Johann **Rudi**

Assistant Professor of Mathematics

Department of Mathematics, Virginia Tech, 225 Stanger Street, Blacksburg, Virginia 24061, USA

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Education

The University of Texas at Austin — *Austin, Texas, USA*

Ph.D. in Computational Science, Engineering & Mathematics — *Aug. 2018*

- Advisors: Omar Ghattas (he) and Georg Stadler (he)

M.S. in Computational Science, Engineering & Mathematics — *Dec. 2014*

- Advisors: Omar Ghattas (he) and Georg Stadler (he)

Universität Paderborn — *Paderborn, Germany*

Diplom in Techno-Mathematics | Mathematics major, Computer Science and Electrical Engineering minors — *July 2010*

- Advisor: Angela Kunoth (she). German Diplom is comparable to three years of a bachelor's plus two years of a master's degree with thesis.

Experience

Department of Mathematics, Virginia Tech — *Blacksburg, Virginia, USA*

Assistant Professor of Mathematics — *Aug. 2022 – present*

- Faculty of the Computational Modeling & Data Analytics (CMDA) program
- Joint Appointment at Mathematics & Computer Science Division, Argonne National Laboratory

Mathematics and Computer Science Division, Argonne National Laboratory — *Lemont, Illinois, USA*

Argonne Scholar — *Sept. 2018 – Aug. 2022*

- Wilkinson Fellow (Sept. 2018 – Sept. 2020), Argonne National Laboratory
- Fellow at Northwestern–Argonne Institute of Science and Engineering (NAISE), Northwestern University

Oden Institute for Computational Engineering & Sciences, The University of Texas at Austin — *Austin, Texas, USA*

Graduate Research Assistant — *Aug. 2011 – Aug. 2018*

- Supervisors: Omar Ghattas (he) and Georg Stadler (he)

Postgraduate Researcher — *April 2010 – July 2011*

- Supervisor: Omar Ghattas (he)

Institut für Mathematik, Universität Paderborn — *Paderborn, Germany*

Graduate Research Assistant — *Sept. 2008 – April 2010*

- Supervisor: Angela Kunoth (she)

Professional Work Experience | Service

FLATmix GmbH & Co. KG (real estate broker) — *Paderborn, Germany*

Web Developer and IT Administrator — *May 2001 – April 2010*

Planbau Rudi GmbH & Co. KG (architecture and construction firm) — *Paderborn, Germany*

Web Developer and IT Administrator — *Sept. 2000 – April 2010*

4. ABC-Abwehrbataillon 7 der Bundeswehr — *Höxter, Germany*

Mandatory Military Service in Germany — *Oct. 2003 – June 2004*

Honors and Awards

Selected Awards

2018 **J. H. Wilkinson Fellowship in Scientific Computing**, Argonne National Laboratory — *Lemont, IL*

2016 **ACM/IEEE-CS George Michael Memorial HPC Fellowship**, Supercomputing Conference 2016 — *Salt Lake City, UT*

2015 **ACM Gordon Bell Prize 2015**, Supercomputing Conference 2015 [*Rudi, Malossi, Isaac, et al., 2015*] — *Austin, TX*

Additional Awards

2019	**Oden Institute's 2019 Outstanding Dissertation Award**, The University of Texas at Austin [*Rudi, 2018*]	*Austin, TX*
2016	**University Graduate Continuing Fellowship (1-year stipend & tuition)**, The University of Texas at Austin	*Austin, TX*
2016	**SIAM Student Travel Award**, SIAM Conference on Parallel Processing for Scientific Computing 2016	*Paris, France*
2016	**Student Paper Prize**, 14th Copper Mountain Conference on Iterative Methods [*Rudi, Stadler, Ghattas, 2016*]	*Copper Mountain, CO*
2015	**Finalist at the 26th Robert J. Melosh Medal Competition**, Duke University [*Rudi, 2015*]	*Durham, NC*
2014	**Best Poster Award**, Supercomputing Conference 2014	*New Orleans, LA*

