensburger, Georg: HauptautorIn; Müller, Stefan: HauptautorIn];

Naumova, V.; Pereverzyev, S.; Sampath, S. (2011, online: 2012) A Meta-Learning Approach to the Regularized Learning -- Case Study: Blood Glucose Prediction. Bericht-Nr. 2011-31; Linz . [Pereverzyev, Sergiy: KoautorIn; Sampath, Sivananthan: KoautorIn; Naumova, Valeriya: KoautorIn];

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C) Sonstige wissenschaftliche Publikationen

Naumova, V.; Pereverzyev, S.; Sampath, S. (2012, online: 2012) A Meta-Learning Approach to the Adaptive Regularization – Case Study: Blood Glucose Prediction. Bericht-Nr. 51/2012; Mathematisches Forschungsinstitut Oberwolfach: Oberwolfach . [Pereverzyev, Sergiy: KoautorIn; Sampath, Sivananthan: KoautorIn; Naumova, Valeriya: KoautorIn]; indiziert

Naumova, V.; Pereverzyev, S.; Sampath, S. (2012, online: 2012) Regularization in Variable RKHSs with application to the Blood Glucose Reading. Bericht-Nr. 51/2012; Mathematisches Forschungsinstitut Oberwolfach: Oberwolfach . [Pereverzyev, Sergiy: KoautorIn; Sampath, Sivananthan: KoautorIn; Naumova, Valeriya: KoautorIn]; indiziert

Naumova, V. (2012) Numerical Methods for Diabetes Technology., Johannes Kepler University, Johannes Kepler University, Linz. [Naumova, Valeriya: AlleinautorIn];

Pereverzyev, S. V.; Naumova, V.; Sampath, S. (2012, online: 2012) Learning in Variable RKHSs with application to the Blood Glucose Reading. Bericht-Nr. 31/2012; Oberwolfach . [Pereverzyev, Sergiy: KoautorIn; Sampath, Sivananthan: KoautorIn; Naumova, Valeriya: KoautorIn]; indiziert

Randlov, J.; Mckennoch, S.; S., S. V. Pereverzyev; Sampath (2012, online: 2012) GLUCOSE PREDICTOR BASED ON REGULARIZATION NETWORKS WITH ADAPTIVELY CHOSEN KERNELS AND REGULARIZATION PARAMETERS. World Intellectual Property Organization, Bd. WO 2012/143505 A2. [Pereverzyev, Sergiy: KoautorIn; Sampath, Sivananthan: KoautorIn]; peer-rev. lang

Rodrigues, S. S.; Aguiar, A. P. (2012) On the linearization up to multi-output injection for a class of nonlinear systems with implicitly defined outputs. Bericht-Nr. 2012-16; Johann Radon Institute for Computational and Applied Mathematics (RICAM): Linz. [Da Silva Rodrigues, Sérgio: KoautorIn];

Rodrigues, S. S. (2012) Local exact boundary controllability of 3D Navier--Stokes equations. Bericht-Nr. 2012-12; Johann Radon Institute for Computational and Applied Mathematics (RICAM): Linz. [Da Silva Rodrigues, Sérgio: AlleinautorIn];

Rosenkranz, M.; A.Korporal (2012) A Noncommutative Mikusinski Calculus. Bericht-Nr. 546432;. [Korporal, Anja: KoautorIn];

Schneider, C.; Vybiral, J. (2012, online: 2012) Non-smooth atomic decompositions, traces on Lipschitz domains, and pointwise multipliers in function spaces. [Vybiral, Jan: KoautorIn]; peer-rev.indiziert lang

Tomar, S.K. (2012) Algebraic multilevel preconditioning in H(\Omega,curl). Bericht-Nr. 2012-27; U. Langer (RICAM):. [Tomar, Satyendra: AlleinautorIn];

Wachsmuth, G.; Wachsmuth, D. (2012) Necessary conditions for convergence rates of regularizations of optimal control problems. Bericht-Nr. 2012-04; RICAM:. [Wachsmuth, Daniel: HauptautorIn];

Willems, J. (2012, online: 2012) Robust Multilevel Methods for General Symmetric Positive Definite Operators. Bericht-Nr. 2012-06; Linz. [Willems, Jörg: AlleinautorIn];

Willems, J. (2012, online: 2012) Robust Multilevel Solvers for High-Contrast Anisotropic Multiscale Problems. Bericht-Nr. 2012-17; Linz. [Willems, Jörg: AlleinautorIn];

Willems, J. (2012, online: 2012) Spectral Coarse Spaces in Robust Two-Level Methods. Bericht-Nr. 2012-20; Linz. [Willems, Jörg: AlleinautorIn]; lang

Zarzer, K. (2012) Sparsity enforcing regularization on the lp[l tief p]-scale with p < 1., Johannes Kepler Universität, Linz. [Zarzer, Clemens: AlleinautorIn];

Dissertationen (z.T. bereits oben gelistet)

Korporal, A. (2012) Symbolic Methods for Generalized Green's Operators and Boundary Problems., Johannes Kepler Universität, Linz. [Korporal, Anja: AlleinautorIn];

Naumova, V. (2012) Numerical Methods for Diabetes Technology., Johannes Kepler University, Johannes Kepler University, Linz. [Naumova, Valeriya: AlleinautorIn];

Zarzer, K. (2012) Sparsity enforcing regularization on the lp[l tief p]-scale with p < 1., Johannes Kepler Universität, Linz. [Zarzer, Clemens: AlleinautorIn];

18. Wissenschaftliche Vorträge und Präsentationen

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Eingeladene wissenschaftliche Vorträge	87
· davon auf internationalen Veranstaltungen	69
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Eingeladene wissenschaftliche Vorträge

Ahmadinezhad, Hamid (08.05.2012) Birational rigidity of 3-fold Mori fibre spaces. Vortrag bei: Group Seminar, Johannes Kepler University, Linz/AUSTRIA.; Typ: Sonstiger eingeladener Veranstaltungsbeitrag

Ahmadinezhad, Hamid (12.11.2012) Algebraic Geometry, Symbolic Computation and Connections to Other Fields. Vortrag bei: Radon Seminar, Johannes Kepler University, Linz/AUSTRIA.; Typ: Sonstiger eingeladener Veranstaltungsbeitrag

Ahmadinezhad, Hamid (29.11.2012) Singular quartic 3-folds and Sarkisov links. Vortrag bei: Conference in algebraic geometry - "Birpol3", Basel/SWITZERLAND .; Typ: Sonstiger eingeladener Veranstaltungsbeitrag (internationale Veranstaltung)

Ahmadinezhad, Hamid (30.10.2012) Birationally nonrigidity of Fano fibre spaces. Vortrag bei: Conference on: Groups of Automorphisms in Birational and Affine Geometry, Trento/ITALY .; Typ: Sonstiger eingeladener Veranstaltungsbeitrag (internationale Veranstaltung)

Aichinger, Michael (16.10.2012) Software Architecture in Financial Software. Vortrag bei: Wolfram Technology Conference, Urbana -Champaign/UNITED STATES.; Typ: Sonstiger eingeladener Veranstaltungsbeitrag (internationale Veranstaltung)

Elbau, Peter (03.05.2012) Photoacoustic Sectional Imaging. Vortrag bei: Second Annual Workshop on Inverse Problems (Larisa Beilina), Sunne/SWEDEN .; Typ: Sonstiger eingeladener Veranstaltungsbeitrag (internationale Veranstaltung)

Elbau, Peter (07.01.2012) Reconstruction Formulas for Photoacoustic Sectional Imaging. Vortrag bei: AMS-MAA Joint Mathematics Meetings 2012, Boston/UNITED STATES .; Typ: Sonstiger eingeladener Veranstaltungsbeitrag (internationale Veranstaltung)

Elbau, Peter (07.05.2012) Mathematical Models for Photoacoustic Sectional Imaging. Vortrag bei: Photoacoustic Imaging Meeting (Günther Paltauf), Seggauberg/AUSTRIA.; Typ: Sonstiger eingeladener Veranstaltungsbeitrag

Elbau, Peter (26.04.2012) Modelling Photoacoustic Sectional Imaging. Vortrag bei: ESI Workshop on Computational Inverse Problems (Peter Maass, Otmar Scherzer), Wien/AUSTRIA.; Typ: Sonstiger eingeladener Veranstaltungsbeitrag (internationale Veranstaltung)

Georgiev, Ivan (14.06.2012) Semi-coarsening Multilevel Preconditioning of Bilinear Nonconforming FEM Systems. Vortrag bei: Fourth Conference of the Euro-American Consortium for Promoting the Application of Mathematics in Technical and Natural Sciences (AMiTaNS'12)), Varna/BULGARIA .; Typ: Sonstiger eingeladener Veranstaltungsbeitrag (internationale Veranstaltung)

Georgiev, Ivan (14.09.2012) On the preconditioning of elliptic problems discretized by a class of discontinuous Galerkin methods. Vortrag bei: 6th European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS 2012), Vienna/ AUSTRIA .; Typ: Sonstiger eingeladener Veranstaltungsbeitrag (internationale Veranstaltung)

Georgiev, Ivan (25.06.2012) Hybrid V-Cycle Multilevel Preconditioning of Non-Conforming Bilinear FEM Systems. Vortrag bei: European Seminar on Computing, Pilsen/CZECH REPUBLIC .; Typ: Sonstiger eingeladener Veranstaltungsbeitrag (internationale Veranstaltung)

Haskovec, Jan (23.01.2012) Collective phenomena emerging from random processes. Vortrag bei: Workshop "Emergent behaviour in multi-particle systems with non-local interactions", Banff/CANADA.; Typ: Sonstiger eingeladener Veranstaltungsbeitrag (internationale Veranstaltung)

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Eingeladene wissenschaftliche Vorträge

Hirsch, Stefanie (08.05.2012) A Simplified Model for a Lamellipodium. Vortrag bei: Graz-Wien Bio-PDE Day/AUSTRIA.; Typ: Sonstiger eingeladener Veranstaltungsbeitrag

Jr., Sergiy Pereverzyev (22.05.2012) Multi-parameter regularization for construction of extrapolating estimators in statistical learning theory. Vortrag bei: International Conference "Inverse Problems: Modeling and Simulation", Antalya/TURKEY.; Typ: Sonstiger eingeladener Veranstaltungsbeitrag (internationale Veranstaltung)

Jr., Sergiy Pereverzyev (24.09.2012) Mathematics in Life Sciences. Vortrag bei: Research Seminar of Bioinformatics Group, Vienna/AUSTRIA.; Typ: Sonstiger eingeladener Veranstaltungsbeitrag (internationale Veranstaltung)

Kasumba, Henry (12.03.2012) Vortex control of instationary channel flows using translation invariant cost functionals. Vortrag bei: Workshop on Numerical Methods for Optimal Control and Inverse Problems (Technische Universität München Faculty of Mathematics), Garching by Munich/GERMANY .; Typ: Sonstiger eingeladener Veranstaltungsbeitrag (internationale Veranstaltung)

Kasumba, Henry (24.05.2012) Vortex control of instationary channel flows using translation invariant cost functionals. Vortrag bei: 41st National Congress of Numerical Analysis (CANUM 2012) (Blaise PASCAL University), Belambra Club "Le Chambourguet"/FRANCE .; Typ: Sonstiger eingeladener Veranstaltungsbeitrag (internationale Veranstaltung)

Kraus, Johannes (20.11.2012) Auxiliary space multigrid: Two-grid analysis and aspects of parallelization. Vortrag bei: Autumn School on Parallel Solution of Large Engineering Problems (Centre of Excellence IT4Innovations, VSB-Technical University of Ostrava and Institute of Geonics of AS CR), Ostrava/CZECH REPUBLIC .; Typ: Sonstiger eingeladener Veranstaltungsbeitrag (internationale Veranstaltung)

Kraus, Johannes (23.04.2012) Robust multilevel methods. Vortrag bei: Worshop on Supercomputing Applications, Bansko/BULGARIA .; Typ: Sonstiger eingeladener Veranstaltungsbeitrag (internationale Veranstaltung)

Kröner, Axel (15.11.2012) Numerical methods for optimal control of wave equations. Vortrag bei: Lothar-Collatz-Kolloquium für Angewandte Mathematik, Bundesstr. 55, 20146 Hamburg/GERMANY.; Typ: Sonstiger eingeladener Veranstaltungsbeitrag (internationale Veranstaltung)

Kügler, Philipp (01.10.2012) Elucidating spatio-temporal coherence of cellular processes by data-driven inverse analysis: redox rhythmicity in yeast and diffusion controlled hormone feedback cycles. Vortrag bei: 'Mathematics and...' Evaluation Day (Wiener Wissenschafts- und Technologiefonds WWTF), Wien/AUSTRIA.; Typ: Sonstiger eingeladener Veranstaltungsbeitrag

Kügler, Philipp (04.05.2012) Variance Fitting for Parameter Estimation in Biochemical Reaction Networks. Vortrag bei: 2nd Workshop on Inverse Problems, Sunne/SWEDEN.; Typ: Sonstiger eingeladener Veranstaltungsbeitrag (internationale Veranstaltung)

Kügler, Philipp (20.10.2012) Underdetermined Inverse Problems in Modelling and Simulation of Biochemical Reaction Networks. Vortrag bei: International Workshop on Inverse Problems: New Trends in Theory and Applications, Shanghai/CHINA.; Typ: Sonstiger eingeladener Veranstaltungsbeitrag (internationale Veranstaltung)

Nagaiah, Chamakuri (23.08.2012) Numerical solutions for boundary control of bidomain equations in cardiac electrophysiology. Vortrag bei: 21st International Symposium on Mathematical Programming (ISMP 2012), Berlin/GERMANY.; Typ: Sonstiger eingeladener Veranstaltungsbeitrag (internationale Veranstaltung)

Naumova, V. (06.12.2012) Numerical Methods for Diabetes Technology. Vortrag bei: Seminar at the Institute for Bioinformatics and Systems Biology Helmholtz Zentrum München (Institute for Bioinformatics and Systems Biology Helmholtz Zentrum München), München/GERMANY.; Typ: Sonstiger eingeladener Veranstaltungsbeitrag

Naumova, V. (14.03.2012) Extrapolation in variable RKHSs with application to the blood glucose reading. Vortrag bei: Workshop on Numerical Methods for Optimal Control and Inverse Problems (Technical University Munich, Germany), Garching/GERMANY .; Typ: Sonstiger eingeladener Veranstaltungsbeitrag (internationale Veranstaltung)

Naumova, V. (22.05.2012) Learning-based regularization. Vortrag bei: The Sixth International Conference Inverse Problems: Modeling and Simulation, Antalya/TURKEY .; Typ: Sonstiger eingeladener Veranstaltungsbeitrag (internationale Veranstaltung)

Naumova, V. (22.05.2012) Regularization methods in blood glucose prediction. Vortrag bei: The Sixth International Conference Inverse Problems: Modeling and Simulation, Antalya/TURKEY .; Typ: Sonstiger eingeladener Veranstaltungsbeitrag (internationale Veranstaltung)

Naumova, V. (27.02.2012) Prediction of Nocturnal Hypoglycemia from SMBG Measurements. Vortrag bei: DIAdvisor 5th General Assembly, Copenhagen/DENMARK.; Typ: Sonstiger eingeladener Veranstaltungsbeitrag (internationale Veranstaltung)

Naumova, Valeriya (23.10.2012) Regularization in Variable RKHSs with Application to the Blood Glucose Reading. Vortrag bei: Oberwolfach Workshop on Computational Inverse Problems, Oberwolfach/GERMANY.; Typ: Sonstiger eingeladener Veranstaltungsbeitrag (internationale Veranstaltung)

Naumova, Valeriya (24.09.2012) Learning in Variable RKHSs with application to the Blood Glucose Reading. Vortrag bei: Dagstuhl

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Eingeladene wissenschaftliche Vorträge

Seminar "Algorithms and Complexity for Continuous Problems", Dagstuhl/GERMANY .; Typ: Sonstiger eingeladener Veranstaltungsbeitrag (internationale Veranstaltung)

Niebsch, Jenny (22.05.2012) Mass and aerodynamic imbalances in wind energy converters. Vortrag bei: Conference Inverse Problems: Modelling & Simulation/TURKEY.; Typ: Sonstiger eingeladener Veranstaltungsbeitrag (internationale Veranstaltung)

Niederreiter, H. (03.07.2012) Randomness and complexity of sequences over finite fields. Vortrag bei: Analytic Combinatorics and Probabilistic Number Theory: Closing Conference of the FWF-Network, Vienna/AUSTRIA.; Typ: Sonstiger eingeladener Veranstaltungsbeitrag (internationale Veranstaltung)

Niederreiter, H. (12.06.2012) Open problems on nets and (t,s)-sequences. Vortrag bei: Workshop on Quasi-Monte Carlo and Pseudorandom Number Generation, Tokio/JAPAN.; Typ: Sonstiger eingeladener Veranstaltungsbeitrag (internationale Veranstaltung)

Niederreiter, H. (25.05.2012) Quasi-Monte Carlo methods: deterministic is often better than random. Vortrag bei: Colloquium University of Tokio, Tokio/JAPAN.; Typ: Sonstiger eingeladener Veranstaltungsbeitrag

