

# RESEARCH REPORT 2010/2011

---

## Dynamical Systems and Control Theory

Chair of Mathematics II  
Institute of Mathematics  
University of Würzburg

Institute of Mathematics  
Emil-Fischer-Str. 40  
97074 Würzburg  
Germany

## Contact:

Institut für Mathematik  
Lehrstuhl für Mathematik II  
Universität Würzburg  
Emil-Fischer-Str. 40  
97074 Würzburg  
Germany

phone : +49 (0)931 31-85004  
fax : +49 (0)931 31-84611  
email : l-math2@mathematik.uni-wuerzburg.de  
http : www2.mathematik.uni-wuerzburg.de

## Research Sponsors:

---



DFG SPP-1305



Bayerisches Staatsministerium für  
Wissenschaft, Forschung und Kunst



DAAD

Deutscher Akademischer Austausch Dienst  
German Academic Exchange Service



IZKF Würzburg

Interdisziplinäres Zentrum für Klinische Forschung der Universität Würzburg

---

# Contents

<b>1</b>	<b>Introduction</b>	<b>1</b>
1.1	Research Group Members . . . . .	2
1.2	Research Areas . . . . .	2
<b>2</b>	<b>Overview of Main Research Activities</b>	<b>4</b>
2.1	Networked Dynamical Systems . . . . .	4
2.2	Control of Quantum Systems . . . . .	5
2.3	Algorithmic Data Processing and Control . . . . .	6
<b>3</b>	<b>Research Activities</b>	<b>8</b>
3.1	Research Projects and Collaborations . . . . .	8
3.2	Research Workshops and Seminars in Würzburg . . . . .	10
3.3	Activities of Group Members . . . . .	10
3.4	Theses . . . . .	17
3.5	External Reports . . . . .	19
3.6	Guests . . . . .	20
<b>4</b>	<b>Publications</b>	<b>20</b>



# 1 Introduction

This report accounts for the research activities within the research group “Dynamical Systems and Control Theory” at the Institute of Mathematics, University of Würzburg, Germany, during the years 2010 and 2011. The research group has long term research record in the areas of mathematical systems and control theory, especially in the following main directions

- Stability theory and analysis of dynamical systems,
- Algebraic and geometric methods for system theory and nonlinear control,
- Optimization on manifolds.

The main objective of our research is to promote mathematical systems and control theory as an efficient tool to comprehensively study and tackle complex problems which increasingly emerge in diverse areas of science and engineering.

During the years 2010/2011, the research group “Dynamical Systems and Control Theory” consisted of 2 professors, 3 senior researchers and 4 postdoctoral research fellows, as well as 8 PhD students and one external PhD student from industry. The group enjoys many international collaborations with partners from other research institutes, universities and industries. The main sources of research funding which enables these collaborations are the German Research Council (DFG), the Federal Ministry of Education and Research (BMBF), the Bavarian State Ministry of Science, Research and Arts (STMWFK), the Volkswagen Foundation and the Interdisciplinary Center of Clinical Research (IZKF) University of Würzburg. Our research fund raising activities are expected to continue in the future and further new research projects are being proposed to increase the capacity of the group in the sense that new research directions and applications will be explored and new members of researchers and PhD students will be recruited.

A new development at the Faculty of Mathematics and Computer Science that has been initiated through the Chair is the foundation of the “Interdisciplinary Center for Mathematics in Science and Technology (IFM)”. The center was founded in 2011 and aims to harness the expertise of several research groups and bridge towards new application fields. New links with the Fraunhofer Institute of Industrial Mathematics (ITWM) Kaiserslautern are currently being established and will lead to further collaborations of the group members with other scientists and engineers.

Würzburg, 2012  
Prof. Dr. Uwe Helmke

## 1.1 Research Group Members

### Professors:

Prof. Dr. Uwe Helmke (Chair), Prof. Dr. Fabian Wirth

### Senior Researchers:

Dr. Gunther Dirr, PD Dr. Knut Hüper, Dr. Jens Jordan

### Postdoctoral Research Fellows:

Dr. Anna von Heusinger, Dr. Indra Kurniawan, Dr. Christian Lageman,  
Dr. Stephan Trenn

### PhD Students:

Oana Curtef, Roman Geiselhart, Indra Kurniawan, Huijuan Li, Markus Mauder (Industry PhD student, Diehl BGT Defence), Frederike Rüppel, Rudolf Sailer, Michael Schönlein, Martin Schröter,

### Bachelor, Diploma and Master Students:

Anita Barthel, Frank Beislein, Michael Götz, Florian Hammer, Maximilian Himsel, Jana Hümpfer, Alexander Klber, Dmitri Nedrenco, Carola Pritsching, Sebastian Pröll, Arie Schlote, Matthias Seibert, Philipp Skavantzoz

## 1.2 Research Areas

Uwe Helmke

Linear and nonlinear systems theory; Model reduction; Algebraic systems theory; Linear algebra; Differential geometric methods; Tracking and estimation for signal processing and control.

Fabian Wirth

Robust stability for nonlinear and time-varying dynamical systems; Spectral theory for linear time-varying systems; Networked Control Systems; Stability of Queueing Systems; Dynamics of Communication Protocols.

Gunther Dirr

Nonlinear control theory with main focus on invariant control systems on Lie groups and homogeneous spaces; Bilinear control systems on matrix Lie groups with applications to quantum control; Riemannian optimization in quantum computing and tensor approximation.

Knut Hüper

Numerical optimization methods on manifolds; Optimization problems in data and signal processing, robotics, computer vision; Differential geometric methods for data analysis and signal processing.

Jens Jordan

Observation and control of networked systems; Dynamics and geometry of iterative algorithms; Discrete-time control systems on manifolds and Lie groups.

Anna von Heusinger

Numerical methods for generalized Nash-equilibrium problems; Distributed optimization algorithms for networked control systems.

Indra Kurniawan

Dynamics and control of open quantum systems; Bilinear control systems on matrix Lie-groups; Stochastic master equations; Quantum filtering equations and robust approximation; Parameter estimation of quantum systems.

Christian Lageman

Networked control systems; Nonlinear control systems; Observer theory and construction; Optimization on manifolds; Estimation problems on manifolds.

Stephan Trenn

Switched differential algebraic equations: solution theory, stability, observability; Funnel control for nonlinear systems.

Oana Curtef

Numerical optimization on Riemannian manifolds; Singular value decomposition (SVD) of tensors; Subspace clustering.

Roman Geiselhart

Networked control systems; Control over digital communication channels.

Huijuan Li

Stability theory of interconnected systems; Zubov's method; Viscosity theory.

Frederike Rüppel

Generalization of the Solovay-Kitaev Theorem to non-compact semisimple Lie groups; Quantum computation.

Rudolf Sailer

Control over digital communication channels; Networked control systems; Control with limited information.

Michael Schönlein

Stability of multiclass queueing networks; Stability and robustness of fluid network models; Positive systems; Robust observation of linear systems; Modelling of logistics networks.

Martin Schröter

Optimization on manifolds including image registration and data compression; Stochastic optimization methods on manifolds.

## 2 Overview of Main Research Activities

### 2.1 Networked Dynamical Systems

In this research area, we concentrate on the analysis of the dynamical properties and the design of large-scale systems which consist of many interconnected subsystems. In particular, we investigate the stability of large-scale systems and develop constructive methods of deriving Lyapunov functions. In a second direction, the problems of decentralized control as well as decentralized state estimation are investigated. In these areas, a delicate and interesting interplay of diverse methods is required in order to describe the characteristics of the coupling structure. Relevant techniques come from linear and nonlinear systems theory, from the theory of dynamical systems, involving graph theory and the theory of positive systems. Furthermore, methods from algebraic systems theory and geometric control theory play an important role and find many applications here.

