Jan Heiland

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Born: January 21, 1983—Friedrichshafen, Germany
Nationality: German

Current Position

Team Leader at the Max Planck Institute for Dynamics of Complex Technical Systems
Junior Professor at the Otto-von-Guericke University Magdeburg

Areas of Specialization

Differential-algebraic Equations, **Navier-Stokes Equations**, **Optimal Control**,
System Theory, Model Reduction, Numerical Analysis

Academic Career

2007–2009	Student Employee at Bombardier Transportation, Department *Special Engineering for Aerodynamics and Acoustics*, Berlin
2009–2013	Full-time research assistant at TU Berlin, Department of Mathematics, Berlin
since 2013	Postdoc at MPI Magdeburg, Department *Computational Methods in Systems and Control Theory*, Magdeburg
since 2014	Team leader of the team *Computer Aided Control System Design* at the MPI Magdeburg
since 2018	Jun.Prof. for *Numerical Methods for Descriptor Systems* at the OVGU Magdeburg

Education

2009	DIPLOMA in technical mathematics, TU Berlin
2014	PHD in mathematics, TU Berlin

Scholarships, Research Stays & Honours

2010–2013	PhD scholarship by *Studienstiftung des dt. Volkes*
2012	Research stay at TUCOROM Poitiers, France, invited by Prof. B. Noack
2014	*Research in Pairs* at *Mathematisches Forschungsinstitut Oberwolfach*
2015&2016	Research stay at Shanghai University, China, as part of the *Recruitment Program of High-end Foreign Experts*
2017	*DAAD travel award* for visiting the *56th IEEE Conference on Decision and Control* in Melbourne, Australia
since 2015	Open Access Ambassador of the *Max Planck Society*

Service to the Community

since 2014	Reviewer for Adv. Comp. Math. — *Acta Appl. Math.* — *Automatica* — *Electron. Trans. Numer. Anal.* — *Math. Control Signals Systems* — *SIAM J. Cont. Opt.* — *SIAM J. Sci. Comput.* — *DAE Forum* — and several conference proceedings
2015	Organization of a young researcher minisymposium on *Analysis, Applications and Approximation of Constrained PDEs* at the GAMM annual meeting in Lecce, Italy
2015	Organization of a minisymposium on *Numerical Approximation of DAEs and Constrained PDEs with Applications* at the ICIAM 2015 in Beijing, China
2016	Organization of the workshop *Modelling, Model Reduction, and Optimization of Flows* in Shanghai, China
2017	Minisymposium *MS 28 – Model reduction methods for simulation and (optimal) control* at the Enumath 2017 in Voss, Norway
2018	Organization of a young researcher workshop *Analysis and Numerical Approximation of Constrained Systems* in Sion, Switzerland
2018	Chair of the focus session *Model order reduction and low-rank approximation for nonlinear problems* at the EUCCO2018 in Trier, Germany
2019	Minisymposium MS29 *Low-rank modelling in uncertainty quantification* at the Enumath 2019 in Eegmond aan Zee, The Netherlands

Academic Self-Governance

since 2018	Assistent member of the faculty board at the faculty for mathematics at the OVGU Magdeburg

Teaching

Courses

2015   Short Course on *Model Reduction of Linear Time Invariant Systems*. Shanghai University, Shanghai, China

2016   Course (4 SWS) on *Differential Algebraic Equations*. Summer Term 2016. Otto-von-Guericke-Universität, Magdeburg

2017   Course (4 SWS) on *Funktionentheorie Lehramt*. Winter Term 2017. Otto-von-Guericke-Universität, Magdeburg

2018   Short Course on *Tensor Techniques* for the *Graduiertenkolleg*. Otto-von-Guericke-Universität, Magdeburg

2018   Course (4 SWS) on *Differential Algebraic Equations*. Winter Term 2018. Otto-von-Guericke-Universität, Magdeburg

2019   Seminar (2 SWS) *Geometric formulations of inviscid fluids and their discretization*. Summer Term 2019. Otto-von-Guericke-Universität, Magdeburg

Tutorials

2010–2012   *Mathematik für PhysikerInnen IV*, *Numerik 1 für Ingenieure* and *Numerik 2*. TU Berlin