Pereverzyev, Sergei V. (10.09.2012) A Meta-Learning Approach to the Regularized Learning - Case Study: Blood Glucose Prediction. Vortrag bei: Workshop on Mathematics for Life Sciences, Kyiv/UKRAINE.; Typ: Sonstiger eingeladener Veranstaltungsbeitrag (internationale Veranstaltung)

Pereverzyev, Sergei V. (23.10.2012) A Meta-Learning Approach to the Adaptive Regularization -- Case Study: Blood Glucose Prediction. Vortrag bei: Oberwolfach Workshop on Computational Inverse Problems, Oberwolfach/GERMANY.; Typ: Sonstiger eingeladener Veranstaltungsbeitrag (internationale Veranstaltung)

Pereverzyev, Sergei V. (25.06.2012) Learning in Variable RKHSs with Application to the Blood Glucose Reading. Vortrag bei: Workshop Learning Theory and Approximation, Oberwolfach/GERMANY.; Typ: Sonstiger eingeladener Veranstaltungsbeitrag (internationale Veranstaltung)

Pereverzyev, Sergei (16.11.2012) A Meta-Learning Approach to the Regularized Learning - Case Study: Blood Glucose Prediction. Vortrag bei: Research Seminar, Shanghai/CHINA.; Typ: Sonstiger eingeladener Veranstaltungsbeitrag

Ramlau, Ronny (19.06.2012) Iterative Reconstruction Methods for Adaptive Optics. Vortrag bei: SIAM 2012 Conference on Applied Linear Algebra, Valencia/SPAIN.; Typ: Sonstiger eingeladener Veranstaltungsbeitrag (internationale Veranstaltung)

Ramlau, Ronny (20.01.2012) Inverse Problems in Adaptive Optics. Vortrag bei: Vortrag an der Universität Graz (Universität Graz), Graz/AUSTRIA.; Typ: Sonstiger eingeladener Veranstaltungsbeitrag

Ramlau, Ronny (22.05.2012) Iterative regularization methods for adaptive optics. Vortrag bei: 6th International Conference "Inverse Problems: Modeling and Simulation, Antalya/TURKEY.; Typ: Sonstiger eingeladener Veranstaltungsbeitrag (internationale Veranstaltung)

Ramlau, Ronny (22.05.2012) Minisymposium: Inverse Problems in Science and Industry Organizers: Ronny Ramlau, Gerd Teschke. Vortrag bei: 6th International Conference "Inverse Problems: Modeling and Simulation" (Department of Mathematics and Computer Sciences, Izmir University, 35350 Uckuyular, Izmir, Turkey), Antalya/TURKEY.; Typ: Sonstiger eingeladener Veranstaltungsbeitrag (internationale Veranstaltung)

Ramlau, Ronny (25.09.2012) Inverse Problems in Adaptive Optics. Vortrag bei: Vortrag an der Universtität Siegen (Universität Siegen), Siegen/GERMANY.; Typ: Sonstiger eingeladener Veranstaltungsbeitrag (internationale Veranstaltung)

Sampath, S. (27.02.2012) Analysis of all predictors performance in DIAdvisor 1D, 1F and 2.1 Trials. Vortrag bei: DIAdvisor 5th General Assembly, Copenhagen/DENMARK.; Typ: Sonstiger eingeladener Veranstaltungsbeitrag (internationale Veranstaltung)

Scherzer, Otmar (20.05.2012) Joint Estimation of Wave Speed and Absorption Density Functions with Photoacoustic Measurement. Vortrag bei: SIAM Conference on Imaging Sciences 2012, Philadelphia/UNITED STATES .; Typ: Sonstiger eingeladener Veranstaltungsbeitrag (internationale Veranstaltung)

Scherzer, Otmar (22.05.2012) Displacement Regularization and Optical Flow. Vortrag bei: SIAM Conference on Imaging Sciences 2012, Philadelphia/UNITED STATES .; Typ: Sonstiger eingeladener Veranstaltungsbeitrag (internationale Veranstaltung)

Sergei V. Pereverzyev, Shuai Lu (22.11.2012) Legendre Polynomials as a recommended basis for numerical differentiation in the presence of square summable or stochastic white noise. Vortrag bei: Canberra Symposium on Regularization - Integrating the Chemnitz Symposium on Inverse Problems on Tour, Canberra/AUSTRALIA .; Typ: Sonstiger eingeladener Veranstaltungsbeitrag (internationale Veranstaltung)

Stefan Janecek, Michael Aichinger (26.06.2012) Electronic Structure Calculations in Strong Magnetic Fields. Vortrag bei: Future Prospects in Many Particle Theory, Linz/AUSTRIA.; Typ: Sonstiger eingeladener Veranstaltungsbeitrag (internationale Veranstaltung)

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Eingeladene wissenschaftliche Vorträge

Tomar, Satyendra (14.09.2012) Multigrid methods for isogeometric discretization. Vortrag bei: Minisymposium Robust multilevel and multiscale methods during ECCOMAS 2012, Vienna/AUSTRIA .; Typ: Sonstiger eingeladener Veranstaltungsbeitrag (internationale Veranstaltung)

Winterhof, A. (20.12.2012) Polynomial Fermat quotients. Vortrag bei: Mathematical Seminar Sabanci University, Istanbul/TURKEY.; Typ: Sonstiger eingeladener Veranstaltungsbeitrag (internationale Veranstaltung)

Winterhof, Arne (10.07.2012) Generalizations of complete mappings of finite fields and some applications. Vortrag bei: WMC 2012, Castro Urdiales/SPAIN.; Typ: Sonstiger eingeladener Veranstaltungsbeitrag (internationale Veranstaltung)

Winterhof, Arne (24.02.2012) Some applications of character sums. Vortrag bei: Seminar Institute of Computer Science Macquarie University, Sydney/AUSTRALIA.; Typ: Sonstiger eingeladener Veranstaltungsbeitrag (internationale Veranstaltung)

Yudytskiy, Mykhaylo (03.05.2012) Wavelet-based methods in atmospheric tomography and adaptive optics. Vortrag bei: Second Annual Workshop on Inverse Problems, Sunne/SWEDEN.; Typ: Sonstiger eingeladener Veranstaltungsbeitrag (internationale Veranstaltung)

Eingeladene wissenschaftliche Vorträge: Keynotes and Named Lectures

Kraus, Johannes (11.06.2012) Algebraic multilevel methods based on domain decomposition. Vortrag bei: Fourth Conference of the Euro-American Consortium for Promoting the Application of Mathematics in Technical and Natural Sciences, Varna/BULGARIA .; Typ: Keynote (internationale Veranstaltung)

Kügler, Philipp (16.02.2012) Predictive Modelling of Biochemical Reaction Networks. Vortrag bei: Workshop at the Interface of {Molecular Biology ⋃ Medicine} and {Computational ⋃ Applied Mathematics}, Wien/AUSTRIA.; Typ: Named Lecture (internationale Veranstaltung)

Kügler, Philipp (20.09.2012) Parameter identification problems in physiology and systems biology. Vortrag bei: JKS Symposium und Radon Colloquium (JKU und RICAM), Linz/AUSTRIA.; Typ: Named Lecture

Kügler, Philipp (26.04.2012) Inverse Probleme in der System Biologie. Vortrag bei: Seminar Angewandte Mathematik, Hohenheim/GERMANY.; Typ: Named Lecture (internationale Veranstaltung)

Kügler, Philipp (26.10.2012) On The Derivative Free Landweber Iteration and The Sparse Update Method. Vortrag bei: School of Mathematical Sciences Seminar Series/CHINA.; Typ: Named Lecture (internationale Veranstaltung)

Langer, Ulrich (02.07.2012) Domain Decomposition Solvers for some Fluid-Structure Interaction Problems. Vortrag bei: Workshop on Efficient Solvers in Biomedical Applications (ESBA 2012) (Universität Graz, TEchnische Universität Graz, Medizinische Universität Graz), Graz/AUSTRIA .; Typ: Keynote (internationale Veranstaltung)

Langer, Ulrich (27.03.2012) A Multiharmonic Finite Element Solve for Time-Periodic Parabolic Optimal Control Problems. Vortrag bei: Gamm 2012, 83rd Annual Scientific Conference in Darmstadt, Darmstadt/GERMANY .; Typ: Keynote (internationale Veranstaltung)

Langer, Ulrich (28.06.2012) FETI-Solvers for Non-standard FE Equations based on Boundary Integral Operators. Vortrag bei: 21st International Conference on Domain Decomposition Methods, Rennes/FRANCE .; Typ: Keynote (internationale Veranstaltung)

Langer, Ulrich (30.07.2012) A Non-Standard Finite Element Method based on Boundary Integral Operators. Vortrag bei: Computational Methods in Applied Mathematics CMAM-5, Berlin/GERMANY .; Typ: Keynote (internationale Veranstaltung)

Manhart, Angelika (26.06.2012) A Boltzmann-like Equation for Myxobacteria. Vortrag bei: Summerschool Weissensee/AUSTRIA.; Typ: Named Lecture

Mantzaflaris, Angelos (02.02.2012) Analysing isolated singularities via Macaulay's inverse systems. Vortrag bei: Linz-Wien Workshop in Sankt Michael/AUSTRIA.; Typ: Named Lecture

Mantzaflaris, Angelos (02.02.2012) Solving a PDE over a given geometry. Vortrag bei: EpΓA-GALAAD workshop, Dept of Informatics, UoA, Athens/GREECE.; Typ: Named Lecture

Mantzaflaris, Angelos (09.10.2012) Isolated Zeros of Polynomial Systems: Multiplicity Computation and Singular Root Deflation. Vortrag bei: 3rd SAGA Workshop, Trento, Italy, Trento/ITALY.; Typ: Named Lecture

Mantzaflaris, Angelos (17.07.2012) Assembly of matrices for isogeometric solving. Vortrag bei: National Research Network (NFN) "Geometry+Simulation" kick-off meeting, Stift Vorau, Austria, Stift Vorau/AUSTRIA.; Typ: Named Lecture

Mantzaflaris, Angelos (20.06.2012) Applied geometry and Isogeometric Analysis. Vortrag bei: CIME-EMS Summer School, IsoGeometric Analysis: a New Paradigm in the Numerical Approximation of PDEs. Cetraro, Italy, Cetraro/AUSTRIA.; Typ: Named Lecture

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Eingeladene wissenschaftliche Vorträge: Keynotes and Named Lectures

Mantzaflaris, Angelos (20.06.2012) Efficient assembly of matrices for isogeometric solving. Vortrag bei: Eighth International Conference on Mathematical Methods for Curves and Surfaces. Oslo, Norway, Oslo/NORWAY.; Typ: Named Lecture

Mantzaflaris, Angelos (22.05.2012) Assembling mass and stiffness matrices for isogeometric solving. Vortrag bei: Radon Seminar talk, RICAM-Linz, Austria, Linz/AUSTRIA.; Typ: Named Lecture

Niederreiter, H. (07.09.2012) Finite fields and quasirandom points. Vortrag bei: RICAM Workshop on Finite Fields and Applications, Strobl/AUSTRIA.; Typ: Keynote (internationale Veranstaltung)

Ölz, Dietmar (06.10.2012) A viscous two-phase model for contractile actomyosin bundles. Vortrag bei: Cell biology and physiology: PDE models/GREECE.; Typ: Named Lecture (internationale Veranstaltung)

Ölz, Dietmar (16.02.2012) On the asymptotic regime of a model for friction mediated by transient elastic linkages. Vortrag bei: MathMod 2012, Vienna/AUSTRIA.; Typ: Named Lecture (internationale Veranstaltung)

Ölz, Dietmar (22.06.2012) Modeling of asymmetric segregation of PIE-1 in C-elegans embryos. Vortrag bei: Seminar/FRANCE.; Typ: Named Lecture (internationale Veranstaltung)

Ölz, Dietmar (25.07.2012) A finite element method for the simulation of the lamellipodium of living cells. Vortrag bei: SMB Annual Meeting 2012/UNITED STATES.; Typ: Named Lecture (internationale Veranstaltung)

Scherzer, Otmar (09.07.2012) Variational Regularization Methods for Image Analysis and Inverse Problems. Vortrag bei: Fields institute Toronto Summer Thematic Program on the Mathematics of Medical Imaging, Toronto/CANADA .; Typ: Keynote (internationale Veranstaltung)

Scherzer, Otmar (12.03.2012) Convex Variational Regularization Methods for Inverse Problems. Vortrag bei: Frontiers in Nonparametric Statistics, Oberwolfach/GERMANY .; Typ: Keynote (internationale Veranstaltung)

Scherzer, Otmar (20.02.2012) Photoacoustic and Coupled Physics Imaging. Vortrag bei: Workshop Inverse Problems in PDEs/ GERMANY.; Typ: Keynote (internationale Veranstaltung)

Scherzer, Otmar (21.09.2012) Tube methods for BV regularization. Vortrag bei: Trends in Optimization and Control, Graz/AUSTRIA .; Typ: Keynote (internationale Veranstaltung)

Scherzer, Otmar (22.10.2012) Reconstruction Formulas for a Single Scattering Model in Photoacoustic Imaging and Applications to Sectional Imaging. Vortrag bei: Workshop on Computational Inverse Problems, Oberwolfach/GERMANY .; Typ: Keynote (internationale Veranstaltung)

Scherzer, Otmar (24.09.2012) Regularization of Ill-posed Linear Equations by the Non-stationary Augmented Lagrangian Method. Vortrag bei: Algorithms and Complexity for Continuous Problems, Schloß Dagstuhl/GERMANY .; Typ: Keynote (internationale Veranstaltung)

Scherzer, Otmar (26.07.2012) Hybrid Photoacoutic Imaging. Vortrag bei: Summer School: Image Reconstruction Mathematics & Applications, München/GERMANY .; Typ: Keynote (internationale Veranstaltung)

Scherzer, Univ. Prof. DI Dr. Otmar (06.01.2012) Nonconvex Regularization, Variational Methods in Banach Spaces for the Solution of Inverse Problems. Vortrag bei: Joint Mathematics Meeting, Boston, USA/UNITED STATES.; Typ: Keynote (internationale Veranstaltung)

Solombrino, Francesco (23.08.2012) Linearly constrained nonsmooth and nonconvex minimization. Vortrag bei: 21st International Symposium on Mathematical Programming, Berlin/GERMANY .; Typ: Named Lecture (internationale Veranstaltung)

Yang, Huidong (27.03.2012) A Class of solvers for the fluid-structure interaction priblems with a nearly incompressible elasticity model. Vortrag bei: 83rd Annual Meeting of the International Association of Applied Mathematics and Mechanics/GERMANY.; Typ: Named Lecture (internationale Veranstaltung)

Sonstige wissenschaftliche Vorträge

Cao, Dr. Hui (17.07.2012) IP: A fast algorithm for parameter identification problems based on multilevel augmentation method. Vortrag bei: Group Seminar IP: A fast algorithm for parameter identification problems based on multilevel augmentation method/ AUSTRIA.; Typ: Sonstiger Veranstaltungsbeitrag

Elbau, Peter (30.01.2012) Reconstruction Formulas for Photoacoustic Sectional Imaging. Vortrag bei: Workshop on Inverse Problems and Imaging (Otmar Scherzer, Sergei Pereverzyev), Linz/AUSTRIA.; Typ: Sonstiger Veranstaltungsbeitrag

Emans, Maximilian (12.06.2012) Efficient Setup of Aggregation AMG for CFD on GPU. Vortrag bei: PARA2012, Helsinki/FINLAND.; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Emans, Maximilian (12.09.2012) Aggregation Schemes for k-cycle AMG. Vortrag bei: ALGORITMY 2012/SLOVAKIA (Slovak

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Sonstige wissenschaftliche Vorträge

Republic).; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Emans, Maximilian (26.06.2012) GPU Implementation of K-cycle AMG for General Purpose Fluid Flow Solvers. Vortrag bei: ESCO 2012, Pilsen/CZECH REPUBLIC.; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Emans, Maximilian (27.06.2012) Steps Towards GPU Accelerated Aggregation AMG. Vortrag bei: ISPDC 2012, München/ GERMANY.; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Fürst, Johannes (03.12.2012) Inverse problems arising in financial model calibration. Vortrag bei: RICAM Group Seminar - Transfer Group, Linz/AUSTRIA.; Typ: Sonstiger Veranstaltungsbeitrag

Gahalaut, Krishan (13.08.2012) Algebraic Multilevel Iteration Methods for Isogeometric Discretization. Vortrag bei: EMG conference/GERMANY.; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Gahalaut, Krishan (16.03.2012) Multigrid Methods for Isogeometric Discretization. Vortrag bei: IGAA Conference/AUSTRIA.; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Gahalaut, Krishan (26.06.2012) Multigrid solvers for isogeometric Discretization. Vortrag bei: DD-21 Conference/FRANCE.; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Haslinger, Josef (01.06.2012) Projektstatus EXCITE. Vortrag bei: IMCC Status Meeting (RICAM und AVL Graz), Graz/AUSTRIA.; Typ: Sonstiger Veranstaltungsbeitrag

Haslinger, Josef (12.06.2012) Application oriented dynamic simulation of elastic multibody systems. Vortrag bei: RICAM Group Seminar - Transfer Group, Linz/AUSTRIA.; Typ: Sonstiger Veranstaltungsbeitrag

Haslinger, Josef (17.02.2012) Projektstatus EXCITE. Vortrag bei: IMCC Status Meeting (RICAM und AVL Graz), Graz/AUSTRIA.; Typ: Sonstiger Veranstaltungsbeitrag