One of our projects, which is supported by the German Research Council (DFG) Priority Program 1305, is the investigation of state estimation, filtering and control of networked dynamical systems over digital communication channels. In general, such channels suffer from fundamental physical limitations which imply hard constraints on the amount of transferable digital data as well as time-varying delays and possible package loss. In this case, conventional approaches from control theory can no longer be directly applied, as it is frequently assumed that all required data transfers are unrestricted and available at any time. Therefore novel approaches will have to be proposed in order to cope with these communication constraints.

A closely related aspect is the modelling of the dynamics of digital data channels. The interplay of these dynamics with that of control systems is an important feature of networked control systems. One of the aspects of our current research is to develop new variants of Transmission Control Protocols (TCP), which represent one of the standard communication protocols for data transfer in internet, as well as communication protocols which are designed to support control schemes.

Another application area of networked systems under investigation are large-scale logistics networks and their dynamic behaviour. In the future, the research area of *quantum networks* poses an interesting challenge for system and control theory.

#### Funding

- Volkswagen Foundation Research Project, “*Stability, Robustness and Approximation of Dynamic Large-Scale Networks - Theory and Applications in Logistics Networks*”.
- DFG - Priority Program 1305, “*Control Theory of Digitally Networked Dynamical Systems*”.  
Project A: Stability and Stabilization of Large Digital Networks.  
Project B: Observation and Control of Heterogeneous Dynamical Systems HE 1858/12-1.  
Project C: Observation and Control of Heterogeneous Dynamical Systems HE 1858/12-2.



- DFG - Project Wi1458/10-1, “*Time-Varying and Switched Differential Algebraic Equations*”.
- EU Marie Curie ITN, “*Sensitivity Analysis of Deterministic Control Design*” (SADCO), subproject “*Stability analysis via coupled Hamilton-Jacobi equations*”.

## Cooperation Partners

- Chair of Mathematics IX: Scientific Computing, University of Würzburg
- Chair of Computer Science VII: Robotics and Telematics, University of Würzburg.
- Bremen Institute of Production and Logistics (BIBA), University of Bremen.
- Center of Technomathematics, University of Bremen.
- Hamilton Institute, NUI Maynooth, Ireland.
- Chair of Applied Mathematics, University of Bayreuth.
- Chair of Applied Analysis and Numerics, University of Augsburg.
- Institute of Mathematics, Technical University Ilmenau.

## 2.2 Control of Quantum Systems

The interest of our research group is directed towards the emerging, interdisciplinary area of quantum control, i.e. towards controlling and observing quantum mechanical systems, in particular, finite dimensional spin systems.

In quantum dynamics, we distinguish between *closed* and *open quantum systems*, i.e. between systems, which are isolated from the environment, and systems, which allow for dissipation and relaxation arising from interaction with the environment. While the time evolution of closed systems is described by one-parameter *groups* of unitary operators, the dynamics of open systems can be modelled by one-parameter *semigroups* of completely positive operators. Then, by including external controls, the corresponding equations of motion, the *Liouville-von Neumann* and *Lindblad-Kossakowski* master equations, lead to bilinear control systems.

The fundamental control-theoretical properties of such bilinear systems are within the scope of our research. Particularly, we are interested in controllability criteria, characterisations of reachable sets and related optimal control problems. For closed quantum systems, it is known that in principle a simple Lie algebra rank condition (LARC) guarantees controllability since the time evolution in this case takes place on unitary and therefore compact Lie groups. Nevertheless, verifying the LARC even for systems with a moderate number of spin particles could be highly involved. Thus we aim at simpler controllability tests and moreover the development of novel numerical methods for optimal control on compact Lie groups. In contrast, for open quantum systems, the proper semigroup structure of the Lindblad-Kossakowski master equation and the high-dimensional state spaces require sophisticated tools from Lie-semigroup theory and model reduction to obtain even a rough picture of the corresponding reachable sets. A more detailed characterisation is currently an open problem and a major research focus of our group.

We expect that new results in the field of quantum control will trigger innovations in application areas such as NMR imaging, NMR spectroscopy, spintronics ect. and highlight important theoretical limitations of quantum computing and quantum information theory. Here, methods from Lie-semigroup theory again play a crucial role for understanding the global structure of the set of all quantum channels. Closely related to these topics, we search for efficient algorithms for computing entanglement measures and work on generalizations of the Solovay-Kitaev Theorem.

In collaboration with the research focus “Networked Dynamical Systems”, we are going to investigate quantum graphs and quantum networks. Progress in the field of parameter identification of quantum mechanical systems provides another crosslink to our other research focus “Algorithmic Data Processing and Control”.

## Funding

- Elite Network of Bavaria (ENB) of the Bavarian State Ministry of Science, Research and Arts, under the framework of International Doctorate Program in Engineering and Computer Science: “*Identification, Optimization and Control with Applications in Modern Technologies*”.

## Cooperation Partners

- Chair of Theoretical Physics I, University of Würzburg.
- Department of Organic Chemistry, Technical University of Munich.  
In collaboration with the other International Doctorate Program of the Elite Network of Bavaria (ENB): “*Quantum Computing, Control and Communications (QCCC)*”. University.

## 2.3 Algorithmic Data Processing and Control

In the area of digital signal and image data processing, and also in control engineering, it is a common problem that the data of the problem under consideration satisfy an intricate geometric constraint. Recently, the related research area of data analysis on manifolds has gained considerable momentum, which increasingly influences the algorithmic development for applications in control engineering and sensor technology. The geometrical analysis of huge data sets is also closely related to the modern development of machine learning, for instance compressed sensing techniques. This approach makes data transfer beyond the Shannon-Nyquist limit feasible.

In the field of computer vision, the problem of 3D-structural analysis from digital camera data leads to a complicated nonlinear estimation problem of trifocal tensors. In medical signal processing, nonlinear image registration is an important tool for the implementation of imaging methods in practical radiology. A particular challenge arises when the comparative representations of data originate from different acquisition techniques e.g. X-ray radiation, microwave, laser or ultrasound technique. Often in this case, relevant geometrical constraints are not appropriately taken into account. An attempt of resolving this issue uses novel mathematical methods e.g. based on kernel functions, spline approximations or wavelet- and Radon-transformations.

A project in cooperation with the Fraunhofer Institute of Industrial Mathematics will focus on algorithmical aspects, especially on their diverse possible application areas originating from biology, medicine and sensor technology. This project, in close collaboration with the users, aims to offer efficient methods. In the framework of industrial projects as well as participations on individual or joint research projects from BMBF and DFG, efficient methods for geometrical data analysis, sensor data fusion, model reduction and data compression, as well as image data reconstruction are investigated. Mathematically speaking, all these questions reduce to the task of finding algorithmic solutions of nonlinear estimation problems on manifolds. In this area the research group has been active in long term collaborative projects investigating NMR spectroscopy, quantum control, computer vision and robotics.

The research focus “Algorithmic Data Processing and Control” of our group thus splits into the following three major sub-areas.

- Data reduction and data analysis:

Development of recursive and real-time methods for analysis and parameter reduction of data sets, also for time-varying systems. The techniques used are, for example, applied harmonic analysis and modern techniques from machine learning and compressed sensing.