BA/MA Theses

2011   Manuel Baumann, BA, TU Berlin: *Modellierung und Simulation von Dispersionen in turbulenter Strömung*

2015   Max Behr, MA, Otto-von-Guericke-Universität Magdeburg: *Optimierung und Stabilisierung von inkompressiblen Strömungen in M.E.S.S.*

2016   Björn Baran, MA, Otto-von-Guericke-Universität Magdeburg: *Optimal Control of a Stefan Problem with Gradient-Based Methods in FEniCS*

2019   Andreas Roth, BA, Otto-von-Guericke-Universität Magdeburg: *Modelling of the impact of multiple scattering on scalar measurements using luminescent particles*

Supervision of PhD Projects

since 2016   Max Behr, Otto-von-Guericke-Universität Magdeburg: *Modellreduktion und Optimalsteuerung von linearen zeitveränderlichen und parameterabhängigen Systemen*

since 2016   Björn Baran, Otto-von-Guericke-Universität Magdeburg: *Riccati Based Feedback Control of Complex Flows*

Third party funding

2017   DAAD – travel grant – 2700 Euro

2016   *Chinesisch-Deutsches Zentrum für Wissenschaftsförderung* – financing of an international workshop[1] – 275500 RMB (about 36700 Euro) for local expenses plus 25500 Euro for international travel

2015&2016   *Chinese State Admistration of Foreign Experts Affairs* and *International Office of Shanghai University* – funding for travel and research stays – 50000 RMB (about 6700 Euro) & 61000 RMB (about 8100 Euro)

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[1]For political reasons, Prof. Peter Benner appeared as the author of the proposal. Prof. Peter Benner benner@mpi-magdeburg.mpg.de will be happy to confirm that the successful proposal was set up and written mainly by me.

Publications

All articles are original research articles.

Journal Publications

2019   *Solution Formulas for Differential Sylvester and Lyapunov Equations*. Calcolo, accepted for publication. (with M. Behr and P. Benner)

2018   *Space-Time Galerkin POD with application in optimal control of semi-linear parabolic partial differential equations*. SIAM Journal on Scientific Computing, Vol. 40(3), pp. A1611–A1641. (with P. Benner and M. Baumann)

2018   *Regularization and Rothe Discretization of Semi-Explicit Operator DAEs*. International Journal of Numerical Analysis and Modeling, Vol. 15(3), pp. 452–477. (with R. Altmann)

2018   *Exponential Stability and Stabilization of Extended Linearizations via Continuous Updates of Riccati Based Feedback*. International Journal of Robust and Nonlinear Control, Vol. 28, pp. 1218–1232. (with P. Benner)

2018   *Optimal Control of a Stefan Problem Fully Coupled with Incompressible Navier-Stokes-Equations and Mesh Movement*. Analele Stiintifice ale Universitatii Ovidius Constanta - Seria Matematica, 26(2), 11–40. (with B. Baran, P. Benner, J. Saak)

2017   *Moment-Matching Based Model Reduction for Navier–Stokes Type Quadratic-Bilinear Descriptor Systems*. ZAMM - Journal of Applied Mathematics and Mechanics, online first. (with M. I. Ahmad, P. Benner, and P. Goyal)

2017   *Simulation of Multibody Systems with Servo Constraints through Optimal Control*. Multibody System Dynamics, Vol. 40(1), pp. 75–98. (with R. Altmann)

2016   *A Differential-Algebraic Riccati Equation for Applications in Flow Control*. SIAM Journal on Control and Optimization, Vol. 54(2), pp. 718–739.

2015   *Finite Element Decomposition and Minimal Extension for Flow Equations*. M2AN - Mathematical Modelling and Numerical Analysis, Vol. 49(5), pp. 1489–1509. (with R. Altmann)

2015   *Time-dependent Dirichlet Conditions in Finite Element Discretizations*. ScienceOpen Research. (with P. Benner)

2012   *Distributed Control of Linearized Navier–Stokes Equations via Discretized Input/Output Maps*. ZAMM - Journal of Applied Mathematics and Mechanics. Vol. 92(4), pp. 257–274. (with V. Mehrmann)

Peer-reviewed Conference Proceedings and Book Chapters

2019   *Robust Controller versus Numerical Model Uncertainties for Stabilization of Navier-Stokes Equations.* IFAC-PapersOnLine, to appear. (with P. Benner and S. Werner)

2019   *Continuous, Semi-discrete, and Fully Discretised Navier-Stokes Equations.* In DAE Forum Volume *Applications of Differential-Algebraic Equations: Examples and Benchmarks*, pp. 277–312. (with R. Altmann)