Hegedues, Gabor (02.02.2012) Closed 5R linkages. Vortrag bei: Linz-Wien Workshop in Sankt Michael, Sankt Michael/AUSTRIA.; Typ: Sonstiger Veranstaltungsbeitrag

Hegedues, Gabor (03.04.2012) The root distribution of reflexive polytopes. Vortrag bei: RICAM Symbolic Computation Group Seminar/AUSTRIA.; Typ: Sonstiger Veranstaltungsbeitrag

Heinzle, Roman (01.06.2012) Projektstatus BOOST RT. Vortrag bei: Projekttreffen (RICAM und AVL Graz), Graz/AUSTRIA.; Typ: Sonstiger Veranstaltungsbeitrag

Heinzle, Roman (15.05.2012) Tailored Cylinder Models for System Level Engine Modelling. Vortrag bei: Group Seminar TG (RICAM), Linz/AUSTRIA.; Typ: Sonstiger Veranstaltungsbeitrag

Heinzle, Roman (17.02.2012) Projektstatus BOOST RT. Vortrag bei: Projekttreffen (RICAM und AVL Graz), Graz/AUSTRIA.; Typ: Sonstiger Veranstaltungsbeitrag

Heinzle, Roman (24.10.2012) Tailored Cylinder Models for System Level Engine Modelling. Vortrag bei: ECOSM 12 (IFP), Rueil-Malmaison/FRANCE.; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Hodorog, Madalina (24.01.2012) Homotopy Continuation Methods for Algebraic Curves. Vortrag bei: RICAM Group Seminar - Symbolic Computation: Homotopy Continuation Methods for Algebraic Curves, RICAM, Altenbergerstrasse 69, 4040 Linz/AUSTRIA.; Typ: Sonstiger Veranstaltungsbeitrag

Janecek, Stefan (09.10.2012) Status Report SinterSimulation. Vortrag bei: Project Meeting SinterSimulation VAI, Linz/AUSTRIA.; Typ: Sonstiger Veranstaltungsbeitrag

Janecek, Stefan (18.04.2012) Sinter Plant Simulation. Vortrag bei: K1 Meeting, Leoben/AUSTRIA.; Typ: Sonstiger Veranstaltungsbeitrag

Janecek, Stefan (20.06.2012) Status Report SinterSimulation. Vortrag bei: Project Meeting SinterSimulation VAI, Linz/AUSTRIA.; Typ: Sonstiger Veranstaltungsbeitrag

Janecek, Stefan (25.07.2012) Status Report SinterSimulation. Vortrag bei: Project Meeting SinterSimulation VAI, Linz/AUSTRIA.; Typ: Sonstiger Veranstaltungsbeitrag

Janecek, Stefan (29.08.2012) Status Report SinterSimulation. Vortrag bei: Project Meeting SinterSimulation VAI, Linz/AUSTRIA.; Typ: Sonstiger Veranstaltungsbeitrag

Jr., Sergiy Pereverzyev (11.12.2012) Conjugate Gradient for the dynamic atmospheric tomography problem: effects of the variable loop gain and spot elongation. Vortrag bei: ESO-Project Seminar, RICAM, Linz/AUSTRIA.; Typ: Sonstiger Veranstaltungsbeitrag

Jr., Sergiy Pereverzyev (19.07.2012) Conjugate Gradient Method for the Atmospheric Tomography Problem in the Multi Conjugate

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Sonstige wissenschaftliche Vorträge

Adaptive Optics. Vortrag bei: ESO-Project Progress Meeting, Linz/AUSTRIA.; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Jr., Sergiy Pereverzyev (29.10.2012) Two methods for one problem: Kaczmarz and Conjugate Gradient for the atmospheric tomography in Adaptive Optics. Vortrag bei: Radon-Seminar, RICAM, Linz/AUSTRIA.; Typ: Sonstiger Veranstaltungsbeitrag

Kalimeris, Konstantinos (12.06.2012) Photoacoustic Imaging in Attenuating Acoustic Media. Vortrag bei: Dissipative Photoacoustic Session, Vienna/AUSTRIA.; Typ: Sonstiger Veranstaltungsbeitrag

Kalimeris, Konstantinos (17.10.2012) Photoacoustic Imaging in Attenuating Acoustic Media on Causal Models. Vortrag bei: International Workshop Vienna 2012: Innovative techniques in Hybrid and Photoacoustic Imaging, Vienna/AUSTRIA.; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Kalimeris, Konstantinos (30.01.2012) Photoacoustic Imaging in Attenuating Acoustic Media. Vortrag bei: Workshop on Inverse Problems and Imaging (Otmar Scherzer, Sergei Pereverzyev), Linz/AUSTRIA.; Typ: Sonstiger Veranstaltungsbeitrag

Kleiss, Stefan (10.05.2012) IETI - Isogeometric Tearing and Interconnecting. Vortrag bei: Austrian Numerical Analysis Day 2012, Vienna/AUSTRIA .; Typ: Sonstiger Veranstaltungsbeitrag

Kleiss, Stefan (13.03.2012) IETI - Isogeometric Tearing and Interconnecting. Vortrag bei: Isogeometric Analysis and Applications, Linz/AUSTRIA .; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Kleiss, Stefan (14.02.2012) IETI - Isogeometric Tearing and Interconnecting. Vortrag bei: New Trends in Applied Geometry 2012, Gazzada Schianno/ITALY .; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Kleiss, Stefan (26.06.2012) IETI - Isogeometric Tearing and Interconnecting. Vortrag bei: 21st International Conference on Domain Decomposition Methods, Rennes/FRANCE .; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Korporal, Anja (24.07.2012) Symbolic computation for ordinary boundary problems in MAPLE (Software demonstration). Vortrag bei: ISSAC 2012, Grenoble/FRANCE.; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Korporal, Anja (27.06.2012) Composition and Factorization of Generalized Inverses and Boundary Problems. Vortrag bei: ACA 2012 Session on Algebraic and Algorithmic Aspects of Differential and Integral Operators Session (AADIOS'12), Sofia/BULGARIA .; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Kraus, Johannes (11.09.2012) Fictitious space multigrid method based on domain decomposition. Vortrag bei: European Congress on Computational Methods in Applied Sciences and Engineering 2012, Vienna/AUSTRIA .; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Kraus, Johannes (14.08.2012) Algebraic multilevel preconditioners for the graph Laplacian based on matching in graphs. Vortrag bei: European Multigrid Conference 2012 (Goethe Center for Scientific Computing (G-CSC)), Schwetzingen Castle/GERMANY .; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Kraus, Johannes (27.06.2012) Robust domain decomposition multigrid methods using additive Schur complement approximation. Vortrag bei: 21st International Conference on Domain Decomposition Methods (Inria), Rennes-Bretagne-Atlantique/FRANCE .; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Kröner, Axel (13.02.2012) Numerical methods for optimal control of the dynamical Lame system. Vortrag bei: Chemnitzer Seminar on Optimal Control/AUSTRIA.; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Kröner, Axel (13.03.2012) Semismooth Newton methods for optimal control of the dynamical Lame system with control constraints. Vortrag bei: Workshop on Numerical Methods for Optimal Control and Inverse Problems (OCIP)/GERMANY.; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Kröner, Axel (15.02.2012) Adaptive Finite Element Methods for Optimal Control of Elastic Waves. Vortrag bei: MATHMOD 2012 - 7th Vienna International Conference on Mathematical Modelling/AUSTRIA.; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Kügler, Philipp (10.07.2012) A sparse update method for the in-silico manipulation of biological signaling pathways. Vortrag bei: SIAM Annual Meeting 2012, Minneapolis/UNITED STATES.; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Kügler, Philipp (23.11.2012) Moment Based Parameter Inference in Biochemical Reaction Networks. Vortrag bei: Canberra Symposium on Inverse Problems, Canberra/AUSTRALIA.; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Kügler, Philipp (24.10.2012) Moment fitting for parameter inference in stochastic biochemical reaction networks. Vortrag bei: International Conference on Inverse Problems and Related Topics 2012, Nanjing/CHINA.; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Lorenz, Norbert (01.06.2012) Projektstatus EXCITE. Vortrag bei: Projekttreffen, Graz/AUSTRIA.; Typ: Sonstiger Veranstaltungsbeitrag

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Sonstige wissenschaftliche Vorträge

Lorenz, Norbert (03.07.2012) Piston Clearance simulation by using a Thermo-elasto Hydrodynamic contact model. Vortrag bei: Group Seminar: Transfer Group, Linz/AUSTRIA.; Typ: Sonstiger Veranstaltungsbeitrag

Lorenz, Norbert (09.10.2012) Status Report SinterSimulation. Vortrag bei: Project Meeting SinterSimulation VAI, Linz/AUSTRIA.; Typ: Sonstiger Veranstaltungsbeitrag

Lorenz, Norbert (17.02.2012) Projektstatus EXCITE. Vortrag bei: Projekttreffen, Graz/AUSTRIA.; Typ: Sonstiger Veranstaltungsbeitrag

Lorenz, Norbert (20.06.2012) Status Report SinterSimulation. Vortrag bei: Project Meeting SinterSimulation VAI, Linz/AUSTRIA.; Typ: Sonstiger Veranstaltungsbeitrag

Lorenz, Norbert (25.07.2012) Status Report SinterSimulation. Vortrag bei: Project Meeting SinterSimulation VAI, Linz/AUSTRIA.; Typ: Sonstiger Veranstaltungsbeitrag

Lorenz, Norbert (29.02.2012) Sinter Plant Simulation. Vortrag bei: Siemens-VAI und VALE S.A. Meeting. Topic: sintering, pelleting and blast furnace (SiemensVAI), Linz/AUSTRIA.; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Müller, Stefan (12.11.2012) Generalized mass action systems. Vortrag bei: Dagstuhl Seminar 12462 - Symbolic Methods for Chemical Reaction Networks, Dagstuhl/GERMANY .; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Müller, Stefan (20.06.2012) An integrated model of carbon fluxes in a photobioreactor. Vortrag bei: Group seminar - Computer algebra group, LIFL, Universite Lille 1, Lille/FRANCE.; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Naumova, Valeriya (24.04.2012) Numerical differentiation by means of Legendre polynomials. Vortrag bei: ESI Workshop on Computational Inverse Problems, Vienna/AUSTRIA.; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Naumova, Valeriya (30.01.2012) A Meta – Learning Approach to the Regularized Learning – Case Study: Blood Glucose Prediction. Vortrag bei: RICAM - Workshop on Inverse Problems and Imaging (Inverse Problems and Imaging Groups), Linz/AUSTRIA.; Typ: Sonstiger Veranstaltungsbeitrag

Niederreiter, Harald (20.02.2012) Improved discrepancy bounds for hybrid sequences. Vortrag bei: MCQMC, Sydney/AUSTRALIA.; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Pereverzyev, S. (24.08.2012) New Mathematical Tools developed in DIAdvisor for Diabetes Technology. Vortrag bei: Fourth DIAdvisor Annual Review, Copenhagen/DENMARK.; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Pereverzyev, Sergei (30.01.2012) Mathematical Tools developed in DIAdvisor for Diabetes Technology. Vortrag bei: RICAM - Workshop on Inverse Problems and Imaging (Inverse Problems and Imaging Groups), Linz/AUSTRIA.; Typ: Sonstiger Veranstaltungsbeitrag

Ramlau, Ronny (19.11.2012) Reconstruction methods for adaptive optics. Vortrag bei: Symposium on Regularisation (Australian National University), Canberra/AUSTRALIA.; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Regensburger, Georg (12.11.2012) Generalized mass action systems and multistationarity. Vortrag bei: Dagstuhl Seminar 12462 - Symbolic Methods for Chemical Reaction Networks, Dagstuhl/GERMANY .; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Sampath, Sivananthan (24.04.2012) Multi-parameter regularization in Learning Theory. Vortrag bei: ESI Workshop on Computational Inverse Problems/AUSTRIA .; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Sevilla, David (29.06.2012) First Steps Towards Radical Parametrization of Algebraic Surfaces. Vortrag bei: Eighth International Conference on Mathematical Methods for Curves and Surfaces/NORWAY .; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Sivananthan, S. (30.01.2012) Multi-parameter regularization in Learning theory. Vortrag bei: RICAM - Workshop on Inverse Problems and Imaging/AUSTRIA.; Typ: Sonstiger Veranstaltungsbeitrag

Stefan Janecek, Jenny Niebsch (18.10.2012) C++ algorithms for imbalance determination of wind turbines. Vortrag bei: Project Meeting Bachmann, Bochum/GERMANY.; Typ: Sonstiger Veranstaltungsbeitrag

Thanh, Nguyen Trung (01.03.2012) On some inverse scattering problems. Vortrag bei: Seminar of Department of Differential Equations, Hanoi Institute of Mathematics, Hanoi/VIET NAM.; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Thanh, Nguyen Trung (05.03.2012) Recursive optimization methods for inverse obstacle scattering problems. Vortrag bei: The 5th International Conference on High Performance Scientific Computing/VIET NAM .; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Willems, Joerg (10.09.2012) Spectral Coarse Spaces for Robust Two- and Multi-Level Methods. Vortrag bei: 6th European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS 2012), Vienna/AUSTRIA.; Typ: Sonstiger

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Sonstige wissenschaftliche Vorträge

Veranstaltungsbeitrag (internationale Veranstaltung)

Willems, Jörg (14.08.2012) Robust Algebraic Multilevel Iterations for Multiscale Problems. Vortrag bei: European Multigrid Conference 2012/GERMANY.; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Willems, Jörg (25.06.2012) Spectral Coarse Space Construction in Robust Multilevel Methods. Vortrag bei: 21st International Conference on Domain Decomposition Methods, Rennes/FRANCE.; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Winkler, Christoph (08.05.2012) Actin filament tracking. Vortrag bei: Graz-Wien Bio-PDE Day/AUSTRIA.; Typ: Sonstiger Veranstaltungsbeitrag

Winkler, Christoph (20.05.2012) Actin Filament Tracking by the Localized Radon Transform in Three-Dimensional Electron Microscope Tomograms of Lamellipodia. Vortrag bei: SIAM Conference on Imaging Science 2012, Philadelphia/UNITED STATES.; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Winkler, Christoph (23.07.2012) Actin filament tracking. Vortrag bei: The 17th European Conference on Mathematics for Industry 2012, Lund/SWEDEN.; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Winkler, Christoph (29.06.2012) Stochastic lamellipodium modelling A work in progress. Vortrag bei: Summer School Weissensee, Techendorf am Weissensee/AUSTRIA.; Typ: Sonstiger Veranstaltungsbeitrag

Winterhof, Arne (04.06.2012) Boolean functions derived from pseudorandom sequences. Vortrag bei: SETA 2012 (University of Waterloo), Waterloo/CANADA.; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Winterhof, Arne (21.02.2012) A survey on recursive nonlinear pseudorandom number generators. Vortrag bei: MCQMC, Sydney/AUSTRALIA.; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Winterhof, Arne (21.06.2012) On the non-existence of Butson-Hadamard matrices. Vortrag bei: Linz Algebra Research Day 2012 (RISC), Hagenberg/AUSTRIA.; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Yudytskiy, Mykhaylo (03.10.2012) Wavelet-based methods in atmospheric tomography and adaptive optics. Vortrag bei: Research visit to INAF - Astronomical Observatory of Padova, Padua/ITALY.; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Yudytskiy, Mykhaylo (05.11.2012) Fast wavelet-based methods in atmospheric tomography. Vortrag bei: Inverse Problems Seminar, University of Helsinki, Helsinki/FINLAND.; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Yudytskiy, Mykhaylo (05.12.2012) Fast wavefront reconstruction with wavelet regularization for MCAO. Vortrag bei: Real Time Control for Adaptive Optics Workshop, Garching/GERMANY.; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Yudytskiy, Mykhaylo (17.12.2012) Fast wavelet-based methods in atmospheric tomography. Vortrag bei: Inverse Days 2012, Jyväskylä/FINLAND.; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Yudytskiy, Mykhaylo (24.05.2012) Wavelet-based methods in atmospheric tomography and adaptive optics. Vortrag bei: Inverse Problems: Modeling and Simulation, Antalya/TURKEY.; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Wissenschaftliche Posterpräsentationen

, Manhart (05.09.2012) A Kinetic Transport Model for Actin-Myosin Interaction. Posterpräsentation bei: Applied Partial Differential Equations in Physics, Biology and Social Sciences: Classical and Modern Perspectives/SPAIN.; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

, Manhart (07.06.2012) A Kinetic Transport Model for Actin-Myosin Interactions. Posterpräsentation bei: M&MKT 2012/ITALY.; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Hirsch, Stefanie (07.06.2012) A Simplified Model for a Lamellipodium. Posterpräsentation bei: M&MKT 2012/ITALY.; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Janecek, Stefan (14.02.2012) Two-dimensional Bloch electrons in perpendicular magnetic fields: The Hofstadter butterfly revisited. Posterpräsentation bei: 17th International Winterschool on New Developments in Solid State Physics (Gesellschaft für Halbleiterphysik und Technologie), Mauterndorf/AUSTRIA .; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Kröner, Axel (25.07.2012) Optimal feedback control of the wave equation by solving the HJB equation. Posterpräsentation bei: Summer school and workshop on Adaptivity and Model Order Reduction in PDE Constrained Optimization/GERMANY.; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Kügler, Philipp (15.04.2012) A sparse update method for the in-silico manipulation of biological signaling pathways. Posterpräsentation bei: ISB Annual Symposium 2012, Seattle/UNITED STATES.; Typ: Sonstiger Veranstaltungsbeitrag