- Model reduction and system identification:

Development of methods for model reduction of parameter-dependent linear systems. In this area, interesting crosslinks between computer algebraic methods and system theoretic techniques emerge.

- Numerical methods in robotics and sensoric:

Development of stable and robust methods for automatic real-time registration problems. This includes e.g. registration problems in medical imaging data, position and pose estimation, tracking from camera data, as well as optimal motion planning and position control in robotics.

## Funding

- Federal Ministry of Education and Research (BMBF), FHprofUnd 2007: Cooperation Program between Universities of Applied Science and companies, “*Development and Implementation of Novel Mathematical Algorithms for Identification and Control of Technical Systems*”.
- Elite Network of Bavaria (ENB) of the Bavarian State Ministry of Science, Research and Arts, under the framework of International Doctorate Program in Engineering and Computer Science: “*Identification, Optimization and Control with Applications in Modern Technologies*”.
- Fraunhofer ITWM - Collaboration Project *Parametrische Modellreduktion*
- FCT - Portugal (PTDC/EEA-CRO/122812/2010) *Differential Geometry for Computer Vision and Pattern Recognition*

## Cooperation Partners

- Department of Radiation Oncology, University of Würzburg, Research Group Precision Radiotherapy.
- Fraunhofer Institute of Industrial Mathematics (ITWM), Kaiserslautern.
- Chair of Signal Processing, Technical University of Munich.
- Chair of Computer Science VII: Robotics and Telematics, University of Würzburg.
- Department of Mathematics, Ben-Gurion University of the Negev, Israel.
- Research School of Information Sciences and Engineering (RSISE), Australian National University, Canberra, Australia.
- Institute of Systems and Robotics and Department of Mathematics, University of Coimbra, Portugal.

## 3 Research Activities

### 3.1 Research Projects and Collaborations

1. Volkswagen Foundation, “*Stability, Robustness and Approximation of Dynamic Large-Scale Networks - Theory and Applications in Logistics Networks*”.  
Project Leaders: F. Wirth, D. Dashkovskiy, B. Scholz-Reiter.  
Researcher: M. Schönlein.  
Period: 11.2007–03.2011.
2. DFG - Project Wi1458/10-1, “*Time-Varying and Switched Differential Algebraic Equations*”.  
Project Leaders: F. Wirth and A. Ilchmann  
Researcher: S. Trenn.  
Period: 2010–2012.
3. DFG - Priority Program 1305, “*Control Theory of Digitally Networked Dynamical Systems*”.  
Project A: Stability and Stabilization of Large Digital Networks.  
Project Leader: F. Wirth.  
Researcher: R. Sailer.  
Period: 01.2008–12.2010.  
  
Project B: Observation and Control of Heterogeneous Dynamical Systems.  
Project Leaders: U. Helmke, K. Schilling.  
Researcher: A. von Heusinger, J. Jordan.  
Period: 10.2007–09.2010.  
  
Project C: Observation and Control of Heterogeneous Dynamical Systems.  
Project Leader: U. Helmke.  
Researcher: A. von Heusinger, J. Jordan.  
Period: 01.2011–12.2013.

4. Federal Ministry of Education and Research (BMBF), FHprofUnd 2007: Cooperation Program between Universities of Applied Science and Industries, “*Development and Implementation of Novel Mathematical Algorithms for Identification and Control of Technical Systems*”.  
 Project Leaders: U. Helmke, K-H. Spindler.  
 Researcher: O. Curtef.  
 Period: 06.2007–05.2010.
5. DAAD: “*Robust Positive Observation*”, Collaboration between University of Würzburg and Dpto. Ingenieria de Sistemas y Automatica Universidad de Valladolid, 47005 Valladolid, Spain.  
 Project Leaders: U. Helmke, M. Ait Rami  
 Researchers Uni Würzburg: U. Helmke, F. Wirth, J. Jordan and M. Schönlein.  
 Researchers Uni Valladolid: F. Tadeo, M. Ait Rami and M. Bolajraf.  
 Period: 2008–2010.
6. Elite Network of Bavaria (ENB), International Doctorate Program in Engineering and Computer Sciences: “*Identification, Optimization and Control with Applications in Modern Technologies*”, University of Erlangen-Nürnberg, University of Bayreuth and University of Würzburg.  
 PhD project: “*Lie Group approach for Image Registration*”  
 Project Leaders: U. Helmke.  
 Researcher: M. Schröter.  
 Period: 2010–2011.
7. Elite Network of Bavaria (ENB), “Bayerische Elitförderungsgesetz (BayEFG)”.  
 PhD project: “*Constructive Controllability of Bilinear Systems on Lie Groups*”.  
 Project Leaders: U. Helmke.  
 Researcher: F. Rüppel.  
 Period: 05.2010–04.2012.
8. Elite Network of Bavaria (ENB), “Bayerische Elitförderungsgesetz (BayEFG)”.  
 PhD project: “*Stability and Stabilization of Large Scale Digital Networks*”.  
 Project Leaders: F. Wirth.  
 Researcher: R. Geiselhart.  
 Period: 12.2010–11.2012.
9. FCT - Portugal (PTDC/EEA-CRO/122812/2010) “*Differential Geometry for Computer Vision and Pattern Recognition*”.  
 Project Leaders: Jorge Batista, ISR Coimbra, Portugal  
 Researcher: Knut Hüper  
 Period: 11.2011–11.2014

### 3.2 Research Workshops and Seminars in Würzburg

1. Workshop *Mathematical Aspects of Network Synthesis*, September 27–28, 2010.  
Organized by U. Helmke.  
Sponsored by DFG Priority Programm 1305: *Control Theory of Digitally Networked Dynamical Systems* and Elite Network of Bavaria (ENB): *Identification, Optimization and Control with Applications in Modern Technologies*.
2. Joint Seminar of the International Doctorate Programs of the Elite Network of Bavaria (ENB): *Identification, Optimization and Control with Applications in Modern Technologies*.  
Winter and Summer Semester 2010/2011  
Organized by U. Helmke, F. Wirth, and L. Grüne (Uni Bayreuth).
3. Summerschool 2011 *Recent Trends in Quantum Control and Quantum Information Theory*, July 24–31, 2011.  
Organized by U. Helmke and G. Dirr.  
Sponsored by the Institute of Mathematics, University of Würzburg.

### 3.3 Activities of Group Members

Gunther Dirr

- Workshop on Quantum Control, the Institut Henri Poincaré, Paris, France, 8-11 Dec, 2010.  
Invited Talk: “New Estimates and Bounds on the Reachable Sets of Controlled Lindblad-Kossakowski Equations”
- 7th Elgersburg Workshop, TU Ilmenau, Germany, 14-17 Feb, 2011.  
“Bilineare Kontrollsysteme: Beispiele Highlights und Sonstiges”
- 25th IFIP TC 7 Conference on System Modeling and Optimization, TU Berlin, Berlin, Germany, 12-16 Sep, 2011.  
Invited talk: “A Bit of Lie-Semigroup Theory and its Application to Optimal Control of Open Quantum Systems”
- QCCC Research Meeting, TU Munich, Germany, 2011.  
Invited Talk “Majorization Properties of Controlled Lindblad-Kossakowski Equations”

Roman Geiselhart

- Contributed Talk “Numerical Verification of Stability Using a Homotopy Algorithm”, CDC, Orlando, Florida, December 12-15, 2011
- Participation at Graduate Schools and Workshops:
  - “Differential Algebraic Equations - Control and Numerics” (by V. Mehrmann) and “Behavioural Approach to Systems Theory” (by J. Willems) , Graduate School on Mathematical Systems Theory, Elgersburg, Germany, March 8-13, 2010.