2017   *Nonlinear Stabilizing Feedback Design for Incompressible Flows via Updated Riccati-Based Gains.* Proceedings of the 56th IEEE Conference on Decision and Control, CDC 2017, pp. 1163–1168. (with P. Benner)

2017   *Convergence of Approximations to Riccati-based Boundary-feedback Stabilization of Laminar Flows.* IFAC-PapersOnLine IFAC, Vol. 50(1), pp. 12296–12300. (with P. Benner)

2016   *Robust Stabilization of Laminar Flows in Varying Flow Regimes.* IFAC-PapersOnLine, IFAC. Vol. 49(8), pp. 31–36. (with P. Benner)

2015   *Discrete Input/Output Maps and their Relation to Proper Orthogonal Decomposition.* Numerical Algebra, Matrix Theory, Differential-Algebraic Equations and Control Theory. Festschrift in Honor of Volker Mehrmann. Springer, pp. 585–608. (with M. Baumann and M. Schmidt)

2015   *LQG-Balanced Truncation Low-Order Controller for Stabilization of Laminar Flows.* Active Flow and Combustion Control 2014, Springer. pp. 365–379. (with P. Benner)

2010   *A new discretization framework for input/output maps and its application to flow control.* Active Flow Control. Papers contributed to the Conference, Springer, pp. 357–372. (with V. Mehrmann and M. Schmidt)

Proceedings and Posters

2015   *A generalized POD space-time Galerkin scheme for parameter dependent dynamical systems*. Poster at MoRePaS 2015 - Model Reduction of Parametrized Systems III, Trieste, Italy. (with M. Baumann and P. Benner)

2010   *Simulation and Control of Drop Size Distributions in Stirred Liquid/Liquid Systems*. Proc. 4th International Conference on Population Balance Modelling, September 15-17 2010, Berlin. (with M. Baumann, A. Walle, V. Mehrmann, and M. Schäfer)

2009   *Shape Optimization in Train Aerodynamics*. Proceedings of Euromech Colloquium 509 Vehicle Dynamics, Berlin. (with A. Herbst, J. Mauss, and A. Orellano)

Selected Preprints

2017   *Example Setups of Navier–Stokes Equations with Control and Observation: Spatial Discretization and Representation via Linear-quadratic Matrix Coefficients*. arXiv:1707.08711. (with M. Behr and P. Benner)

2016   *Best Practices for Replicability, Reproducibility and Reusability of Computer-Based Experiments Exemplified by Model Reduction Software*. arXiv:1607.01191. (with J. Fehr, C. Himpe, and J. Saak)

2016   *Space-time Galerkin POD with application in optimal control of semi-linear parabolic partial differential equations*. arXiv:1611.04050. (with M. Baumann and P. Benner)

2015   *Simulation of Multibody Systems with Servo Constraints through Optimal Control*. Oberwolfach Preprint OWP 2015-18. (with R. Altmann)

Theses

2014   PhD thesis – *Decoupling and optimization of differential-algebraic equations with application in flow control*. TU Berlin.

2009   Diploma thesis – *Distributed Control of Semidiscretized Oseen Equations*. TU Berlin.

Publication of Code

2017   `nse-quadform-mats`. Data and example code for pure *Python/Octave/Matlab* imple-
        mentations of example setups of distributed or boundary control of incompressible flows.
        DOI:10.5281/zenodo.834940

2017   `spacetime-genpod-burgers`. A *Python* implementation of a generalized space-time
        POD method with application to optimal control of the Burgers' equation.
        DOI:10.5281/zenodo.583296

2016   `NSE-DAE-Riccati`. A *Python* implementation of an index-2 differential Riccati equa-
        tion solver for the solution of tracking problems for Navier-Stokes equations.
        DOI:10.5281/zenodo.192348

2014   `lqgbt-oseen`. A *Python* implementation of the LQGBT approach to low-dimensional
        controllers for the stabilization of incompressible flows. Application example: Stabiliza-
        tion of the cylinder wake.

2014   `dolfin-navier-scipy`. A *Python* interface between *FEniCS* for Finite Element dis-
        cretizations of flow equations and *Scipy* for time integration, model reduction, or control
        algorithms.

For weblinks to the publications see www.janheiland.de/publication

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