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Wissenschaftliche Posterpräsentationen

(internationale Veranstaltung)

Kügler, Philipp (15.08.2012) Variance Fitting for Parameter Estimation in Markov Models of Voltage Gated Ion Channels. Posterpräsentation bei: International Conference on Systems Biology, Toronto/CANADA.; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Mantzaflaris, Angelos (02.02.2012) Yet another algorithm for generalized Voronoi diagrams. Posterpräsentation bei: 27th Symposium on Applied Computing (SAC'12)/ITALY.; Typ: Named Lecture

Mantzaflaris, Angelos (09.10.2012) Voronoi Diagrams of Algebraic Distance Fields. Posterpräsentation bei: 17th Symposium on Solid and Physical Modeling (SPM'12), Dijon/FRANCE.; Typ: Named Lecture

Nadir, Bayramov (20.06.2012) Subspace correction methods for applications in natural sciences. Posterpräsentation bei: Hearing DK W1246-B20 Nano-Analytics of Cellular Systems, Wien/AUSTRIA.; Typ: Sonstiger Veranstaltungsbeitrag

Nagaiah, Chamakuri (19.06.2012) Boundary control of bidomain equations. Posterpräsentation bei: PDESoft international conference, Münster/GERMANY .; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Naumova, V. (09.02.2012) Prediction of Nocturnal Hypoglycemia from SMBG Measurements. Posterpräsentation bei: 5th International Conference on Advanced Technologies & Treatments for Diabetes (ATTD 2012), Barcelona/SPAIN .; Typ: Sonstiger eingeladener Veranstaltungsbeitrag (internationale Veranstaltung)

Naumova, V. (16.02.2012) Extrapolation in variable RKHSs with application to blood glucose reading and nocturnal hypoglycemia prediction. Posterpräsentation bei: iBiolMath Workshop at the Interface of {Molecular Biology ⋃ Medicine} and {Computational ⋃ Applied Mathematics} (CeMM & RICAM), CeMM, Vienna/AUSTRIA .; Typ: Sonstiger eingeladener Veranstaltungsbeitrag

Ölz, Dietmar (04.09.2012) On the asymptotic regime of a model for friction mediated by transient elastic linkages. Posterpräsentation bei: ESF Mathematics Conference in Partnership with EMS and ERCOM Applied Partial Differential Equations in Physics, Biology and Social Sciences: Classical and Modern Perspectives/SPAIN.; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

Sivananthan, S. (16.02.2012) Some of the DIAdvisor Methods and Results with Perspective to Prediction of Blood Glucose for Diabetes Patients in India. Posterpräsentation bei: iBiolMath Workshop at the Interface of {Molecular Biology ⋃ Medicine} and {Computational ⋃ Applied Mathematics} (CeMM & RICAM), CeMM, Vienna/AUSTRIA .; Typ: Sonstiger eingeladener Veranstaltungsbeitrag

Yudytskiy, Mykhaylo (01.03.2012) Wavelet-based methods in atmospheric tomography and Adaptive Optics. Posterpräsentation bei: Mathematics for Innovation: Large and Complex Systems, Tokyo/JAPAN.; Typ: Sonstiger Veranstaltungsbeitrag (internationale Veranstaltung)

2.7. Scientific Events 2012

2.7.1. Workshop on Inverse Problems and Imaging

Organisers: W. Drexler and O. Scherzer

This workshop was organised within the NFN Photoacoustic Imaging in Biology and Medicine.

2.7.2. Workshop at the Interface of Molecular Biology & Medicine and Computational & Applied Mathematics, 6 Februar 2012, CeMM Lecture Hall, 8th floor, Lazarettgasse 14, 1090 Vienna.

Organisers: P. Kügler, joint with Jacques Colinge, CeMM

At the initiative of the Austrian Academy of Sciences CeMM and RICAM hosted this one day workshop attended by approximately 120 scientists. The goal was to stimulate

interdisciplinary research activities among Viennese scientists working in the areas of mathematics linked to biology or medicine. Thirteen presentations, an inspiring keynote Lecture by Peter Schuster, as well as a poster session built the basis for lively discussions and networking among a large number of participants.

2.7.3. Workshop on "Finite Fields and Their Applications: Character Sums and Polynomials", September 2nd - September 7th, 2012, St. Wolfgang / Strobl

Organisers: P. Charpin, H. Niederreiter, G. Mullen, D. Panario, A. Pott, A. Winterhof

The topic of the conference was the theory of *finite fields*. Finite fields play important roles in many application areas such as coding theory, cryptography, design theory, quasi-Monte Carlo methods, pseudorandom number generation, computational algebra, and wireless communication, to name just a few. In our workshop, we focused (but did not restrict ourselves) on sequences, character sums and polynomials over finite fields in view of the above mentioned application areas.

We had 30 contributed 30 min talks, 10 invited 1h talks, and altogether 59 participants. The proceedings will appear in the Radon Series on Computational and Applied Mathematics of de Gruyter very soon.

Further information: http://www.ricam.oeaw.ac.at/events/workshops/ffta2012/

2.7.4. Other Scientific Events

The complete AkademIs report is attached as DVD, other scientific events are shown in chapter **2.9 Seminars**.

2.8. Scientific cooperation 2012

Here we only mention the most important scientific cooperation leading to joint publications or research projects with other RICAM / JKU / DK groups and with other groups or scientists in Austria and worldwide:

2.8.1. Group "Computational Methods for Direct Field Problems"

Internal (RICAM / JKU / DK) cooperation:

- **J. Kraus** cooperates with M. Wolfmayr (DK) on robust multilevel preconditioners for heterogeneous reaction-diffusion problems.
- **J. Kraus** cooperated with **K. Gahalaut** and **S. Tomar** on multigrid methods for isogeometric discretization.
- **B. Jüttler, S. Kleiss and S. Tomar** cooperated with C. Pechstein on isogeometric tearing and interconnecting method.
- **A. Mantzaflaris** cooperated with Veronika Pillwein from the RISC institute and Christoph Koutschan from the Symbolic Computation group on recursive formulas for B-spline integrals.
- **NFN S117** (see below)

External cooperation:

- There is a special Collaborative Research Project on "Robust Large-Scale Scientific Computing Methods and Scalable Algorithms" (2009 - 2012) of RICAM with the Institute of Information and Communication Technologies (IICT) of the Bulgarian Academy of Sciences (BAS) at Sofia (Bulgaria). This cooperation has resulted in numerous joint publications robust algebraic multilevel methods. The collaboration will be prolongated for further 4 years.
- U. Langer, A. Mantzaflaris and S. Tomar are participating in the National Research Network NFN S 117 on "Geometry and Simulation" (March 1 2012 – February 28 2016). In this NFN we directly cooperate with B. Jüttler (JKU Linz and RICAM), M. Rumpf (University of Bonn) O. Scherzer (University of Vienna and RICAM), and W. Zulehner (JKU Linz) who are project partners in the NFN. Beside the intensive

cooperation within the NFN, the NFN will establish an international netwotk of cooperation partners.

- J. Willems cooperates with R. Lazarov (Texas A&M University) on the development of efficient and robust methods for heterogeneous, highly porous flow problems. This work is supported by the mutual NSF project DMS-1016525 "Subgrid Discontinuous Galerkin Approximations of Brinkman Equation with Highly Heterogeneous Coefficients".
- SFB “MAXWELL++": J. Kraus and U. Langer prepared one project part of the full proposal that has been submitted to the FWF and presented at the hearing at the *Haus der Forschung* in Vienna. Though the entire SFB has not been funded, the project part by Kraus/Langer had an excellent evaluation by the referees. A resubmission is planed.
- BioDK “Nano-Analytics of Cellular Systems”: J. Kraus prepared one project part of the full proposal that has been submitted to the FWF and presented at the hearing. Though the entire DK has not been funded the project part by Kraus had an excellent evaluation by the referees. A short-track resubmission is planned for 2013.
- J. Kraus cooperates with L. Zikatanov (Penn State University) on the analysis of algebraic multilevel methods and on subspace correction methods for elasticity problems.
- J. Kraus cooperates with L. Zikatanov (Penn State University) and P. Vassilevski (Lawrence Livermore National Laboratory) on two-level methods with polynomial smoothers and on extending the framework of algebraic multilevel iteration (AMLI) methods to indefinite problems.
- H. Yang cooperates with W. Fitch (University of Vienna) and C. Elemans (University of Southern Denmark) on “Computational Fluid-Structure Interaction with Applications to Vocal Production“ and submitted a proposal to the FWF. Unfortunately, the FWF decided not to fund the project and proposed a revision. We will prepare a revised version including Prof. Ramlau for inverse problems as further co-operation partner from RICAM.

- A. Mantzaflaris is in close connection with the group of B. Mourrain (INRIA Sophia - Antipolis, France) on the level of software development. In particular, we work on visualization of Isogeometric simulations and on the creation of a user interface that uses the Axel modeler being developed at INRIA and the IGA simulation library developed by our group.

2.8.2. Group "Inverse Problems"

Internal cooperation:

- A joint work has been started together with Prof. Dr. Massimo Fornasier.
- Cooperation with R. Ramlau, on optimal regularization methods.
- Cooperation with R. Ramlau, on the Kaczmarz method and data preprocessing.

External Cooperation:

- Prof. Dr. Sergei V. Pereverzyev continued active and fruitful cooperation with Dr. Shuai Lu (School of Mathematical Science, Fudan University, Shanghai, China) that resulted in joint research visits and work on the monograph. Joint research project has been started with Prof. Dr. Hrushikesh Mhaskar (California State University, USA).
- A. Boumenir (West Georgia, USA) on waveguides.
- G. Hu (WIAS, Germany) on exact models for scattering by point-like obstacles.
- A. Kirsch (KIT, Germany) and D. Gintides (AUT, Greece) on scattering by elastic waves.
- N. Thanh (North Carolina) on the multifrequency scattering.

2.8.3. Group "Symbolic Computation"

Internal cooperation:

- With S. Müller, we analyze positive equilibria for generalized mass action systems.

- With A. Mantzaflaris (Group "Computational Methods for Direct Field Problems") and Veronika Pillwein from the RISC institute, we gave recursive formulas for B-spline integrals.

External cooperation:

- With H. Hauser, we worked on a joint FWF project on the resolution of singularities. We wrote two joint papers in that topic and organized a Clay Summer School.
- With H.-P. Schröcker, we developed the factorization method for constructing linkages and Bond theory for the analysis of linkages.
- With J. Gonzalez and I. Polo-Blanco (University of Cantabria) and M. Harrison (Univ. Sydney), we developed algorithms for Del Pezzo surfaces of degree 5.
- With H. Albrecher (University of Lausanne), C. Constantinescu (University of Liverpool), Z. Palmowski (University of Wroclaw), and M. Rosenkranz (University of Kent), we give closed form and asymptotic results for insurance-risk models with surplus-dependent premiums. Markus Rosenkranz also was a co-advisor of A. Korporal.
- With Alban Quadrat (INRIA Saclay), we classified certain types of solutions and annihilators of ordinary integro-differential systems.
- With Li Guo (Rutgers University) and Markus Rosenkranz, we studied algebraic properties of integro-differential algebras.
- With G. Ivanyos and L. Ronyai (University of Budapest), we developed an algorithm for splitting matrix algebras.

2.8.4. Group "Analysis of Partial Differential Equations"

Internal cooperation:

- Massimo Fornasier (START-Project) and Francesco Solombrino continued their very close collaboration.

External cooperation:

- Francesco Solombrino has continued his very close connection with SISSA/Trieste (http://www.sissa.it/) in Italy with regular visits.

2.8.5. Group “Optimization and Optimal Control”

Internal cooperation:

- S. Beuchler (Group: Computational Methods for Direct Field Problems) on boundary concentrated finite elements.

External cooperation:

- P. Aguiar (University of Porto) on boundary controllability.
- C. Engwer (University of Münster) on numerical fronttracking.
- M. Falcke (Max Delbrück Center for Molecular Medicine) on electro-physiological modelling.
- K. Ito (North Carolina State University) on sparse controls.
- A. Laurain (Technical University of Berlin) on Bilevel-shape optimization.
- M. Weiser (Zuse Insitute Berlin) on storage reduction in optimal control.
- H. Zidani (ENSTA ParisTech) on Hamilton Jacobi Bellman equations.

2.8.6. Group “Mathematical Imaging”

Internal cooperation:

- With U. Langer, B. Jüttler, W. Zulehner within the NFN Geometry and Simulation.

External cooperation:

- M. de Hoop and L. Liu (Purdue University) on iterative regularization of nonlinear ill-posed problems.
- T. Filder, M. Grasmair (University of Vienna) on geometrical problems in imaging.
- T. Widlak (University of Vienna) on hybrid imaging.
- D. Meyer and R. Schulze (University of Innsbruck) on photoacoustic imaging.
- M. Rumpf (University of Bonn) on shell problems.

2.8.7. Group “Mathematical Methods in Molecular and Systems Biology”

Internal cooperation:

- S. Müller cooperates with G. Regensburger (RICAM group "Symbolic Computation") on chemical reaction network theory; co-applicants in EU proposal "An Open Platform for Symbolic Analysis of Biochemical Reaction Networks", Fet-Open Xtrack, FP7-ICT-2013.
- C. Zarzer cooperates with R. Ramlau on sparsity enforcing regularization methods for nonlinear inverse problems.

External cooperation:

- S. Hirsch, A. Manhart, C. Schmeiser, and C. Winkler cooperate with the group of Vic Small (IMBA, ÖAW) in the framework of a WWTF funded project, led by Schmeiser.
- P. Kügler collaborates with Gottfried Köhler (Department of Structural and Computational Biology, Max F. Perutz Laboratories) on modelling of glucocorticoid mediated feedback mechanisms in the hypothalamus-pituitary-adrenal axis.
- A. Manhart, D. Ölz, and Ch. Schmeiser cooperate with N. Sfakianakis (University of Mainz) on modeling of depolymerization of actin filaments and on Finite Element methods for lamellipodium simulations.
- P. Kügler collaborates with Steffen Hering (Department of Pharmacology and Toxicology, University of Vienna) on modeling of voltage gated ion channels.
- S. Müller cooperates with Leonie Ringrose (IMBA, ÖAW) on epigenetic switches
- S. Müller cooperates with Jan Cerveny (CzechGlobe, Czech Academy of Sciences) on carbon fluxes in a photobioreactor.
- P. Kügler and W. Yang collaborate with Wolfram Weckwerth (Molecular Systems Biology, University of Vienna) on the identification of perturbation sites in metabolomic reaction networks.
- S. Müller cooperates with Ralph Steuer (Institute for Theoretical Biology, Humboldt University, Berlin) on evolutionary optimization of metabolic pathways.
- D. Ölz cooperates with Vuk Milisic (University of Paris XIII) on the mathematics of stick/slip behavior of protein bonds.

- D. Ölz cooperates with Carrie Cowan (IMP, Vienna) on asymmetric distribution of PIE-1.
- D. Ölz cooperates with Jan Haskovec (KAUST, Jeddah) on mathematics of diffusion models with non-continuous diffusivity.
- D. Ölz cooperates with Klemens Fellner (University of Graz) on asymtotic regimes of the PIE-1 modelling.
- D. Ölz and C. Schmeiser cooperate with Jeroen Dobbelaere (IMP, Vienna) on Modeling and data analysis of PCM (Pericentriolar Material)-micrographs.
- D. Ölz and C. Schmeiser cooperate with Bojan Zagrovic (Max F. Perutz Laboratories, University of Vienna) on Modeling of hydrophobic phase separation.

2.8.8. Transfer Group

Internal cooperation:

- S. Pereverzyev, on optimal regularization methods.
- O. Scherzer, on the Kaczmarz method and data preprocessing.
- U. Langer and C. Pechstein, on numerical methods for solving pde's on atmospheric layers.
- C. Zarzer, on sparsity enforcing regularization methods for nonlinear inverse problems.
- within the transfer group: cooperation between M. Emans, C. Kletzmayr and M. Aichinger on numerical methods on the GPU.
- within the transfer group: cooperation between J. Niebsch and S. Janecek, on the development of a software tool for a balancing box for WEC.

External cooperation:

- AVL List GmbH, Graz, modeling and simulation of automotive components.
- Siemens VAI, on simulation of chemical processes in iron production.
- Christian Doppler Laboratory for Model Based Calibration Methodologies, on surrogate models and calibration methods for automotive components.