- Workshop on "Communication over distributed control systems", Kaiserslautern, Germany, November 29-30, 2010.
- "Nonlinear Control" (by R. Freeman) and "Observers for Nonlinear Systems" (by L. Praly), Graduate School on Mathematical Systems Theory, Elgersburg, Germany, March 28 - April 2, 2011.
- "Control Theory of Digitally Networked Dynamical Systems", Second PhD School of DFG Priority Programme 1305, Marienheide-Rodt, Germany, September 26-30, 2011
- Workshop on "Robust Hybrid Control Systems" at the 50th CDC, Orlando, Florida, December 11, 2011

Uwe Helmke

- Associate Editor: SIAM J. Control and Optimization; Systems and Control Letters; Mathematics of Control, Signals and Systems.
- Dean of the Faculty of Mathematics and Computer Science, University of Würzburg
- Vice Dean of the Graduate School Science and Technology, University of Würzburg.
- Director of the Interdisciplinary research Center for Mathematics in Science and Technology (IFM), University of Würzburg.
- Consulting: Bosch Rexroth; Fraunhofer Institute ITWM, Kaiserslautern.
- IEEE Fellow Award for Contributions to Geometric Theory, Estimation and Tracking.
- Research Visit: RSISE, Australian National University (October 2011; host: Prof. B.D.O. Anderson).
- Participation at Workshops/Seminars :
  - "Von der geometrischen Invariantentheorie zur Klassifikation von Matrixbüscheln", Workshop Elgersburg, 2010.
  - "A Celebration of the Field of Systems and Control An international symposium on the occasion of two milestones in the careers of Chris Byrnes and Anders Lindquist", KTH, Stockholm, september 9-11, 2010  
Invited Talk: "Unimodular Equivalence of Polynomial Models".
  - Conference "Workshop in Celebration of the Life, Mathematics and Memories of Christopher I. Byrnes", Texas Tech University, Lubbock, September 10–12.  
Invited Talk: "Chris Byrnes in Würzburg: Revisiting the topology of  $Rat(n)$ ".
  - Conference "19th International Symposium on Mathematical Theory of Networks and Systems", Budapest, Hungary, July 5–9, 2010.  
Contributed Talk: "Global observability of real analytic systems".
  - "The Dynamics of Control" - A workshop on the occasion of the 60th birthday of Fritz Colonius, Kloster Irsee, October 1–3, 2010.  
Invited Talk: "Shift spaces and the classification of matrices".

- “Perspective in Mathematical System Theory, Control, and Signal processing” - A workshop on the occasion of the 60th birthday of Yutaka Yamamoto, Kyoto University, Japan, 2010.  
Invited Talk: “Control and stabiolization of linear equation solvers”.
- 49th IEEE Conference on Decision and Control, Atlanta, Georgia, USA, 15-17 December 2010,  
Contributed Talk: “Intertwining balancing and sign iterations”.

Anna von Heusinger

- Contributed Talks:
  - Eröffnungsworkshop zur zweiten Förderperiode des DFG-Schwerpunktprogramms 1305  
*Beobachtung und Regelung vernetzter Systeme* with J. Jordan
- Participation at Graduate Schools, Conferences and Workshops:
  - Conference *SIAM Conference on Optimization*  
Darmstadtium Conference Center, Darmstadt, May 16-19, 2011.
  - Second PhD School  
*Control Theory of Digitally Networked Dynamical Systems*  
Landhaus Wirth, Marienheide, Rodt, September 26–30, 2011.

Knut Hüper

- Organization, jointly with Christian Lageman, of special session: ”Differential Geometric Methods for Computational Engineering Applications” within the 19th International Symposium on Mathematical Theory of Networks and Systems (MTNS 2010), Budapest, Hungary, July 5-9, 2010.
- Co-Organization of special session ”Special Session on Geometric Control Theory” at CONTROLO’2010 9th Portuguese Conference on Automatic Control, Coimbra, Portugal, September 8-10, 2010.
- Research visit to ISR Coimbra, Portugal, September 13–17, 2010.
- Contributed Talks:
  - 19th International Symposium on Mathematical Theory of Networks and Systems (MTNS 2010), Hungary, July 5–9, 2010.  
”On the computation of means on Grassmann manifolds” and ”A geometric visit to the trace quotient problem”
  - CONTROLO’2010 9th Portuguese Conference on Automatic Control September 8–10, 2010, Coimbra, Portugal.  
”Rolling of Riemannian Manifolds: On the Isometric Embedding Problem”
- Participation at Workshops:
  - ”Mathematics for Personalized Medicine”, ITWM Fraunhofer Institut Kaiserslautern, June 14, 2010.



- 1<sup>st</sup> ABBY-Net Workshop on "Natural Resource Management and Energy Systems under Changing Environment Conditions", Technische Universität München, November 10–12, 2011.

Jens Jordan

- Contributed Talk: "Beobachtung und Regelung vernetzter Systeme", Eröffnungsworkshop zur 2. Förderperiode des SPP 1305, Regelungstheorie digital vernetzter dynamischer Systeme, Ruhr-Universität Bochum, 10 - 11. Februar, 2011.
- Contributed Talk: "Das Propädeutikum: studienbegleitende Fortführung des Vorkurses", mathematische Vor- und Brückenkurse: Konzepte und Perspektiven, khdm-Arbeitstagung, Universität Kassel, 03. November 2011.
- Research Visit, Dpto. Ingenieria de Sistemas y Automatica Universidad de Valladolid, Spain, Sept 29 – October 5, 2010 (host: Dr. Mustapha Ait Rami).
- Participation at Graduate Schools and Workshops:
  - Workshop on Mathematical Aspects of Network Synthesis, Würzburg, September 27-28, 2010.
  - 7. Elgersburg Workshop, Elgersburg, February 14 - 17, 2011

Christian Lageman

- Organization, jointly with Knut Hüper, of the Special Session: "Differential Geometric Methods for Computational Engineering Applications" within the 19th International Symposium on Mathematical Theory of Networks and Systems (MTNS 2010), Budapest, Hungary, 5-9 July, 2010.
- Contributed Talks in the 19th International Symposium on Mathematical Theory of Networks and Systems (MTNS 2010), Budapest, Hungary, 5-9 July, 2010.
  - "Joint subspace intersections as a fitting problem".
  - "Observability of partial states of invariant systems".

Rudolf Sailer

- Contributed Talks:
  - "A Multichannel IOPs Small-Gain Theorem for Large Scale Systems", MTNS, Budapest, Hungary, Juli 5-9, 2010.
  - "Stabilization by encoded feedback with Markovian communication channels", NOLCOS, Bologna, Italy, September 1-3, 2010.
  - "Multichannel Small-Gain Theorems for Large Scale Networked Systems", CDC, Atlanta, USA, December 15-17, 2010.
  - "Stabilisierung großer digitaler Netzwerke", 7. Elgersburger Arbeitstagung, Elgersburg, Germany, February 14-17, 2011.
  - "On a Small-Gain Approach to Distributed Event-Triggered Control", IFAC World Congress, Milano, Italy, 28. August - 2. September, 2011.