- Virtual Vehicle Competence Center, on air condition modelling for automotive industry.
- uni software plus GmbH, Linz, on computational finance.
- MathConsult, Linz: G. Auzinger, A. Obereder, M. Rosensteiner, on Adaptive Optics.
- Industrial Mathematics Institute, Kepler University Linz: I. Shatokhina, A. Neubauer, S. Kindermann, S. Pereverzyev Jun., M. Zhariy, E. Klann, cooperations in Adaptive Optics and medical imaging.
- European Southern Observatory: R. Clare, E. Fedrigo, M. Le Louarn, M. Kasper, on Adaptive Optics.
- C. Béchet, Université Claude Bernard Lyon 1, on Adaptive Optics.
- C. Vogel, The Optical Science Company, on Adaptive Optics.
- N. Bharmal, A. Basden, Durham University, on Adaptive Optics.
- T. Helin, University of Helsinki, on Adaptive Optics.
- N. Bharmal, A. Basden, Durham University, on Adaptive Optics.
- D. Gratadour, Universite Paris Diderot, on Adaptive Optics.
- F. Rigaut, Australian National University Canberra, on Adaptive Optics.
- Microgate, Bozen, on Adaptive Optics.
- T. Quinto, Tufts University, medical imaging and tomography.
- L. Reichel, Kent State University, on multilevel wavelet methods.
- B. Hofmann and S. Anzengruber, TU Chemnitz, on regularization theory in Banach spaces.
- G. Teschke, Hochschule Neubrandenburg, on sparse regularization.
- W. Ring, University of Graz, on shape optimization and medical imaging.
- P. Maaß and Christina Brandt, University of Bremen, balancing of ultra precision cutting machines.
- A. Krause, Laboratory for Precision Machining, University of Bremen, Germany, balancing of ultra precision cutting machines.

- H. Fritsch, J. Buchwald, Bachmann Monitoring GmbH Rudolstadt/Feldkirch, Germany/Austria, on mathematical methods for monitoring of wind power plants.
- M. Melsheimer from BerlinWind GmbH Berlin, Germany, on mathematical methods for monitoring of wind power plants.
- H. Holl, ACCM Linz, on signal processing.
- E. R. Hernandez, Instituto de Ciencia de Materiales de Madrid (ICMM-CSIC), Madrid, electronic structure calculations.

2.8.9. Research Project "Applied Discrete Mathematics and Cryptography"

Internal cooperation (JKU):

- A. Winterhof cooperates with G. Pirsic (Institute of Financial Mathematics) on Boolean functions for cryptography.
- H. Niederreiter cooperates with R. Hofer (Institute of Financial Mathematics) on low-discrepancy sequences.

External cooperation:

- A. Winterhof cooperated with Macquarie University Sydney (A. Ostafe, I. Shparlinski), Carleton University Ottawa (J. He, D. Panario, D. Thomson, Q. Wang), Putian University (Z. Chen), Sabanci University Istanbul (W. Meidl), University of Cantabria (D. Gomez) on cryptographic functions and sequences as well as on character sums. Moreover, he has a joint paper with M. Rötteler (NEC Labs America) on quantum computing and finite fields. The book on finite fields will be co-edited by P. Charpin (INRIA, Paris) and A. Pott (University of Magdeburg).
- H. Niederreiter cooperated with University of Applied Sciences Bremerhaven (M. Vielhaber), Tsing Hua University Beijing (L. Wang), Armenian Academy of Sciences (A. Shahverdian).

2.8.10. START-Project Y432 „ Sparse Approximation and Optimization in High Dimensions “

Internal Cooperations:

- The members of the START-Project (Massimo Fornasier, Jan Haskovec, Andreas Langer, Karin Schnass, Jan Vybiral) have actively worked on several joint papers.

External Cooperations:

- On several joint papers the START-Project members collaborated in 2012 with the following international scientists (in the order of appearance in our publications):

  G. Steidl (Technische Universität Keiserslautern), Y. Kim (University of California Irvine), C.-B. Schönlieb (University of Cambridge), R. Erban (University of Oxford), H. Kempka (University of Jena), W. Sickel (University of Jena), L. Skrzypczak (Adama Mickiewicz University), C. Schneider (University Erlangen-Nuremberg).

2.9. Seminars

As in the previous years, the seminar series has been structured into three groups:

Radon Colloquia:
In these talks, prominent external scientists should present overviews over important fields dedicated also to non-specialists. All RICAM employees are expected to attend the colloquia.

Radon Seminars:
These are a bit more specialized talks, both by our own scientists and by external visitors. They should not strictly focus on a specialized topic but have connections to work of at least two groups at RICAM and should therefore be attended by all RICAM scientists. One purpose is to initiate internal cooperation; all new PostDocs should give talks in this series.

Group Seminar:
These are specialized talks by internal and external scientists intended mostly for members of the organizing group(s), although, of course, members of other groups are also welcome.

In 2012, the following talks were given in these three categories mentioned:

RADON COLLOQUIA
Prof. Ludmil Zikatanov Pennsylvania State University, USA June 12, 2012, 15:30 Johannes Kepler University, SP2 416
Title: Efficient iterative solvers, coarse spaces and optimal preconditioning
Abstract: In this talk, we present recent progress in both the theoretical analysis as well as the design of robust solvers for linear systems arising in the discretizations of Partial Differential Equations (PDEs). Our approach falls into the class of auxiliary space multilevel preconditioners, in which the multilevel hierarchy is generated on an auxiliary space where it is easier to obtain such hierarchy. The coarse degrees of freedom are selected using an aggregation approach in combination with Algebraic Multilevel Iteration (AMLI) methods. This leads to optimal methods for wide class of problems (including non-symmetric and indefinite). We present numerical experiments for applications in oil reservoir modeling and the results demonstrate the efficacy of the Fast Auxiliary Space Preconditioning (FASP) approach. In addition, we show that this classes of methods perform robustly in handling more complicated situations, for example discretizations of coupled systems of partial differential equations describing complex flows in porous media.
Prof. Gabriel Wittum Goethe University Frankfurt, Germany July 06, 2012, 13:45 Johannes Kepler University, Lecture Hall 9
Title: Modelling and Simulation of Biological Systems
Abstract: Biological systems are distinguished by their enormous complexity and variability. That is why mathematical modelling and computational simulation of those systems is very difficult, in particular thinking of detailed models which are based on first principles. The difficulties start with geometric modelling which needs to extract basic structures from highly complex and variable phenotypes, on the other hand also has to take the statistic variability into account. Moreover, the models of the processes running on these geometries are not yet well established, since these are equally complex and often couple many scales in space and time. Thus, simulating such systems always means to put the whole frame to test, from modelling to the numerical methods and software tools used for simulation. These need to be advanced in connection with validating simulation results by comparing them to experiments. To treat problems of this complexity, novel mathematical models, methods and software tools are necessary. In recent years, such models, numerical methods and tools have been

developed, allowing attacking these problems. In the talk we consider two examples as paradigms for the process of modelling and simulation in biosciences. The first example is the diffusion of xenobiotics through human skin; the second one is the automatic reconstruction of neurons and nueclei by means of numerical methods for partial differential equations.

Prof. Daniel Szyld

Temple University Philadelphia, USA

September 6, 2012, 15:00

Johannes Kepler University, SP2 416

Title: Multi-preconditioned GMRES

Abstract: Standard Krylov subspace methods for the solution of nonsymmetric linear systems only allow the user to choose a single preconditioner, although in many situations there may be a number of possibilities. Here we describe multi-preconditioned GMRES, which allows the use of more than one preconditioner. These multiple preconditioners can be combined in an optimal manner. We give some theoretical results; propose a practical algorithm, and present numerical results from problems in domain decomposition and PDE-constrained optimization. These numerical experiments illustrate the applicability and potential of the multi-preconditioned approach. (joint work with Chen Greif and Tyrone Rees).

Philipp Kügler

RICAM

September 20, 2012, 15:30

Johannes Kepler University, SP2 416

Title: Parameter identification problems in physiology and systems biology

Abstract: Along with the advances in experimental techniques comes a transformation of life science into a highly quantitative discipline. While statistics and bioinformatics are widely used for data analysis, applied mathematics is more and more acknowledged as an equal contributor in the quest to understand the functional interactions of cellular components, organs and systems. Visions of this interdisciplinary approach include personalized medicine, computer designed drugs or large scale biofuel usage. With life being a dynamic process, modelling and simulation of biological systems often involves time-dependent differential equations and brings along a diversity of parameter identification problems. After a general introduction with links to papers collected in my habilitation thesis, I focus on two problem types related to biochemical reaction networks. One deals with moment-based inference of reaction rate parameters from repeated observations of molecule copy numbers, the other is about the manipulation of qualitative network behaviour for the return from diseased to healthy states.

Prof. Todd Quinto

Tufts University Medford, USA

October 10, 2012, 15:00

Johannes Kepler University, SP2 416

Title: Microlocal Analysis and algorithms in three-dimensional Tomography

Abstract: In this talk, we will introduce fully three dimensional problems in electron microscopy in which the data are acquired in novel ways that are just beginning to be used in practice. After setting up the mathematical framework and getting a feel for the mathematics, we will introduce microlocal analysis. This will allow us to explain which singularities of the object are visible from the given data as well as what singularities can be added by reconstruction algorithms. After understanding where these added singularities come from, we will use microlocal analysis to decrease their effect. Reconstructions will be given that illustrate this.

Wolfgang L. Wendland

University of Stuttgart, Germany

November 16, 2012, 13:45

Johannes Kepler University, SP2 416

Title: Elliptic potentials and boundary value problems

Abstract: Beginning with the classical boundary potentials and boundary integral equations for the Dirichlet and Neumann problems with the Poisson equation, we give a brief overview of the history of these methods in relation to different assumptions for the domain's boundary and function spaces involved. Then the introduction of energy spaces and coerciveness properties lead to strongly elliptic problems with coercive and strongly elliptic boundary integral equations. These methods can still be applied to the original Gauss problem of potential theory as well as to the Helmholtz equation, the Lam'e equations of linear elasticity, to stationary Stokes and Brinkman equations although the latter are not strongly elliptic but elliptic, and also to time harmonic Maxwell equations. The lecture ends with an outlook to more general regularity properties and to problems on manifolds.

RADON SEMINARS

Symbolic Computation

Hamid Ahmadinezhad

RICAM

November 12, 2012, 15:30

Johannes Kepler University, SP2 416

Title: Algebraic Geometry, Symbolic Computations and Connections to Other Fields

Abstract: Algebraic geometry is the study of the solution sets of polynomial equations. I begin the talk by briefly discussing the classical results in the classification problem in this subject, and mention some problems that I am currently working on in this field. Then I explain the interactions between algebraic geometry and symbolic computation and particularly the

problem of parametrization, which has many applications both within the scientific community and industry. Next, I go into more details about the most combinatorial object in algebraic geometry: toric varieties. I give a solution to a problem that appears naturally in this field and provide an algorithm for it that everyone can understand. Some other links with statistics will also be mentioned.

Christoph Koutschan
RICAM
November 5, 2012, 15:30
Johannes Kepler University, SP2 416

Title: Selected Applications of Symbolic Summation and Integration

Abstract: Definite sums and integrals are omnipresent in mathematics and other sciences. The method of creative telescoping is a meanwhile classical approach to deal with them. In our work we consider the class of holonomic functions: these are, roughly speaking, multivariate functions which, for each variable, satisfy a differential equation or a recurrence; in both cases the equation is required to be linear and to have polynomial coefficients. An important property of this class is that it is closed under addition, multiplication, certain substitutions, and definite summation and integration. Many elementary and special functions (e.g., Bessel functions, elliptic integrals, orthogonal polynomials) are holonomic. A basic introduction into the theory of holonomic functions is given that does not presuppose any knowledge of symbolic computation. At the same time, we demonstrate our Mathematica package HolonomicFunctions which provides an implementation of the above mentioned operations. In order to show connections to other areas of mathematics and to stimulate collaborations with the other research groups of RICAM, we present various applications in combinatorics, numerical analysis, quantum topology, and physics.

Georg Regensburger
RICAM
December 10, 2012, 15:30
Johannes Kepler University, SP2 416

Title: Symbolic Computation for Differential Equations with Boundary Conditions

Abstract: Boundary (value) problems play a dominant role in applied mathematics. Despite this fact, they have not been considered much from a symbolic computation perspective. For differential equations per se, there has been a lot of research in (computer) algebra to develop methods for simplifying and solving (systems of) differential equations. Current computer algebra systems provide many algorithms to compute with differential equations.
A long-term research goal with our co-authors is to develop an algebraic foundation and algorithmic framework for solving, transforming, and simplifying (systems of) boundary problems and integro-differential equations, complementing numerical methods.

In this talk, we first illustrate by examples some of the existing symbolic methods for differential equations and the corresponding algebraic structures. Then we outline our algebraic and symbolic approach to boundary problems. We focus on ordinary integro-differential operators, which provide an algorithmic setting for boundary problems and Green's operators for linear ordinary differential equations. We present the corresponding algorithms using the IntDiffOp package for the computer algebra system Maple developed by Anja Korporal.

Transfer Group

Sergiy Pereverzyev
RICAM
October 29, 2012, 15:30
Johannes Kepler University, SP2 416

Title: Two methods for one problem: Kaczmarz and Conjugate Gradient for the atmospheric tomography in Adaptive Optics

Abstract: Optical telescope is an instrument for magnifying parts of the night sky [1]. The diameter of its objective (mirror that collects and focuses the light from the part that is under a study) determines the ability of the telescope to resolve the small details of the sky: the larger is the objective, the finer details can be examined by the telescope. The European Southern Observatory (ESO) [2] is an international research organization for astronomy. ESO has built and operated some of the largest and most technologically advanced telescopes in the world. Currently, ESO plans to build the so called European Extremely Large Telescope (E-ELT) [3]. The diameter of E-ELT will be around 40 meters, and it will be the world's largest optical telescope. To obtain sharp images, big telescopes need to employ a special technique: the so called Adaptive Optics [4]. The wavefront of the light from a remote object is plane before the light reaches the Earth atmosphere. The atmospheric turbulence disturbs the wavefront of the light, and because of the perturbed wavefront, the image from the telescope, without a correction of the wavefront, will be blurred. Adaptive Optics is a technique for correcting perturbations in the wavefront of the light. One of the realizations of Adaptive Optics is the so called Multi Conjugate Adaptive Optics (MCAO). In this realization, one observes the light wavefront from different directions of the guide stars. Then, the task is to design the shapes of deformable mirrors such that the light wavefront, which is reflected by these mirrors, is corrected in the directions of the field of view. This task leads to the so called atmospheric tomography problem. A practical challenge here is to solve this problem fast in order to be able to deal effectively with the changing observed light wavefronts. The structure of the atmospheric tomography problem, namely as a system of operator equations, suggests the application of the so called Kaczmarz method [5,6]. This application has been recently successfully realized in [7]. The system of operator equations in the atmospheric tomography

problem can be also considered as one combined operator equation. Such a view motivates to use a prominent iterative method: Conjugate Gradient (CG). In this talk, the application of CG for the atmospheric tomography problem in different settings will be presented. The numerical results of this application will be shown and compared to the results obtained by the Kaczmarz method. This work is done in the framework of the project "Mathematical algorithms and software for ELT adaptive optics" with ESO [8], in particular in cooperation with Ronny Ramlau, Andreas Obereder, Matthias Rosensteiner. References: [1] http://en.wikipedia.org/wiki/Optical_telescope [2] http://en.wikipedia.org/wiki/European_Southern_Observatory [3] http://en.wikipedia.org/wiki/European_Extremely_Large_Telescope [4] http://en.wikipedia.org/wiki/Adaptive_optics [5] Kaczmarz S, 1937, Angenäherte Auflösung von Systemen linearer Gleichungen, Bull. Int. Acad. Pol. Sci. Lett. Cl. Sc. Math. Nat. A 35 355–7. [6] McCormick S F, 1977, The methods of Kaczmarz and row orthogonalization for solving linear equations and least squares problems in Hilbert spaces, Indiana Univ. Math. J. 26 1137–50. [7] R Ramlau and M Rosensteiner, 2012, An efficient solution to the atmospheric turbulence tomography problem using Kaczmarz iteration, Inverse Problems, 28(9), 095004. [8] http://eso-ao.indmath.uni-linz.ac.at/

Optimization and Optimal Control

Nagaiah Chamakuri

RICAM

October 15, 2012, 15:30

Johannes Kepler University, SP2 416

Title: Optimal control of bidomain equations in cardiac electrophysiology

Abstract: The focus of this work is on the development and implementation of an efficient numerical technique to solve an optimal control problem related to a reaction-diffusion system arising in cardiac electrophysiology. The bidomain equations are widely accepted as one of the most complete descriptions of the cardiac bioelectric activity at the tissue and organ level. In particularly, we use the Fenton-Karma ionic model in our simulation study. In this ionic model, the source functions are discontinuous in state space solution. The optimal control approach is based on minimizing a properly chosen cost functional $J(v,I_e)$ depending on the extracellular current I_{e} as input, which must be determined in such a way that wavefronts of transmembrane voltage v are smoothed in an optimal manner, where the transmembrane potential v as one of the state variables. The optimal control formulation is presented and a formal derivation of the adjoint equations and the first order optimality conditions, which are the basis for numerical solution are provided. The derivative of discontinuous source functions, due to the Fenton-Karma model, is required to solve the adjoint equations, which poses a lot of computational challenges. The efficient numerical

techniques for boundary control of the bidomain model as well as computational techniques to track the derivatives of discontinuous source functions in adjoint equations will be demonstrated. The numerical realization is described in detail and numerical experiments, which demonstrate the capability of influencing and terminating reentry phenomena, are presented. A numerical feasibility study in a parallel environment will be shown for the current problem.

Mathematical Methods in Molecular and Systems Biology

Stefan Müller
RICAM
December 3, 2012, 15:30
Johannes Kepler University, SP2 416

Title: Biomass/biofuels from cyanobacteria - an integrative model of carbon fluxes in a photobioreactor

Abstract: Cyanobacteria (also called blue-green algae) are unicellular organisms which obtain their energy through photosynthesis: they use light to convert atmospheric CO2 (and water) into carbohydrates (and oxygen). Recently, cyanobacterial growth and synthesis of particular metabolites have received increasing attention regarding the production of CO2-neutral biomass and biofuels. Related basic research questions involve cell biology (photosynthesis and metabolic pathways) as well as physics and chemistry of the cellular environment. We provide an integrative model of carbon fluxes in a photobioreactor (gas/liquid CO2 transfer, carbonate chemistry, and cellular exchange). Starting from a detailed dynamic model with many unknown parameters, we eliminate fast time scales and obtain a reduced model containing only parameters available from independent experiments. The model allows to determine all CO2 related exchange rates of a cell culture, to reason about the internal mechanisms of carbon fixation, and to estimate maximum production rates of biomass/biofuels for the upscaling to industrial level.

Stefan Müller & Georg Regensburger (Symbolic Computation)
RICAM
December 17, 2012, 15:30
Johannes Kepler University, SP2 416

Title: Chemical Reaction Network Theory for generalized mass action kinetics

Abstract: Dynamical systems arising from chemical reaction networks with mass action kinetics are the subject of chemical reaction network theory (CRNT). In particular, this theory provides results about existence, uniqueness, and stability of equilibria independently of rate constants. However, the validity of the underlying mass action law is limited; it only holds for elementary reactions in homogeneous and dilute solutions. Since intracellular environments are highly structured and characterized by macromolecular crowding, the rate law has to be

modified for applications in Systems Biology. We propose a notion of generalized mass action systems that can serve as a more realistic kinetic model. In addition to the complexes of a network and the related stoichiometric subspace, we introduce corresponding kinetic complexes, which represent the exponents in the rate functions and determine the kinetic-order subspace. We show that several results of classical CRNT carry over to the case of generalized mass action kinetics. Our main result gives conditions for the existence of a unique positive steady state independently of rate constants in the generalized setting. We also discuss necessary and sufficient conditions for multistationarity, which is an important property in biological applications (cell differentiation). The conditions are formulated in terms of sign vectors (oriented matroids) of the stoichiometric and kinetic-order subspace and face lattices of related cones.

RADON GROUP SEMINARS

Computational Methods for Direct Field Problems

Huidong Yang

RICAM

January 10, 2012, 15:30

Johannes Kepler University, SP2 416

Title: A Class of Fluid-Structure Interaction Solvers with a Nearly Incompressible Elasticity Model

Abstract: In this paper, we present some numerical studies on two partitioned fluid-structure interaction solvers: a preconditioned GMRES solver and a Newton based solver, for the fluid-structure interaction problems employing a nearly incompressible elasticity model in a classical mixed displacement-pressure formulation. Both are highly relying on robust and efficient solvers for the fluid and the structure sub-problems obtained from an extended and stabilized finite element discretization on hybrid meshes. For solving the sub-problems, a special algebraic multigrid method capable of handling a general saddle point system arising from the incompressible and nearly incompressible sub-problems is investigated.

Krishan Gahalaut

RICAM

January 17, 2012, 15:30

Johannes Kepler University, SP2 416

Title: Multigrid analysis for isogeometric methods

Abstract: In this talk the (geometric) multigrid methods for the isogeometric discretization of Poisson equation will be presented. The bound for condi- tion number of resulting sti ness matrix will be discussed. The smoothing property of the relaxation methods and the approximation property of the intergrid transfer operators are analyzed for two-grid cycle. It

will be shown that the convergence of the two-grid solver is independent of the discretization parameter h, and that the overall solver is of optimal com- plexity. For two-grid and multigrid cycles supporting numerical results will be provided for the smoothing property, the approximation property, convergence factor and iterations count for V -, W- and F- cycles, and the linear dependence of V -cycle convergence on the smoothing steps. The numerical results are complete up to polynomial degree p = 4, and from minimum smoothness C0 to maximum smoothness Cp□1.

Stefan Kleiss

RICAM

January 24, 2012, 13:45

Johannes Kepler University, SP2 416

Title: IETI - Isogeometric Tearing and Interconnecting

Abstracts: Finite Element Tearing and Interconnecting (FETI) methods are a powerful approach to designing solvers for large-scale problems in computational mechanics. The numerical simulation problem is subdivided into a number of independent sub-problems, which are then coupled in appropriate ways. NURBS- (Non-Uniform Rational B-spline) based isogeometric analysis (IGA) applied to complex geometries requires to represent the computational domain as a collection of several NURBS geometries. Since there is a natural decomposition of the computational domain into several subdomains, NURBS-based IGA is particularly well suited for using FETI methods. This paper proposes the new IsogEometric Tearing and Interconnecting (IETI) method, which combines the advanced solver design of FETI with the exact geometry representation of IGA. We describe the IETI framework for two classes of simple model problems (Poisson and linearized elasticity) and discuss the coupling of the subdomains along interfaces (both for matching interfaces and for interfaces with T-joints, i.e. hanging nodes). Special attention is paid to the construction of a suitable preconditioner for the iterative linear solver used for the interface problem. We report several computational experiments to demonstrate the performance of the proposed IETI method.

DI Michael Kolmbauer

JKU Linz

January 31, 2012, 15:30

Johannes Kepler University, SP2 416

Title: The multiharmonic FEM-BEM coupling method for simulation and control of eddy current problems

Abstract: This talk is devoted to the simulation and control of time-dependent eddy current problems. In order to discretize in time, we apply a multiharmonic approach. The resulting system of frequency domain equations is discretized either in terms of a FEM method or in terms of a symmetrically coupled FEM-BEM method. For the resulting large system of linear

equations, we construct block-diagonal preconditioners, used in a MinRes setting, that are robust with respect to the space and time discretization parameters and all additionally involved parameters (i.e. conductivity, reluctivity, regularization parameters).

Nadir Bayramov

RICAM

February 7, 2012, 15:30

Johannes Kepler University, SP2 416

Title: Optimization and optimal control for parabolic and hyperbolic equations: Fourier method and some regularization techniques

Abstract: The talk is devoted to the general Fourier method for solution of optimal control problems used in my Master Thesis and in some previous research work while studying at Moscow State University. Parabolic equation as a model of air pollution of the environment, and hyperbolic equation, describing vibrations of a membrane or a plate, is considered as well as control problems (with quadratic cost functionals) for them, where control is found in the state equation. Common approach using expansion of state and control into Fourier series is described, as well as arising problems with generalization of results for various types of control, domain of the system, boundary conditions and the minimized cost functional.

Prof. Coen P.H. Elemans

University of Southern Denmark, Denmark

May 8, 2012, 10:00

Johannes Kepler University, SP2 416

Title: Modeling birdsong production and control

Abstract: Like human infants, most songbirds acquire their beautiful songs by imitation. They can generate an incredible range of sounds that are controlled by complicated neural networks driving the uniquely avian sound-producing organ: the syrinx. To understand how neural signals are translated into acoustic signals, I study the neuromuscular control and biomechanics of sound production in the syrinx. Instead of working from the brain down to the vocal organ, my aim is to define neural control parameters and constraints by understanding the function of the syrinx. I use a variety of in vivo and in vitro experimental techniques such as electro- and muscle physiology and am developing a preparation to study sound production in vitro. Hand in hand with experimental work, we now plan to also use theoretical approaches to understand neural control by developing mathematical models of sound production.

Prof. Dirk Pauly

University of Duisburg-Essen, Germany

June 4, 2012, 13:45

Johannes Kepler University, SP2 416

Title: Functional A Posteriori Error Estimates for Maxwell Type Problems

Abstract: This talk is concerned with the derivation of computable and guaranteed upper and lower bounds of the difference between the exact and the approximate solution of boundary value problems for static Maxwell type equations. Our analysis is based upon purely functional argumentation and does not attract specific properties of an approximation method. Therefore, the presented estimates are applicable to any approximate solution which is square integrable. In particular, our results hold for non-conforming approximations. Such estimates (also called error majorants of functional type) have been derived earlier, e.g., for elliptic problems. We note that generalizations to differential forms are straight forward. Moreover, also the full (time-dependent, hyperbolic) generalized Maxwell system can be treated by similar techniques.

Ivan Georgiev

RICAM

June 5, 2012, 15:30

Johannes Kepler University, SP2 416

Title: Semi-coarsening multilevel method for nonconforming bilinear discretizations

Abstract: In this talk we consider a nonconforming discretization of scalar elliptic problem. For construction of efficient preconditioner the semi-coarsening approach will be applied. Different constructions of hierarchical two-level splitting of the finite element space are presented. Uniform estimates for the related constants in the strengthened CBS inequality are derived. Combining these results with the theory of the hybrid V-cycle multilevel methods we obtain an optimal order multilevel preconditioner.

DI Lorenz John

TU Graz

June 14, 2012, 15:30

Johannes Kepler University, SP2 416

Title: Preconditioning of optimal Dirichlet boundary control problems in energy spaces

Abstract: We consider preconditioning techniques for iterative solution methods applied to the optimality system discretized by finite elements for Dirichlet boundary control problems in appropriate energy spaces. In particular, we focus on the robustness with respect to the mesh size and the cost coefficient. Further, we present some numerical examples which confirm the obtained theoretical results.

Prof. Olaf Steinbach

TU Graz

June 15, 2011, 09.00

Johannes Kepler University, SP2 416

Title: Boundary element methods for variational inequalities

Abstract: In this talk we present a priori error estimates for the Galerkin solution of variational inequalities which are formulated in fractional Sobolev spaces, i.e. in $widetilde{H}^{1/2}(Gamma)$. In addition to error estimates in the energy norm we also provide an error estimate in $L_2(Gamma)$, by applying the Aubin-Nitsche trick for variational inequalities. The resulting discrete variational inequality is solved by using a semi-smooth Newton method, which is equivalent to an active set strategy. A numerical example is given which confirms the theoretical results. Other applications involve boundary value problems with Signorini boundary conditions, and optimal Dirichlet boundary control problems.

Dr. Naveed Ahmed
University of Kassel, Germany
July 24, 2012, 15:30
Johannes Kepler University, MT 132

Title: Numerical studies of Galerkin-type time discretizations applied to transient convection-diffusion-reaction equations

Abstract: It is well known that the Galerkin finite element method is unstable for the numerical solution of convection-dominated problems since the solution is typically polluted by spurious oscillations. To enhance the stability while keeping the accuracy of the Galerkin method, several stabilization techniques have been developed. We consider the streamline upwind Petrov-Galerkin (SUPG) method and local projection stabilization (LPS) method to stabilize the Galerkin discretization. The SUPG formulation is strongly consistent whereas, the LPS method lies in the class of symmetric stabilizations and weakly consistent. We shall employ the combination of SUPG and LPS methods in space with the variational type time-discretization schemes for the numerical solution of time- dependent convection-diffusion-reaction equations. In particular, we consider the discontinuous Galerkin (dG) and continuous Galerkin-Petrov (cGP) method to discretize the problem in time. Several numerical tests have been performed to assess the accuracy of the higher order time-discretization schemes. For smooth solution, optimal order of convergence for cGP and dG-methods are obtained. Further, numerical comparison of SUPG and LPS methods for the smooth solution shows that both stabilization techniques perform quite similar and no difference among them can be appreciated. Finally, the dependence of the results on the stabilization parameters is discussed.

Dr. James Brannick
Penn State University, USA
September 18, 2012
Johannes Kepler University, SP2 416

Title: Multigrid methods for solving the Dirac equation

Abstract: In this talk, I give an overview of recent research on designing Multigrid methods for solving the Wilson discretization of the Dirac equation in Lattice Quantum Chromodynamics. Several Multigrid algorithms have been developed for solving the Wilson system, dating back to works in the early 1980's by Brower and Rebbi from Boston University. While these earlier efforts resulted in significant progress, both in lattice QCD computations and in MG algorithm development, they failed in providing a scalable solver for this system. Recently, advances in adaptive MG have led to new robust solvers for the Wilson system. Results of variants of such methods applied to the 2D and the 4D Wilson Dirac systems are presented. It is also shown that the solver is effective for mass shifts that yield indefinite Wilson systems. As such, the solver can additionally be applied to the chiral Domain Wall formulation of the Dirac equation.

Prof. Vadim Korneev

St. Petersburg State Technical University, Russia

October 1, 2012, 15:30

Johannes Kepler University, SP2 416

Title: Fast domain decomposition solvers for discrete problems with chaotically subdomain wise variable orthotropism

Abstract: The second order elliptic equation is considered in the domain, composed of some shape and size irregular rectangles, which are nests of the orthogonal nonuniform decomposition mesh. The matrix of coefficients of the elliptic operator, written in the divergent form, is diagonal and its nonzero coefficients in each subdomain are arbitrary positive numbers. The orthogonal finite element mesh satisfies only one condition: it is uniform on each subdomain. No other conditions on the coefficients of the elliptic equation and on variable step sizes of the discretization and decomposition meshes are imposed. For the resulting discrete finite element problem, we present the DD (domain decomposition) preconditioner of the Dirichlet-Dirichlet type, in which d.o.f.'s at nodes of the decomposition mesh are split from others, and it is assumed that the contribution of the subproblem, related to these d.o.f.'s, to the computational cost of the DD solver is secondary. Essential components of DD preconditioner are the same as in the paper of Korneev, Poborchii & Salgado (2007). However, here we remove the weak dependence of the relative condition number of the DD preconditioner on some measure of the local orthotropism of the discretization. We show that the DD solver has linear complexity, independently of the aspect ratios of the three types of orthotropism listed above. The result became possible due to the special way of the interface preconditioning by means of the inexact solver employing the preconditioner-multiplicator and the preconditioner-solver. The interface preconditioning makes also the main difference from other authors works on fast DD solvers for similar problems, e.g., of Khoromskij & Wittum (1999,2004) and Kwak, Nepomnyaschikh & Pyo

(2004).

Dr. Andy Wathen

University of Oxford, United Kingdom

October 2, 2012, 10:15

Johannes Kepler University, SP2 416

Title: Combination Preconditioning of saddle-point systems for positive-definiteness

Abstract: There are by now several examples of preconditioners for saddle-point systems which destroy symmetry but preserve self-adjointness in non-standard inner products. The method of Bramble and Pasciak was the earliest of these. We will describe how combining examples of this structure allow the construction of preconditioned matrices which are self adjoint and positive definite and allow rapid linear system solution by the Conjugate Gradient method in the appropriate inner product. This is joint work with Jen Pestana.

Prof. Valeria Simoncini

University of Bologna, Italy

October 16, 2012, 13:45

Johannes Kepler University, SP2 059

Title: Model-assisted effective large scale matrix com-putations

Abstract: Advanced mathematical models very often require the solution of (sequences of) large algebraic linear systems, whose numerical treatment should incorporate problem information in order to be computationally effective. For instance, ma-trices and vectors usually inherit crucial (e.g., spectral) properties of the underlying continuous operators. In this talk we will discuss a few examples where the performance of state-of-the-art iterative linear system solvers can be dramatically enhanced by exploiting these properties. Our presentation will focus on struc-tured linear systems stemming from the numerical discretization of systems of partial differential equations, as well as of optimal control problems constrained by partial differential equations

Nadir Bayramov

RICAM

October 22, 2012, 15:30

Johannes Kepler University, SP2 059

Title: Convection-diffusion equations with small diffusion and approaches for their solution

Abstract: Transient PDE-constrained optimal control problem is considered.

Corresponding projection gradient method for its numerical solution leads to a set of convection-diffusion problems with different right-hand sides.

Because of the small diffusion coefficient standard methods result in unstable numerical solutions, therefore advanced schemes for convection-diffusion equations are considered.

Krishan Gahalaut

RICAM

October 30, 2012, 16:00

Johannes Kepler University, SP2 059

Title: Condition Number Estimates and Fast Solvers

Abstract: In the first part of this talk, we shall derive the bounds for the extremal eigenvaluesand the spectral condition number of matrices for isogeometric[1] discretizations of elliptic partial differential equations in 2 Rd; d = 2; 3. For the h-refinement, the condition number of the stiffness matrix is bounded above and below by a constant times h□2, and the condition number of the mass matrix is uniformly bounded. For the p-refinement, the condition number is bounded above by p2d4pd and p2(d□1)4pd for the stiffness matrix and the mass matrix respectively. Numerical results supporting the theoretical estimates will be presented. Some numerical results on the condition number for varying smoothness of the basis functions will also be discussed. In the second part, we shall briefly discuss fast solution techniques. We recently introduced geometric multigrid methods for isogeometric discretizations [2], as a next step we consider algebraic multilevel iteration (AMLI)[3] methods. We shall review our current progress on AMLI for isogeometric discretizations. Theoretical bounds for the constant in the strengthened Cauchy-Bunyakowski-Schwarz inequality will be discussed. For a fixed p, the constant will be analyzed for different regularities of the B-spline basis functions. References [1] J.A. Cottrell, T.J.R. Hughes and Y. Bazilevs. Isogeometric Analysis: Toward Integration of CAD and FEA. Wiley, 2009. [2] K.P.S. Gahalaut, J.K. Kraus and S.K. Tomar. Multigrid Methods for Isogeometric Discretization. Comput. Methods Appl. Mech. Engrg., 2012. [3] J.K. Kraus and S. Margenov. Robust Algebraic Multilevel Methods and Algorithms. Radon Series on Computational and Applied Mathematics, 2009.