- Participation at Graduate Schools and Workshops:
  - “Differential-Algebraic Equations - Control and Numerics” (by V. Mehrmann) and “Behavioural Approach to Systems Theory” (by J. C. Willems) Graduate Summer School on Mathematical Systems Theory, Elgersburg, Germany, March 8-13, 2010.
  - 6. Elgersburg Workshop, Elgersburg, March 1-4, 2010
  - Workshop on Networked Robotics, Würzburg, May 7, 2010
  - Workshop on Information-based Analysis and Design of Networked Control Systems, Munich, June 28, 2010.
  - Workshop on Mathematical Aspects of Network Synthesis, Würzburg, September 27-28, 2010.
  - Workshop on Kommunikation in verteilten Regelungssystemen, Kaiserslautern, November 29-30, 2010.
  - 3rd Elgersburg School  
*Nonlinear Control*, R. Freeman,  
*Observers for Nonlinear Systems*, L. Praly.  
 Elgersburg, Germany, March 28 - April 2, 2011.
- Research Visits:
  - University of Twente, Enschede, The Netherlands, February 15-26, 2010 (host: Prof. C. De Persis).
  - Dpto. Ingenieria de Sistemas y Automatica, Universidad de Valladolid, Spain, 29 September - 8 October, 2010 (host: Dr. Mustapha Ait Rami).
  - University of Illinois at Urbana-Champaign, USA, December 8-14, 2010 (host: Prof. D. Liberzon).

Michael Schönlein

- Contributed Talk: *Stabilität von Warteschlangen-Netzwerken: Fluid Approximationen and Lyapunov Funktionen*, 6. Elgersburger Arbeitstagung, Elgersburg, Germany, March 1-4, 2010.
- Contributed Talks in the 19th International Symposium on Mathematical Theory of Networks and Systems (MTNS 2010), Budapest, Hungary, 5-9 July, 2010.
  - *Stability of fluid network models and Lyapunov functions.*
  - *Interval Observers for Linear Systems with Time-Varying Delays.*
- Contributed Talk: *Intervall-Beobachter für lineare Systeme mit zeitvarianten Verzögerungen*, 7. Elgersburger Arbeitstagung, Elgersburg, Germany, February 14-17, 2011.
- Contributed Talk: *Converse Lyapunov theorems for fluid networks*, The Applied Probability Society Conference, Stockholm, Sweden, July 6-8, 2011.
- Contributed Talk: *Supply Network Engineering: An Approach to Robust Capacity Allocation for Stochastic Production Processes*, IFAC World Congress, Milano, Italy, 28. August - 2. September, 2011.

- Research Visits:
  - Dpto. Ingenieria de Sistemas y Automatica, Universidad de Valladolid, Spain, 29 September - 8 October, 2010 (host: Dr. Mustapha Ait Rami).  
Talk: *Interval Observers for Linear Systems with Time-Varying Delays*.
  - Department of Automatic Control, Lund University, Lund, Schweden, May 18-28, 2010.  
Talk: *Stability and Robustness of Logistics Networks*, in LCCC Seminars, Lund, May 27th 2010.
  - Department of Mechanical Engineering, Eindhoven University of Technology, The Netherlands, January 10-14, 2011 (host: Dr. Erjen Lefeber).
- Participation at Graduate Schools and Workshops:
  - 2nd Elgersburg School  
*Differential-Algebraic Equations - Control and Numerics*, V. Mehrmann, *Behavioral Approach to Systems Theory*, J. C. Willems.  
Elgersburg, Germany, March 8-13, 2010.
  - Workshop on *Distributed Model Predictive Control and Supply Chains*, Lund, Schweden, May 19-21, 2010.
  - Workshop on *Stochastic Models of Manufacturing Systems*, Eindhoven University of Technology, The Netherlands, June 24-25, 2010.
  - Workshop *Mathematical Aspects of Network Synthesis*, University of Würzburg, September 27–28, 2010.
  - 3rd Elgersburg School  
*Nonlinear Control*, R. Freeman, *Observers for Nonlinear Systems*, L. Praly.  
Elgersburg, Germany, March 28 - April 2, 2011.

Martin Schröter

- Contributed Talk: “Medical Image Registration with Robbins-Monro Algorithms”, XVI-th International Conference on the Use of Computers in Radiation Therapy, ICCR 2010, Amsterdam, The Netherlands, May 31–June 3, 2010.

Stephan Trenn

- Contributed Talks in the 49th IEEE Conference on Decision and Control (CDC 2010), Atlanta, USA, December 15-17, 2010:
  - “Detection of impulsive effects in switched DAEs with applications to power electronics reliability analysis”
  - “On observability of switched differential-algebraic equations”
  - “The bang-bang funnel controller”
- Contributed Talk: “Commutativity and asymptotic stability for linear switched DAEs”, 50th IEEE Conf. on Decision and Control and European Control Conf. (CDC-ECC 2011), Orlando, USA, December 12, 2011

- Participation at Workshops:
  - Workshop on Hybrid Dynamic Systems, Waterloo, Canada, July 29–31, 2010  
Contributed Talk: Switched differential algebraic equations: Solution theory, Lyapunov functions, and stability
  - Workshop “Mathematical Aspects of Network Synthesis”, Würzburg, September 27–28, 2010
  - Workshop “The dynamics of control”, Irsee, October 1–3, 2010
  - Elgersburg Workshop, Elgersburg, Germany, February 14–17, 2011  
Contributed Talk: “Stabilität von geschalteten DAEs”
  - Meeting of the GAMM-Fachausschuss “Dynamik und Regelungstheorie”, Linz, Austria, March 18-19, 2011  
Contributed Talk: “Beobachtbarkeit von geschalteten DAEs”
  - Meeting of the GAMM-Fachausschuss ”Dynamik und Regelungstheorie”, Bayreuth, Germany, October 14–15, 2011  
Contributed Talk: “Der Bang-Bang Funnel Controller”
- Research Visits:
  - University of Waterloo, Waterloo, Ontario, Canada, July 26-30, 2010 (host: Prof. Daniel Miller).  
Invited talk in research seminar: “The bang-bang funnel controller”.
  - University of Sannio, Benevento, Italy, September 13-17, 2010 (host: Prof. Francesco Vasca).  
Invited talk in research seminar: “Modeling electrical circuits with switched differential algebraic equations”.
  - University of Illinois, Urbana-Champaign, USA, December 7-14, 2010 (host: Prof. Daniel Liberzon).

Fabian Wirth

- Co-Organization of the 2nd Elgersburg School on Mathematical Systems Theory: “Differential-Algebraic Equations - Control and Numerics” and “Behavioural Approach to Systems Theory”, with Achim Ilchmann (TU Ilmenau) and Timo Reis (TU Berlin).  
Elgersburg, Germany, March 8-13, 2010.
- Co-Organization of the workshop “The Dynamics of Control - A Workshop on the Occasion of the 60th Birthday of Fritz Colonius”, with Lars Grüne (U Bayreuth).  
Kloster Irsee, Germany, October 1–3, 2010.
- Research visit during the Focus Period ”Distributed Model Predictive Control and Supply Chains” Lund Center for Control of Complex Engineering Systems, Lund Sweden, May 18-28, 2010.
- Research visit, Dpto. Ingenieria de Sistemas y Automatica, Universidad de Valladolid, Spain, October 4-10, 2010 (host: Dr. Mustapha Ait Rami).