Ivan Georgiev

RICAM

December 4, 2012, 15:30

Johannes Kepler University, SP2 059

Title: Preconditioning of discontinuous Galerkin approximations of elliptic problems with jumps in the coefficients

Abstract: We consider interior penalty discontinuous Galerkin discretizations of scalar elliptic problems with highly varying coefficients.
Two-level method based on additive approximation of the Schur complement will be presented. We will show numerically the stable behavior of the condition number with respect to the coefficient jumps and the problem size.

Qingguo Hong

RICAM

December 11, 2012, 15:30

Johannes Kepler University, SP2 059

Title: Stable Discretizations for Non-Newtonion Flow Models

Abstract: This talk presents a semi-Lagrangian DG method and a semi-Lagrangian nonconforming method that use lower-order polynomial to keep the exact divergence-free of the solution and preserve the positive-definiteness of the conformation tensor regardless of the time and spatial resolutions for the non-Newtonian flow model. Since using lower-order polynomial to approximate velocity, the accuracy of the velocity can match the accuracy of the approximation for the conformation tensor. The discretization schemes are available both in 2-dimensional models and in 3-dimensional models. Because of the divergence-free discrete velocity, we can obtain the robustness of the numerical method by proving the discrete energy estimate. Furthermore, although the existence of the global solution is not clear for the model, but we can prove the existence of the global solution for the discrete problems. Finally, we design a fast solver for the semi-Lagrangian DG discretization, which shows that the semi-Lagrangian DG discretization is solver friendly.

Prof. Sergej Rjasanow

Saarland University

December 18, 2012. 15:30

Johannes Kepler University, SP2 059

Title: Radial basis functions with applications to solid mechanics

Abstract: Radial basis functions (RBFs) have become increasingly popular for the construction of smooth interpolant s : Rn ! R through a set o f N scattered, pairwise distinct data points. In the rst part of the talk we introduce the RBF's [?] and discuss their properties. The second part of the talk is devoted to the reconstruction of the threedimensional metal sheet surfaces obtained via incremental forming techniques. [?]. In this application, the data comes from optical measurements of sheet metal parts. The top and the bottom surfaces of the part are measured in a xed frame of reference, and a distribution of thickness along the part is sought. In the third part of the talk, a boundary integral formulation for a mixed boundary value problem in linear elastostatics with a conservative right hand side is considered [?]. A meshless interpolant for the scalar potential of the volume force density is constructed by means of radial basis functions. An exact particular solution to the Lame system with the gradient of this interpolant as the right hand side is found. Thus, the need of approximating the Newton potential is eliminated. The procedure is illustrated on numerical examples.

Inverse Problems

Dr. Shuai Lu

WIAS-Berlin, Gemany and Fudan University, China

February 13, 2012, 10:00

Johannes Kepler University, SP2 416

Title: Multiscale analysis for ill-posed problems with semi-discrete Tikhonov regularization

Abstract: Using compactly supported radial basis functions of varying radii; Wendland has shown how multiscale analysis can be applied to the approximation of Sobolev functions on bounded domains, when the available data is discrete and noisy. Here, we examine the application of this analysis to the solution of linear moderately ill-posed problems using semi-discrete Tikhonov regularization. As in Wendland's work, the actual multiscale approximation is constructed by a sequence of residual corrections, where different support radii are employed to accommodate different scales. Convergence of the algorithm for noise free data is proven. Parameter choices and associated error bound estimations for the noise data at each level are derived using an a posteriori parameter choice rule based on the Morozov discrepancy principle. A numerical example is presented to illustrate the appropriateness of the proposed method.

Dr. Guanghui Hu

WIAS-Berlin, Gemany

March 14, 2012, 14:00

Johannes Kepler University, SP2 416

Title: Elastic Scattering by Unbounded Rough Surfaces

Abstract: In this talk we consider the elastic wave scattering problem due to an inhomogeneous source term whose support lies within a finite distance above a rough surface. The rough surface is supposed to be the graph of a bounded and uniformly Lipschitz continuous function, on which the elastic displacement vanishes. We propose an upward propagating radiation condition (angular spectrum representation) for solutions of the Navier equation in the upper half-space above the rough surface, and establish an equivalent variational formulation. Existence and uniqueness of solutions at arbitrary frequency are proved by applying a priori estimates for the Navier equation and perturbation arguments for semi-Fredholm operators.

This is a joint work with Johannes Elschner at WIAS.

Prof. Mikola Ivanchov

Ivan Franko National University of Lviv, Ukraine

March 21, 2012, 10:00

Johannes Kepler University, SP2 416

Title: Inverse Problems for Parabolic Equations in free boundary domains

Abstract: The lecture is devoted to inverse problems for parabolic equations in which an unknown coefficient depends on the time variable. Free boundary problems, as it appears, are closely linked to inverse problems and may be considered jointly. In the first part of the

lecture, an overview of results in the mentioned subject area will be proposed. The second part has the aim to present in more details two recent results on free boundary problems.

Leonidas Mindrinos

National Technical University of Athens, Greece

June 25, 2012, 11:00

Johannes Kepler University, SP2 416

Title: Solving the Inverse Scattering Problem in Linear Elasticity using non - linear Integral Equations

Abstract: The inverse scattering problem of determining the shape of an obstacle in two - dimensional linear elasticity is considered. The scatterer is in a homogeneous and isotropic elastic medium. The problem is solved using the method of non - linear integral equations proposed by Kress and Rundell. This method arises from the integral representation of the solution and trans-forms the problem into a system of integral equations. The system is non - linear with respect to the unknown boundary of the scatterer and also ill-posed. The linearization is performed using Frechet derivatives of the integral operators and we approximately solve the system via Tikhonov regularization. To overcome the singularities of the integral operators we use special collocation and quadrature rules. The numerical solution is achieved via an iterative algorithm based on an initial guess about the position of the scatterer. Reconstructions are given which illustrate the applicability of the method.

Prof. Hui Cao

Sun Yat-Sen University, Guangzhou, China

July 17, 2012, 10:00

Johannes Kepler University, SP2 416

Title: A fast algorithm for parameter identification problems based on multilevel augmentation method

Abstract: A multilevel augmentation method for solving parameter identification problems in elliptic systems is considered. Based on multilevel decomposition in a solution space, multilevel augmentation method leads to a fast algorithm for solving discretized ill-posed problem. Combining with Tikhonov regularization, in the implementation of multilevel augmentation method, one only needs to invert the same matrix with a relatively small size and perform a matrix- vector multiplication at the linear computational complexity. As a result, the computation cost can be dramatically reduced. A posteriori regularization parameter choice rule and the convergence rate for the regularized solution are studied in this work.

Prof. Hrushikesh Mhaskar

California State University, USA

October 8, 2012, 11:00

Johannes Kepler University, SP2 416

Title: Function approximation on data defined manifolds

Abstract: We give a brief survey of some of our recent work on approximation of functions of unstructured, high dimensional data sets. One can assume that the data set is a sample from an unknown low dimensional manifold. While di ffusion maps have been used to study the geometry of this manifold, we have developed a theory of wavelet-like representation of functions on the unknown manifold based on the eigenfunctions of the heat kernel. In turn, the heat kernel can be approximated using the data set, as is well known from the theory of Laplacian eigenmaps and di ffusion maps. We describe also some applications of this theory to the analysis of some practical data sets.

Dr. Rajesh Kumar

École polytechnique fédérale de Lausanne, Switzerland

November 5, 2012, 11:00

Johannes Kepler University, SP2 416

Title: Numerical analysis of finite volume schemes for Population balance equations (PBEs)

Abstract: First part of this talk deals with the stability and convergence analysis of a finite volume scheme for solving non-linear aggregation-breakage PBEs. The proof is based on the basic existing theorems and definitions from the book of Hundsdorfer and Verwer[1] and the paper of Linz[2]. It is shown that the scheme is second order convergent inde-pendent of the meshes for linear problem while for non-linear it depends on the meshes taken for computations. The results are verified numerically by taking two test problems. Next we introduce the definition of moment preservation. Based upon it we discuss one-moment and two-moments preserving numerical methods to solve the couple mass and number preserving PBEs. We use finite volume schemes for solving aggregation, breakage and growth terms whereas upwind scheme is used for source terms. Numerical verifications are made for various coupled processes. References [1] W. Hundsdorfer and J.G. Verwer. Numerical solution of time-dependent advection-diffusion-reaction equations. Springer-Verlag, New York, USA, 1st edition 2003. [2] P. Linz. Convergence of a discretization method for integro-differential equations. Numer. Math., 25:103-107, 1975.

Dinh-Liem Nguyen

École Polytechnique Palaiseau Cedex, France

November 19, 2012, 11:00

Johannes Kepler University, SP2 416

Title: On Shape Identification of Diffraction Gratings from Spectral Data

Abstract: (Joint work with Armin Lechleiter) We consider the shape identification problem of diffraction gratings from measured spectral data involving of scattered electromagnetic waves. The model problem that we study here is motivated by the important applications of such structures in optics. Applications include diffractive optical filters and organic light-

emitting diodes, and non-destructive testing is an important issue to guarantee the functioning of such devices. Recently, the Factorization method, introduced in [3], has been extended to periodic inverse scattering problems as a tool for imaging. In [1, 2] the authors studied the Factorization method for the imaging problem of impenetrable periodic structures with Dirichlet and impedance boundary conditions. The paper [5] considered imaging of penetrable periodic interfaces between two dielectrics in two dimensions. In the present work, the Factorization method has been studied for identifying shape of diffraction gratings constituted by penetrable periodic/biperiodic dielectrics in three dimensions. We provide a rigorous analysis for the method as well as numerical experiments to examine its performance. Our analysis extends the approaches in [4, 1, 5] to the case of TM mode as well as Maxwell's equations. We use the special incident fields introduced in [1] which allows us to suitably factorize the near field operator. Further, a modified version of the method studied in [5] treats the case that the imaginary part of the middle operator in the factorization is just semidefinite. Finally, the neccessary properties of the middle operator are obtained by the approach in [4] for obstacle inverse scattering of electromagnetic waves. References [1] T. Arens and N. Grinberg, A complete factorization method in inverse scattering from periodic structures, Computing, 75:111-132, 2005. 1 [2] T. Arens and A. Kirsch, Factorization method for inverse scattering from periodic structures, Inverse Problems, 19:1195-1211, 2003. [3] A. Kirsch, Characterization of the shape of a scattering obstacle using spectral data of the far field operator, Inverse Problems, 14:1489-1512, 1998. [4] A. Kirsch and N.I. Grinberg, The Factorization Method for Inverse Problems, Oxford Lecture Series in Mathematics and its Applications 36, 2008. [5] A. Lechleiter, Imaging of periodic dielectrics, BIT Numer. Math., 50:59-83, 2010.

Symbolic Computation

Dr. Adrien Poteaux
Université Lille, France
January 9, 2012, 14:00
Johannes Kepler University, SP2 416

Title: Computing Puiseux series approximations: a modular-numerical algorithm

Abstract: We will present a symbolic-numeric strategy to compute efficiently and accurately floating point Puiseux series. In essence, computations modulo a well chosen prime number p are used to obtain the exact information needed to guide floating point computations. Puiseux series are fundamental objects of the theory of algebraic curves. Unfortunately, usual algorithms, namely the Newton-Puiseux algorithm and its variants, are symbolic algorithms. Therefore, computing Puiseux series may be costly - because of the extension fields involved and the coefficient growth, and so difficult to use in practice. To solve the matter, we first compute the Puiseux series modulo a well chosen prime number p. This gives us the

structure of the Puiseux series, which we store in a “polygon tree”. Then, we show how to follow this polygon tree to compute numerical approximations of the Puiseux series coefficients. This is a work made during my PhD at the University of Limoges, in collaboration with Marc Rybowicz.

Cevahir Demirkiran

RICAM

January 16, 2012, 14:00

Johannes Kepler University, SP2 416

Title: Counting Hyperelliptic Curves that Admit a Koblitz Model

Abstract: In this talk, for a finite field k of odd characteristic, I will be explaining a technique for counting hyperelliptic curves over k. We shall find closed formulas for k-isomorphism classes of pointed, non-pointed, hyperelliptic curves of genus g, admitting a Koblitz model.

Madalina Hodorog

RICAM

January 24, 2012, 14:00

Johannes Kepler University, SP2 416

Title: Homotopy continuation methods for algebraic curves

Abstract: In this talk, we report on homotopy continuation methods for solving numerically systems of polynomials equations. Together with the elimination and the subdivision methods, the homo-topy methods represent one of the basic tools for solving polynomial systems. We analyze two basic cases: (i) the case in which the polynomial systems have zero-dimensional isolated solutions, i.e the systems have finite solutions; (ii) and the case in which the polynomial systems have positive dimensional solutions sets, i.e. the systems have infinite solutions. As applications, we use the homotopy methods as follows: (1) to compute the singularities of a plane complex algebraic curve; (2) to compute the topology (i.e. the geometric representa-tion) of a plane real algebraic curve, representation that has effective applications in computer graphics, computational geometry and object modeling. We use the Bertini system and the Mathematica computer algebra system to implement and to test our methods. This is joint work with Dan Bates from Colorado State University and Josef Schicho from RICAM, Linz.

Dr. Kiwamu Watanabe

University of Tokyo, Japan

February 9, 2012, 11:00

Johannes Kepler University, SP2 416

Title: P1 bundles over projective manifolds and Campana-Peternell conjecture of dimension 4

Abstract: We give a complete classification of P1 -bundles over a projective manifold of Picard number one which admit another smooth morphism of relative dimension one.

Furthermore, we consider relations of the result with Campana-Peternell conjecture on Fano manifolds with nef tangent bundle of dimension 4.

Peof. J. Rafael Sendra

University of Alcalá de Henares, Spain

February 21, 2012, 14:00

Johannes Kepler University, SP2 416

Title: Normality and Singularities of Rational Surface Parametrizations

Abstract: In this talk we plan to review some of our new achievements in two different problems, both related to rational surface parametrizations. On one hand we will deal with the problem of deciding the normality (i.e. surjectivity) of the rational map associated to the parametrization and, on the other, we will focus on the question of decomposing the parameter projective plane of the parametrization in terms of the mul-tiplicity, on the surface, of the achieved point via de parametrization.

Gabor Hegedüs

RICAM

April 3, 2012, 10:00

Johannes Kepler University, SP2 416

Title: The root distribution of reflexive polytopes

Abstract: We call a polytope P which contains the origin in its interior re-flexive, if the polar polytope of P is a lattice polytope. We clas-sify in this lecture the root distribution of small dimensional reexive polytopes.

Niels Lubbes

RICAM

April 18, 2012, 11:00

Johannes Kepler University, SP2 416

Title: Families of circles on real surfaces

Abstract: An example of a family of circles on a surface is the horizontal plane sections of the real sphere. The sphere has an infinite number of families of circles. It is classically known that the torus has four families of circles: the orbits of rotation, the rotating circles, and the two families of Villarceau circles. In 1980 Blum conjectured that a real surface has either at most 6 families of circles or an infinite number. For compact surfaces this conjecture has been proven by Takeuchi in 1987 using topological methods. In 2001 Schicho classified complex surfaces with at least two families of conics. Recent work of Nilov, Pottmann, Shi and Skopenkov considers families of circles in more detail. In this talk we will combine algebro-geometric methods with Moebius geometry for classifying real surfaces with at least two families of circles.

Zijia Li

RICAM

May 2, 2012, 14:00

Johannes Kepler University, SP2 416

Title: 6R Angle-Symmetric Linkages

Abstract: There is no complete result about the classification of closed 6R linkages. In this talk we will consider a special closed 6R linkage. As it has a Angle-Symmetric property which is t1=t4,t2=t5,t3=t6, we call it 6R Angle-Symmetric Linkage. We will use dual quaternions as a tool for the analysis of linkages.

Hamid Ahmadinezhad

RICAM

May 8, 2012, 14:00

Johannes Kepler University, SP2 416

Title: Birational rigidity of 3-fold Mori fibre spaces

Abstract: The talk begins by a gentle introduction of birational geometry with some historical background. Then the classification techniques, mainly from the Mori theory, will be discussed. The main focus will be on the relations between these birational classes, and the so-called notion of “birational rigidity”, in dimension three.

Dr. Jérémy Berthomieu

Université de Versailles, France

July 3, 2012, 14:00

Johannes Kepler University, SP2 416

Title: Fast Relaxed Algorithms for *p*-adic Hensel lifting and applications to algebraic systems

Abstract: After explaining what are lazy power series and *p*-adic numbers, I will explain the relaxed product. This product was first introduced by Fischer and Stockmeyer for the integers and by van der Hoeven for polynomials and power series. Its complexity is quasi-linear in the precision. Then, I will introduce our algorithms for solving a polynomial in one variable, a linear system and finally an algebraic sys-tem over *p*-adic number, with a complexity which is also quasi-optimal in the precision. Examples of our implementation in C++ for Mathemagix and a comparison with Linbox will be given. It is a joint work with Romain Lebreton from LIX at the École polytechnique.

Dr. Adrien Poteaux

Université Lille, France

July 4, 2012, 14:00

Johannes Kepler University, SP2 416

Title: Towards a fast Newton-Puiseux algorithm?

Abstract: We will present a work in progress about the arithmetic complexity of the Newton-Puiseux algorithm. Puiseux series are fundamental objects of the theory of algebraic curves.

Last and best (to our knowledge) result [1] about the arithmetic complexity for computing the Puiseux series of a polynomial F 2 L[X; Y] is in O~(D5) where D is the total degree of F. This improvement from [2] (who gives a result in O(D8)) is mainly due to two points: ¤ we truncate the powers of X, ¤ we show how to use fast multiplication during the algorithm. However, with such a complexity, this algorithm cannot be considered as a fast one. We will present some ideas that will hopefully lead us to a O~(D3) complexity. The main ones are: ¤ We factorize the input polynomials during the algorithm, so that we make substitutions only in the part of the polynomial we are interested in, ¤ We shift the penultimate coecient to compute common terms at once, which enable to control the number of recursive call of the Newton-Puiseux algorithm me make. ¤ We use relax algorithms (see Jeremy Berthomieux's talk) so that we can truncate the power of X without a priori bound. In particular, we will provide a relax algorithm to apply the Hensel lemma, ¤ We re ne our truncation bounds to improve the complexity result. This work is in collaboration with Marc Rybowicz (university of Limoges). References [1] Adrien Poteaux and Marc Rybowicz. Complexity bounds for the rational newton-puiseux algorithm over nite elds. Applicable Algebra in Engineering, Communication and Computing, 22:187-217, 2011. 10.1007/s00200-011-0144-6. [2] Dominique Duval. Rational Puiseux Expansions. Compositio Mathematica, 70:119-154, 1989.

Research Project Applied Discrete Mathematics and Cryptography

Dr. Wilfried Meidl

Sabanci University, Istanbul, Turkey

October 29, 2012, 10:00

Johannes Kepler University, SP2 416

Title: Walsh spectrum of quadratic functions and the linear complexity of periodic sequences

Abstract: Quadratic functions F: Fpn ! Fp F(x) = Trn(Σk i=0 aixpi+1); ai 2 Fpn; (1) are always s-plateuaed, i.e. the Walsh transform b F(b) = Σ x2Fpn "F(x)□Trn(bx) p ; "p = e2i=p; is 0 or has absolute value p(n+s)=2 for all b 2 Fpn, where s is a fixed integer depending on F. In this talk a relationship between the Walsh transform of quadratic functions of the form (1) with coefficients in the prime field Fp and the linear complexity of periodic sequences is pointed out. Results on the number of such quadratic functions with a prescribed value for s are obtained using methods from the theory of the linear complexity of sequences.

Transfer Group

Prof. Curtis R. Vogel

The Optical Sciences Company, USA

May 10, 2012, 10:30

Johannes Kepler University, SP2 416

Title: Modeling, Parameter Identification, and Go-To Control of Deformable Mirrors for Adaptive Optics

Abstract: In this talk we will outline general procedures for the modeling, parameter estimation, and go-to control of electro-mechanical devices known as deformable mirrors (DMs), which are used for wavefront correction in the field of adaptive optics. The key idea is to apply a 4-th order, 2-dimensional PDE known as the thin plate equation to model the face sheet of the DM. This is coupled with a system of scalar equations, with one equation per DM actuator. Depending on the physics, the actuator equation may be a nonlinear scalar equation, or if hysteresis is present, it may be a nonlinear ODE. We will illustrate the techniques with data from a pair of DMs---a commercially available MEMS (Micro Electo Mechanical System) DM produced by the Boston Micromachines Corporation and a prototype DM for the Thirty Meter Telescope Project produced by the French company CILAS.

Roman Heinzle

RICAM

May 15, 2012, 10:00

Johannes Kepler University, SP2 416

Title: Tailored Cylinder Models for System Level Engine Modelling

Abstract: The model of the cylinder block represents the most challenging part of the engine model when establishing appropriate balance between the level of detail of the model and its prediction accuracy. Furthermore its coupling to the gas path model significantly influences the performance of the overall engine model. The paper addresses various couplings of the 0D gas path model to the surrogate and to the crank angle resolved cylinder block model. In addition two innovative coupling approaches are introduced: 1. coupling of the mean value gas path model and the crank angle resolved cylinder block model and 2. time domain decoupled interaction between the filling and emptying gas path model and the crank angle resolved cylinder block model. In the paper physical background of the models is presented along with their characteristics and computational performance in terms of RT factors.

Josef Haslinger

RICAM

June 12, 2012, 10:00

Johannes Kepler University, SP2 416

Title: Application oriented dynamic simulation of elastic multibody systems

Abstract: In the first part of this talk we give an overview about the mathematical back-ground of the multibody simulation package AVL-EXCITE. Multibody systems that are treated thereby are mainly powertrains in combustion engines. The dynamic equations of motion are formulated using the „Floating frame of ref-erence“ approach. Large rotations are parameterized by unit quaternions. The time integration method for the resulting differential-algebraic equation system is a backward differentiation formula. We describe the solution procedure for the discretized nonlinear system of equations. In the second part of the talk, a

special feature of the multibody simulation pack-age is considered: the simulation of coil contacts of valve springs. Coil clashes are treated by directly including the Signorini contact conditions. Finally, it is de-scribed how the solution of the resulting system is obtained by applying a semi-smooth Newton method.

Dr. Kirk Soodhalter

JKU, Linz

June 26, 2012, 10:00

Johannes Kepler University, SP2 416

Title: Krylov subspace recycling for families of shifted linear systems

Abstract: We address the solution of a sequence of families of linear systems. For each family, there is a base coefficient matrix Ai, and the coefficient matrices for all systems in the family differ from Ai by a multiple of the identity, e.g., Aixi = bi and (Ai + (`) i I)x(`) i = bi for ` = 1 : : :Li; where Li is the number of shifts at step i. This is an important problem arising in various applica- tions. We extend the method of subspace recycling to solve this problem by introducing a GMRES with subspace recycling scheme for families of shifted systems. This new method solves the base system using GMRES with subspace recycling while constructing approximate corrections to the solutions of the shifted systems at each cycle. These corrections improve the solutions of the shifted system at little additional cost. At convergence of the base system solution, GMRES with subspace recycling is applied to further improve the solutions of the shifted systems to tolerance. The method is also amenable to recursion. We present analysis of this method and numerical results involving systems arising in lattice quantum chromodynamics.

M.Sc. Bernadette Hahn

Saarland University, Germany

June 28, 2012, 10:15

Johannes Kepler University, SP2 416

Title: Reconstruction of dynamic objects in computerized tomography

Abstract: One basic assumption in classical computerized tomography is that the object does not change during the data acquisition process. In many applications, this assumption does not hold, for example due to respiratory and cardiac motion in medical imaging. The application of standard reconstruction methods leads to serious motion artifacts in the images. Hence, the algorithms have to take the dynamics of the investigated object into account. To obtain an adequate reconstruction, some a priori information of the motion is required. Therefore, we consider a certain type of movements and develop respective algorithms for the dynamic problem, using the method of the approximate inverse. An algorithm to determine the parameters of the motion from the measured data is proposed as well. Numerical examples illustrate the advantages of the new method.

Norbert Lorenz

RICAM

July 3, 2012, 10:00

Johannes Kepler University, SP2 416

Title: Piston Clearance simulation by using a Thermo-elasto Hydrodynamic contact model

Abstract: In this talk, a specific feature of the multibody simulation package AVL-EXCITE is considered: the simulation of the piston clearance contact. This contact model is prescribed by the averaged Reynolds equation considering local and time variable dynamic viscosity in a mixed lubrication domain. The 2D temperature approach is derived from the 3D energy equation considering partly filled clearance gaps and mixed lubrication conditions.

DI Diana Hufnagl

JKU, Linz

July 24, 2012, 10:15

Johannes Kepler University, SP2 416

Title: Dipolar Quantum Gases – A Challenge in Many-body Theory

Abstract: The goal in many-body theory is to understand the properties of macroscopic systems based on the microscopic properties of their constituents. Due to the large amount of particles in typical many-body systems, like gases and liquids, this is a very challenging task, both theoretically and numerically. An additional difficulty arises if the interaction between these particles is strong. I will give a short overview over the method we are using to calculate ground state properties of quantum many-body systems. Recently ultracold quantum gases have become a topic of great interest. Although these gases are very dilute, they can be strongly interacting, therefore correlations play an important role in these systems. Especially interesting are dipolar quantum gases, since the dipole--dipole interaction is both long-ranged and anisotropic. Thus it is expected that many interesting new properties arise in these systems, which are not observed in isotropic quantum gases. I will show how dipolar quantum gases can be treated theoretically and which new features occur due to the nature of the interaction.

Johannes Fürst

RICAM

December 3, 2012, 10:00

Johannes Kepler University, SP2 416

Title: Inverse problems arising in financial model calibration

Abstract: Assuming a stochastic process for the evolution of the underlying, the problem of model calibration deals with the identification of the unknown parameter functions of the process, using market quotes of liquidly traded basis instruments. Mathematically spoken, the calibration problem is an inverse problem which is often ill posed and needs special numerical

treatment. Since the robust identification of the model parameters is of high importance for the pricing of complex instruments, to solve the inverse problem in a reasonable way, regularization methods have to be used. Since there is no “true” model for the stochastic behaviour of the markets, every model is a rough simplification of the real world. While in simple models, closed form solutions for the basic instruments are available, increasing model complexity leads to a better description of reality, but more difficult pricing formulas arise, for which advanced numerical methods have to be applied. We will review different models for equities and interest rates and the problems arising in the pricing and calibration procedure.

Optimization and Optimal Control

Dr. Aurora-Mihaela Marica
Basque Center for Applied Mathematics, Spain
February 20, 2012, 11:00
Johannes Kepler University, SP2 416

Title: Some sophisticated numerical approximations for the wave equation: propagation, observability and control

Abstract: In this talk, we present some theoretical results and numerical simulations concerning the propagation, observation and control of some more complex numerical methods approximating the solution of the wave equation, as the discontinuous Galerkin and the quadratic finite element methods on uniform meshes. Both these methods produce two Fourier modes, a physical and a spurious one. On each mode one can construct high frequency wave packets propagating with arbitrarily slow velocity showing that the well-known observability property of continuous waves fails to be uniform with respect to the mesh size parameter in the discrete case. The key notion for the wave propagation on uniform meshes is the group velocity. The next step in our analysis is to show the efficiency of the Fourier truncation and of the bi-grid filter-ing algorithms to recover the uniform propagation property. The second part of the talk is devoted to the propagation of waves approximated by simple numerical schemes (finite differences) but on non-uniform meshes obtained as diffeomorphic transformations of uniform ones. We point out new phenomena with respect to the homogeneous case as the fact that the rays of Geometric Optics are curved and that they can have oscillating trajectories inside the computational domain without reflecting on the boundary. All these phenomena may be undestood by simply looking the phase portrait of the Hamiltonian system of the bi-characteristic rays.

Dr. M. Hassan Farshbaf-Shaker
University Regensburg, Germany
February 23, 2012, 14:00

Johannes Kepler University, SP2 416

Title: A penalty approach to optimal control of Allen-Cahn variational inequalities: MPEC-view

Abstract: A scalar Allen-Cahn-MPEC problem is considered and a penalization technique is applied to show the existence of an optimal control. We show that the stationary points of the penalized problems converge to some stationary points of the limit problem, which however are weaker than C-stationarity conditions.

Dr. Martin Nolte

Albert-Ludwigs-University of Freiburg, Germany

April 17, 2012, 10:00

Johannes Kepler University, SP2 416

Title: Efficient Numerical Approximation of the Effective Hamiltonian

Abstract: The so-called effective Hamiltonian plays an important role in the homogenization of nonlinear partial differential equations. It turns out that analytical expressions for the effective Hamiltonian are only available in rare cases and its evaluation needs to be done numerically. We shall revisit a few numerical schemes for the approximation of the effective Hamiltonian and compare them for efficiency and robustness. In the case of a time-dependent Hamiltonian, the design of an efficient numerical scheme becomes especially challenging. It is, however, possible to extend one of the presented numerical schemes to handle the time-dependent case without additional numerical cost.

Tobias Brüll

TU Berlin, Germany

May 7, 2012, 11:00

Johannes Kepler University, SP2 416

Title: The behavioral nature of infinite-time linear quadratic optimal control

Abstract: I will first give an introduction to optimal control in the behavioral setting and then show a result which characterizes the solvability of the linear quadratic optimal control problem. The optimal solution can be derived from an optimality system which involves the adjoint equation. In a second result I will show that the Lagrange multiplier depends linearly on the state.
Both results are, of course, standard for linear systems with regular cost functionals. However, since we exploit the behavioral nature of the problem, the presented results can be applied to differential-algebraic systems with singular cost functionals. In particular, the second result formulates a generalization of the algebraic Riccati equation.

Tran Dinh Quoc

Katholieke Universiteit Leuven, Belgium

July 10, 2012, 13:00

Johannes Kepler University, SP2 416

Title: Structure-Exploiting Approaches for Nonlinear Optimization

Abstract: Many optimization problems in practice possess certain structures such as convexity and separability which can be eciently exploited in numerical solu- tion methods. In this talk we propose to use two techniques called sequential convex programming (SCP) and dual decomposition to tackle such problems. We present in the rst part of the talk a generic framework for solving parametric nonconvex optimization problems which is especially suitable to treat nonlinear model predictive control problems. As a special case of SCP, we propose an inner convex approximation method to solve a class of nonconvex semide nite programming problems, especially, applicable to optimization problems with bilinear matrix constraints. In the second part, we study the Lagrangian dual decomposition framework for solving separable optimization problems. Cur- rently, we focus on convex optimization problems. We propose two classes of algorithms to solve these problems and investigate their complexity. The algo- rithms developed in this work will be illustrated via some numerical examples.

Dr. Christian Engwer
University of Münster, Germany
September 7, 2012, 10:00
Johannes Kepler University, SP2 416

Title: Efficient Simulations of Multi-physics and Multi-domain applications

Abstract: We are facing an increasing complexity in the models of scientific computing. Multi-physics applications, highly non-linear processes and domains exhibiting a complex shape are only some examples of such complexity. These changes pose a big chal-lenge to the development of scientific software. On the one hand the requirements on the software are growing, e.g. broader feature sets, demand for easy parallelism. On the other hand the turn over times is getting shorter, which requires shorter develop-ment times. To handle these requirements, DUNE provides a flexible framework for grid based methods for the solution of PDEs. We present extensions of the DUNE framework to handle multi-physics and multi-domain applications. The modules allow flexible computations while still allowing an efficient, i.e. rapid, implementation of new simulations.

Mathematical Imaging

Dr. Gabriel Peyré
Université Paris-Dauphine, France
March 27, 2012, 10:00
Johannes Kepler University, SP2 416

Title: Robust Sparse Analysis Regularization

Abstract: In this talk I will detail several key properties of L1-analysis regularization for the resolution of linear inverse problems [5]. With the notable exception of [1,3], most previous

theoretical works consider sparse synthesis priors where the sparsity is measured as the norm of the coefficients that synthesize the signal in a given dictionary, see for instance [3,4]. In contrast, the more general analysis regularization minimizes the L1 norm of the correlations between the signal and the atoms in the dictionary. The corresponding variational problem includes several well-known regularizations such as the discrete total variation, the fused lasso and sparse correlation with translation invariant wavelets. I will first study the variations of the solution with respect to the observations and the regularization parameter, which enables the computation of the degrees of freedom estimator. I will then give a sufficient condition to ensure that a signal is the unique solution of the analysis regularization when there is no noise in the observations. The same criterion ensures the robustness of the sparse analysis solution to a small noise in the observations. Lastly I will define a stronger condition that ensures robustness to an arbitrary bounded noise. In the special case of synthesis regularization, our contributions recover already known results [2,4], that are hence generalized to the analysis setting. I will illustrate these theoritical results on practical examples to study the robustness of the total variation, fused lasso and translation invariant wavelets regularizations. (This is a joint work with S. Vaiter, C. Dossal, J. Fadili) Bibliography: [1] E. Candes, Y.C. Eldar, D. Needell, and P. Randall. Compressed sensing with coherent and redundant dictionaries. Applied and Computational Harmonic Analysis, 31(1):59–73, 2010. [2] J.J. Fuchs. On sparse representations in arbitrary redundant bases. IEEE Transactions on Information Theory, 50(6):1341–1344, 2004. [3] S. Nam, M.E. Davie, M. Elad, R. Gribonval, The Cosparse Analysis Model and Algorithms, preprint arXiv:1106.4987, 2011. Robust Sparse Analysis Regularization. [4] J.A. Tropp. Just relax: Convex programming methods for identifying sparse signals in noise. IEEE Transactions on Information Theory, 52 (3):1030–1051, 2006. [5] S. Vaiter, G. Peyré, C. Dossal, J. Fadili, Robust Sparse Analysis Regularization, preprint arXiv:1109.6222v1, 2011.

Dr. Jerome Boulanger
Centre national de la recherche scientifique, Paris, France
May 14, 2012, 11:00
Johannes Kepler University, SP2 416

Title: Image reconstruction from total internal reflection microscopy

Abstract: Fluorescent microscopy became an essential tool for every day cell biology studies. Using the properties of evanescent wave's illumination, it is possible to modulate the depth at which fluorophores are excited. We will present an approximation of the forward model and provide some early solutions for the reconstruction of tri-dimensional volumes from a collection of 2D images.

3. Attachment: Data report from AkademIS (CD-ROM)