- Associate Editor: SIAM J. Control and Optimization; Systems and Control Letters.
- Participation at Workshops:
  - “Workshop on Distributed Model Predictive Control and Supply Chains”, Lund Center for Control of Complex Engineering Systems, Lund Sweden, May 19–21, 2010.  
Contributed Talk: “Logistics, queueing networks and model reduction”.
  - “Workshop on Stochastic Models of Manufacturing Systems”, Eindhoven, The Netherlands, June 24–25, 2010.  
Contributed Talk: “Structure preserving model reduction for logistic networks”.
  - Conference “19th International Symposium on Mathematical Theory of Networks and Systems”, Budapest, Hungary, July 5–9, 2010.  
Contributed Talk: “Epidemics in Time-Dependent Networks”.
  - “The Dynamics of Control” - A workshop on the occasion of the 60th birthday of Fritz Colonius, Kloster Irsee, October 1–3, 2010.  
Contributed Talk: “Linear time-varying systems and growth rates”.
  - “Communication in Distributed Control Systems”, Workshop of the DFG-SPP 1305, TU Kaiserslautern, November 29–30, 2010.  
Contributed Talk: “Realisation of Try-Once-Discard in wireless multi-hop-networks”
- Third Party Funding:
  - DFG Research Grant “Time-varying and Switched Differential-Algebraic Equations”, joint project with Achim Ilchmann (TU Ilmenau). Project duration July 2010 – October 2013.
  - EU Marie-Curie ITN “Sensitivity Analysis for Deterministic Controller Design - SADCO”, subproject “Stability analysis via coupled Hamilton-Jacobi equations”, joint project with Lars Grüne (U Bayreuth). Project duration: October 2011 – October 2014.
  - DFG Workshop Grant for the Workshop “The Dynamics of Control”, Kloster Irsee, October 1–3, 2010.

## 3.4 Theses

### Completed Diploma Theses

- *Stability of TCP models*, Arie Schlote, January 2010.  
Supervisor: F. Wirth.
- *Homotopy algorithms and the numerical construction of ISS Lyapunov functions*, Roman Geiselhart, July 2010.  
Supervisor: F. Wirth.
- *Properties of the BFGS-Method on Riemannian Manifolds*, Matthias Seibert, December 2011,  
Supervisor: Knut Hüper

- *The Dynamics of the “Empirical Mode Decomposition”-Algorithm*, Maximilian Himsel, December 2011.  
Supervisor: F. Wirth.

### Completed Bachelor Theses

- *Contributions to the Efficient Computation of PageRank*, Dmitri Nedrenco, December 2010.  
Supervisor: F. Wirth.
- *Convergence Behavior of GMRES(m) for Different Norms*, Alexander Klber, March 2011.  
Supervisors: U. Helmke, J. Jordan.
- *Stability of Interconnected Systems*, Sebastian Pröll, March 2011.  
Supervisor: F. Wirth.
- *Perturbation Theory in the Analysis of the PageRank-Algorithm*, Philipp Skavantzios, March 2011.  
Supervisor: F. Wirth.
- *On the Convergence of the BFGS-Method*, Frank Beislein, July 2011.  
Supervisor: Knut Hüper
- *On the Dynamics of Rayleigh Quotient Iterations*, Matthias Tuchscherer, July 2011.  
Supervisor: Knut Hüper
- *Central force problems and dynamical systems*, Jana Hümpfer, November 2011.  
Supervisor: Knut Hüper
- *The cubic function  $f_\lambda(x) = \lambda x - x^3$  as a discrete dynamical system*, Carola Pritsching, November 2011.  
Supervisor: Knut Hüper
- *Boolean Functions and Elementary Quantum Gates*, Michael Götz, December 2011.  
Supervisors: U. Helmke, G. Dirr.
- *Random Graphs and PageRank*, Florian Hammer, December 2011.  
Supervisor: F. Wirth.

### Industrial Placements

- *Implementation and testing of pattern recognition algorithms*, Markus Zenk, July -September 2011, in collaboration with SME: Medea AV, Erlangen, Germany.  
Supervisors: Knut Hüper, Christian Lagemann

### Diploma Theses in Progress

- *Communication Protocols and Stability of Consensus Algorithms*, Anita Barthel, since April 2010.  
Supervisor: F. Wirth.

## Completed PhD Theses

- *Controllability Aspects of The Lindblad-Kossakowski Master Equation: A Lie-Theoretical Approach*, Indra Kurniawan, January 2010.  
Supervisor: U. Helmke and G. Dirr.
- *Stability and Robustness of Fluid Networks: A Lyapunov Perspective*, Michael Schönlein, since 01.11.2007.  
Supervisor: F. Wirth.

## PhD Theses in Progress

- *Stabilization in large scale digital networks*, Roman Geiselhart, since 01.12.2010.  
Supervisor: F. Wirth.
- *Stability analysis via coupled Hamilton-Jacobi equations*, Huijuan Li, since 01.10.2011.  
Supervisor: F. Wirth.
- *Stability and stabilization of large scale digital networks*, Rudolf Sailer, since 01.01.2008.  
Supervisor: F. Wirth.
- *Newton methods for medical image registration*, Martin Schröter, since 01.04.2007.  
Supervisor: U. Helmke.
- *Numerical algorithms for the optimization of Rayleigh-quotient like functions on Riemannian manifolds*, Oana Curtef, since 01.11.2006.  
Supervisor: U. Helmke and G. Dirr.
- *Time-optimal control of the bi-steerable robot: A case study in optimal control of non-holonomic systems*, Markus Mauder (external PhD student), since 23.06.2004.  
Supervisor: U. Helmke.
- *Constructive controllability of bilinear systems on Lie groups*, Frederike Rüppel, since 01.04.2010.  
Supervisor: U. Helmke and G. Dirr.

## 3.5 External Reports

K. Hüper

- Referee for Project Proposals of International Graduate School of Science and Engineering (IGSSE), Technische Universität München, 2011

F. Wirth

- PhD thesis, Technical University of Ilmenau, March 2010.
- PhD thesis, University of L'Aquila, April 2011.
- Masters' thesis, Hamilton Institute NUI Maynooth, May 2011.
- PhD thesis, University of Bremen, August 2011.

### 3.6 Guests

- Dr. Mustapha Ait Rami, December 2010  
Universidad de Valladolid, Spain.
- MSc Corey O’Meara, October 2010  
QCCC Program University of Guelph, Canada.
- Dr. Jana Nemcova, October 2010  
APICS (INRIA Institut National De Recherche En Informatique Et En Automatique).
- Prof. Dr. P. Dewilde, July 2010  
Technal University of Munich, Germany.
- Dr. J. Trumpf, July 2010  
Australian National University, Australia.
- Mr. Mohamed Bolajraf, July 2010  
Universidad de Valladolid, Spain.
- Prof. Dr. Thomas Chambrion, July 2011  
Université Henri Poincaré, Nancy, France.

## 4 Publications

### Journal papers and Chapters in books

- [1] M. Ait Rami, F. Tadeo, and U. Helmke. Positive observers for linear positive systems, and their implications. *Internat. J. Control*, 84(4):716–725, 2011.
- [2] V. Bokhaire, O. Mason, and F. Wirth. Stability and positivity of equilibria for subhomogeneous cooperative systems. *Nonlinear Analysis A: TMA*, 74(17):6416–6425, 2011.
- [3] J. Cardoso, K. Hüper, and P. Saraiva, editors. *Mathematical papers in honour of Fátima Silva Leite. Selected papers based on the presentations at the special session on geometric control theory – a tribute to Fátima Silva Leite on the occasion of her 60th anniversary, held at the 9th Portuguese conference on automatic control, CONTROL’2010, Coimbra, Portugal, September 8–10, 2010*. Textos de Matemática. Série B 43. Coimbra: Universidade de Coimbra, Departamento de Matemática, 2011.
- [4] S. Dashkovskiy, H. Ito, and F. Wirth. On a small gain theorem for ISS networks in dissipative Lyapunov form. *European Journal of Control*, 17(4):357–365, 2011.
- [5] S. Dashkovskiy, M. Kosmykov, and F. Wirth. A small gain condition for interconnections of ISS systems with mixed ISS characterizations. *IEEE Transactions on Automatic Control*, 56(6):1247–1258, 2011.



- [6] S. N. Dashkovskiy, B. S. Rüffer, and F. R. Wirth. Small gain theorems for large scale systems and construction of ISS Lyapunov functions. *SIAM J. Control Optim.*, 48(6):4089–4118, 2010.
- [7] T. S. Doan, A. Kalauch, S. Siegmund, and F. R. Wirth. Stability radii for positive linear time-invariant systems on time scales. *Systems Control Lett.*, 59(3-4):173–179, 2010.
- [8] A. Dreves, A. von Heusinger, C. Kanzow, and M. Fukushima. A globalized Newton method for the computation of normalized Nash equilibria. *Journal of Global Optimization*, pages 1–14, 2011.
- [9] P. A. Fuhrmann and U. Helmke. On the elementary divisors of the Sylvester and Lyapunov maps. *Linear Algebra Appl.*, 432(10):2572–2588, 2010.
- [10] P. A. Fuhrmann and U. Helmke. On the use of functional models in model reduction. In *Perspectives in mathematical system theory, control, and signal processing*, volume 398 of *Lecture Notes in Control and Inform. Sci.*, pages 177–187. Springer, Berlin, 2010.
- [11] P. A. Fuhrmann and U. Helmke. Tensored polynomial models. *Linear Algebra Appl.*, 432(2-3):678–721, 2010.
- [12] P. A. Fuhrmann and U. Helmke. Equivalence conditions for behaviors and the Kronecker canonical form. *Math. Control Signals Systems*, 22(4):267–293, 2011.
- [13] H. Gluesing-Luerssen, U. Helmke, and J. I. Iglesias Curto. Algebraic decoding for doubly cyclic convolutional codes. *Adv. Math. Commun.*, 4(1):83–99, 2010.
- [14] U. Helmke and J. Jordan. Control and stabilization of linear equation solvers. In *Perspectives in Mathematical System Theory, Control, and Signal Processing*, volume 398 of *Lecture Notes in Control and Inform. Sci.*, pages 73–82. Springer, Berlin, 2010.
- [15] U. Helmke and M. Kleinsteuber. A differential equation for diagonalizing complex semisimple Lie algebra elements. *Systems Control Lett.*, 59(1):72–78, 2010.
- [16] U. Helmke and E. I. Verriest. Structure and parametrization of periodic linear systems. *Math. Control Signals Systems*, 23(1-3):67–99, 2011.
- [17] K. Hüper, K. A. Krakowski, and F. Silva Leite. Rolling maps in a Riemannian framework. In J. Cardoso, K. Hüper, and P. Saraiva, editors, *Textos de Matemática. Série B 43*, pages 15–30. Universidade de Coimbra, Departamento de Matemática, 2011.
- [18] C. Lageman and R. Sepulchre. Optimal data fitting on Lie groups: a coset approach. In M. Diehl, F. Glineur, E. Jarlebring, and W. Michiels, editors, *Recent Advances in Optimization and its Applications in Engineering*, pages 173–182. Springer-Verlag, Berlin, 2010.

- [19] C. Lageman, J. Trumppf, and R. Mahony. Gradient-like observers for invariant dynamics on a Lie group. *IEEE Trans. Automat. Control*, 55(2):367–377, 2010.
- [20] B. S. Rüffer, R. Sailer, and F. R. Wirth. Comments on “A multichannel IOS small gain theorem for systems with multiple time-varying communication delays”. *IEEE Trans. Automat. Control*, 55(7):1722–1725, 2010.
- [21] B. S. Rüffer and F. R. Wirth. Stability verification for monotone systems using homotopy algorithms. *Numer. Algorithms*, 58(4):529–543, 2011.
- [22] S. Said, C. Lageman, N. Le Bihan, and J. H. Manton. Decomposing on compact Lie groups. *IEEE Trans. Inform. Theory*, 56(6):2766–2777, 2010.
- [23] B. Scholz-Reiter, T. Makuschewitz, F. Wirth, M. Schönlein, S. Dashkovskiy, and M. Kosmykov. A comparison of mathematical modelling approaches for stability analysis of supply chains. *International Journal of Logistics Systems and Management*, 10(2):208–223, 2011.
- [24] B. Scholz-Reiter, F. Wirth, S. Dashkovskiy, T. Makuschewitz, M. Schönlein, and M. Kosmykov. Structure-preserving model reduction of large-scale logistics networks: Applications for supply chains. *The European Physical Journal B - Condensed Matter and Complex Systems*, 84(4):501–520, 2011.
- [25] B. Scholz-Reiter, F. Wirth, T. Makuschewitz, and M. Schönlein. Robust capacity allocation in dynamic production networks. *CIRP Annals-Manufacturing Technology*, 60:445–448, 2011.
- [26] T. Schulte-Herbrüggen, S. Glaser, G. Dirr, and U. Helmke. Gradient flows for optimization in quantum information and quantum dynamics: foundations and applications. *Reviews in Math. Phy.*, 22(6):597–667, 2010.

## Submissions

- [27] M. Ait Rami, J. Jordan, and M. Schönlein. Estimation of linear systems with unknown time-varying delays. *European Journal of Control*, submitted.
- [28] O. Curtef, G. Dirr, and U. Helmke. Riemannian optimization on tensor products of Grassmann manifolds: Applications to generalized Rayleigh-quotients. *ArXiv e-prints*, May 2010.
- [29] I. Kurniawan and G. Dirr. Accessibility generic property of open quantum control systems. *IEEE Trans. Automat. Control*, 2011. submitted.
- [30] I. Kurniawan, G. Dirr, and U. Helmke. Controllability aspects of quantum dynamics: A unified approach for closed and open systems. *IEEE Trans. Automat. Control*, 2011. submitted.
- [31] D. Liberzon and S. Trenn. Switched nonlinear differential algebraic equations: Solution theory, Lyapunov functions, and stability. *submitted*, 2010.

- [32] C. O’Meara, G. Dirr, and T. Schulte-Herbrüggen. Illustrating the geometry of coherently controlled unital open quantum systems. *IEEE Trans. Automat. Control*, 2011. submitted.
- [33] F. Rüppel and U. Helmke. Bilinear control of Toeplitz formations. *Z. angew. Math. Mech.*, 2011. submitted.

## Conference papers

- [34] F. Assaad, G. Dirr, F. Goth, and U. Helmke. Control aspects of a finite length Hubbard chain. In *Proc. 19th Int. Symp. on Mathematical Theory of Networks and Systems (MTNS2010)*, pages 547–551, Budapest, Hungary, July 5–9 2010.
- [35] V. Bokharaie, O. Mason, and F. Wirth. Spread of epidemics in time-dependent networks. In *Proc. 19th Int. Symp. on Mathematical Theory of Networks and Systems (MTNS2010)*, pages 1717–1719, Budapest, Hungary, July 5–9 2010.
- [36] M. Bolajraf, M. Ait Rami, and U. Helmke. Robust positive interval observers for uncertain positive systems. In *Preprints of the 18th IFAC World Congress*, pages 14330–14334, Milano, Italy, August 28 – September 2 2011.
- [37] C. de Persis, R. Sailer, and F. Wirth. On a small-gain approach to distributed event-triggered control. In *Preprints of the 18th IFAC World Congress*, pages 2401–2406, Milano, Italy, August 28 – September 2 2011.
- [38] A. D. Domínguez-García and S. Trenn. Detection of impulsive effects in switched DAEs with applications to power electronics reliability analysis. In *Proc. 49th IEEE Conf. Decis. Control, Atlanta, USA*, pages 5662–5667, Dec. 15–17 2010.
- [39] R. Geiselhart and F. Wirth. Numerical construction of LISS Lyapunov functions under a small gain condition. In *Proc. 50th IEEE Conf. Decis. Control and European Control Conference ECC 2011, Orlando, USA*, pages 6967–6972, December 1215 2011.
- [40] H. Gluesing-Luerssen, U. Helmke, and J. Curto. Decoding of a class of convolutional codes. In *Proc. 19th Int. Symp. on Mathematical Theory of Networks and Systems (MTNS2010)*, Budapest, Hungary, July 5–9 2010.
- [41] O. Heimlich, R. Sailer, and L. Budzisz. NMLab: A co-simulation framework for Matlab and NS-2. In *Proc. Second International Conference on Advances in System Simulation, SIMUL ’10*, pages 152–157, Nice, France, August 22–27 2010.
- [42] K. Hüper, U. Helmke, and S. Herzberg. On the computation of means on Grassmann manifolds. In *Proc. 19th Int. Symp. on Mathematical Theory of Networks and Systems (MTNS2010)*, pages 2439–2441, Budapest, Hungary, July 5–9 2010.

- [43] I. Kurniawan, G. Dirr, and U. Helmke. A unified approach to controllability of closed and open quantum systems. In *Proc. 19th Int. Symp. on Mathematical Theory of Networks and Systems (MTNS2010)*, pages 2333–2338, Budapest, Hungary, July 5–9 2010.
- [44] C. Lageman. Observability of partial states of invariant systems. In *Proc. 19th Int. Symp. on Mathematical Theory of Networks and Systems (MTNS2010)*, pages 1117–1120, Budapest, Hungary, July 5–9 2010.
- [45] C. Lageman and K. Hüper. Joint subspace intersections as a fitting problem. In *Proc. 19th Int. Symp. on Mathematical Theory of Networks and Systems (MTNS2010)*, pages 2445–2449, Budapest, Hungary, July 5–9 2010.
- [46] C. Lageman, K. Hüper, U. Helmke, and P. Lang. LQG balancing: Intertwining balancing and sign iterations. In *Proc. 49th IEEE Conf. Decis. Control, Atlanta, USA*, pages 5356–5361, Dec. 15–17 2010.
- [47] D. Liberzon and S. Trenn. The bang-bang funnel controller. In *Proc. 49th IEEE Conf. Decis. Control, Atlanta, USA*, pages 690–695, Dec. 15–17 2010.
- [48] M. A. Rami, J. Jordan, and M. Schönlein. Interval observers for linear systems with time-varying delays. In *Proc. 19th Int. Symp. on Mathematical Theory of Networks and Systems (MTNS2010)*, pages 75–79, Budapest, Hungary, July 5–9 2010.
- [49] R. Sailer and F. Wirth. A multichannel IOPs small-gain theorem for large scale systems. In *Proc. 19th Int. Symp. on Mathematical Theory of Networks and Systems (MTNS2010)*, pages 1477–1482, Budapest, Hungary, July 5–9 2010.
- [50] R. Sailer and F. Wirth. Multichannel small-gain theorems for large scale networked systems. In *Proc. 49th IEEE Conf. Decis. Control, Atlanta, USA*, pages 6571–6576, Dec. 15–17 2010.
- [51] R. Sailer and F. Wirth. Stabilization by encoded feedback with Markovian communication channels. In *Proc. 8th IFAC Symposium on Nonlinear Control Systems–NOLCOS*, pages 84–89, Bologna, Italy, September 2010.
- [52] B. Scholz-Reiter, M. Schönlein, M. Kosmykov, and T. Makuschewitz. A comparison of mathematical modelling approaches for stability analysis of supply chains. In *Proc. ICIL' 2010, International Conference on Industrial Logistics 'Logistics and Sustainability'*, pages 297–305, Rio de Janeiro, Brazil, March 2010.
- [53] B. Scholz-Reiter, F. Wirth, S. Dashkovskiy, M. Kosmykov, T. Makuschewitz, and M. Schönlein. An approach to model reduction of logistic networks based on ranking. In H.-J. Kreowski, B. Scholz-Reiter, and K.-D. Thoben, editors, *Dynamics in Logistics*, pages 91–103. Springer, 2011.

- [54] B. Scholz-Reiter, F. Wirth, S. Dashkovskiy, M. Schönlein, T. Makuschewitz, and M. Kosmykov. Some remarks on stability and robustness of production networks based on fluid models. In H.-J. Kreowski, B. Scholz-Reiter, and K.-D. Thoben, editors, *Dynamics in Logistics*, pages 27–35. Springer, 2011.
- [55] B. Scholz-Reiter, F. Wirth, T. Makuschewitz, and M. Schönlein. An approach to supply chain design based on robust capacity allocation of production locations. In *POMS 2010 - Operations in Emerging Economies*, Vancouver, Canada, May 2010. Paper 015-0639, available online at: <http://www.pomsmeetings.org/ConfPapers/015/015-0639.pdf>.
- [56] M. Schönlein and F. Wirth. Stability of fluid network models and Lyapunov functions. In *Proc. 19th Int. Symp. on Mathematical Theory of Networks and Systems (MTNS2010)*, pages 871–878, Budapest, Hungary, July 5–9 2010.
- [57] M. Schönlein, F. Wirth, T. Makuschewitz, and B. Scholz-Reiter. Supply network engineering: an approach to robust capacity allocation for stochastic production processes. In *Preprints of the 18th IFAC World Congress*, pages 441–446, Milano, Italy, August 28 – September 2 2011.
- [58] M. Schröter and O. Sauer. Medical image registration with robbins-monro algorithms. In *Proc. XVI-th International Conference on the Use of Computers in Radiation Therapy, ICCR 2010*, page on USB, Amsterdam, The Netherlands, June 2010.
- [59] H. Shen, K. Diepold, and K. Hüper. A geometric revisit to the trace quotient problem. In *Proc. 19th Int. Symp. on Mathematical Theory of Networks and Systems (MTNS2010)*, pages 2143–2146, Budapest, Hungary, July 5–9 2010.
- [60] A. Tanwani and S. Trenn. On observability of switched differential-algebraic equations. In *Proc. 49th IEEE Conf. Decis. Control, Atlanta, USA*, pages 5656–5661, Dec. 15–17 2010.

## PhD theses

- [61] I. Kurniawan. *Controllability Aspects of the Lindblad-Kossakowski Master Equation: A Lie-Theoretical Approach*. PhD thesis, University of Würzburg, Germany, 2010.
- [62] M. Schönlein. *Stability and Robustness of Fluid Networks: A Lyapunov Perspective*. PhD thesis, University of Würzburg, Germany, 2011.