Publications

Refereed Publications

1. Hu, J, **Rudi, J,** Gurnis, M & Stadler, G. Constraining Earth's Nonlinear Mantle Viscosity Using Plate-Boundary Resolving Global Inversions. *Proceedings of the National Academy of Sciences* **121,** e2318706121. doi:10.1073/pnas.2318706121 (2024).
2. **Rudi, J,** Heldman, M, Constantinescu, EM, Tang, Q & Tang, XZ. Scalable implicit solvers with dynamic mesh adaptation for a relativistic drift-kinetic Fokker–Planck–Boltzmann model. *Journal of Computational Physics* **507,** 112954. doi:10.1016/j.jcp.2024.112954 (2024).
3. Getter, D, Bessac, J, **Rudi, J** & Feng, Y. Statistical Treatment of Convolutional Neural Network Superresolution of Inland Surface Wind for Subgrid-Scale Variability Quantification. *Artificial Intelligence for the Earth Systems* **3,** e230009. doi:https://doi.org/10.1175/AIES-D-23-0009.1 (2024).
4. Lenzi, A, Bessac, J, **Rudi, J** & Stein, ML. Neural Networks for Parameter Estimation in Intractable Models. *Computational Statistics & Data Analysis* **185.** doi:10.1016/j.csda.2023.107762 (Sept. 2023).
5. Jackson, C, Chardon, M, Wang, YC, **Rudi, J,** Tresch, M, Heckman, CJ & Quinn, RD. *Multimodal Parameter Inference for a Canonical Motor Microcircuit Controlling Rat Hindlimb Motion* in *Biomimetic and Biohybrid Systems* (eds Meder, F, Hunt, A, Margheri, L, Mura, A & Mazzolai, B) (Springer Nature Switzerland, 2023), 38–51.
6. Wang, YC, **Rudi, J,** Velasco, J, Sinha, N, Idumah, G, Powers, RK, Heckman, CJ & Chardon, MK. Multimodal Parameter Spaces of a Complex Multi-Channel Neuron Model. *Frontiers in Systems Neuroscience* **16.** doi:10.3389/fnsys.2022.999531 (2022).
7. Dubey, A, Weide, K, O'Neal, J, Dhruv, A, Couch, S, Harris, JA, Klosterman, T, Jain, R, **Rudi, J,** Messer, B, *et al.* Flash-X: A Multiphysics Simulation Software Instrument. *SoftwareX* **19,** 101168. doi:10.1016/j.softx.2022.101168 (2022).
8. **Rudi, J,** Gurnis, M & Stadler, G. Simultaneous Inference of Plate Boundary Stresses and Mantle Rheology Using Adjoints: Large-Scale 2-D Models. *Geophysical Journal International* **231,** 597–614. doi:10.1093/gji/ggac207 (2022).
9. Hu, J, Gurnis, M, **Rudi, J,** Stadler, G & Müller, RD. Dynamics of the Abrupt Change in Pacific Plate Motion Around 50 Ma. *Nature Geoscience* **15,** 74–78. doi:10.1038/s41561-021-00862-6 (2022).
10. **Rudi, J,** Bessac, J & Lenzi, A. *Parameter Estimation with Dense and Convolutional Neural Networks Applied to the FitzHugh–Nagumo ODE* in *Proceedings of the 2nd Mathematical and Scientific Machine Learning Conference* (eds Bruna, J, Hesthaven, J & Zdeborova, L) **145** (PMLR, 2022), 781–808.
11. **Rudi, J,** Shih, YH & Stadler, G. Advanced Newton Methods for Geodynamical Models of Stokes Flow with Viscoplastic Rheologies. *Geochemistry, Geophysics, Geosystems* **21.** doi:10.1029/2020GC009059 (2020).
12. **Rudi, J,** Stadler, G & Ghattas, O. Weighted BFBT Preconditioner for Stokes Flow Problems with Highly Heterogeneous Viscosity. *SIAM Journal on Scientific Computing* **39,** S272–S297. doi:10.1137/16M108450X (2017).
13. **Rudi, J,** Malossi, ACI, Isaac, T, Stadler, G, Gurnis, M, Staar, PWJ, Ineichen, Y, Bekas, C, Curioni, A & Ghattas, O. *An Extreme-Scale Implicit Solver for Complex PDEs: Highly Heterogeneous Flow in Earth's Mantle* in *SC15: Proceedings of the International Conference for High Performance Computing, Networking, Storage and Analysis* (ACM, 2015), 5:1–5:12. doi:10.1145/2807591.2807675.
14. Sundar, H, Biros, G, Burstedde, C, **Rudi, J,** Ghattas, O & Stadler, G. *Parallel Geometric-Algebraic Multigrid on Unstructured Forests of Octrees* in *SC12: Proceedings of the International Conference for High Performance Computing, Networking, Storage and Analysis* (ACM/IEEE, 2012). doi:10.1109/SC.2012.91.
15. **Rudi, J,** Pabel, R, Jager, G, Koch, R, Kunoth, A & Bogena, H. Multiscale Analysis of Hydrologic Time Series Data using the Hilbert–Huang Transform. *Vadose Zone Journal* **9,** 925–942. doi:https://doi.org/10.2136/vzj2009.0163 (2010).

Reports | Theses | Workshop and Competition Papers

16. O'Neal, J, Wahib, M, Dubey, A, Weide, K, Klosterman, T & **Rudi, J.** *Domain-Specific Runtime to Orchestrate Computation on Heterogeneous Platforms* in *Euro-Par 2021: Parallel Processing Workshops* (Springer International Publishing, 2022), 154–165. doi:10.1007/978-3-031-06156-1_13.
17. **Rudi, J,** Bessac, J & Constantinescu, E. *Deep Neural Networks for Parameter Estimation with Inverse Maps and for Subgrid-Scale Models on the Cerebras CS-2 AI-Cluster* tech. rep. ANL-22/36. 2021 AI Testbed Expeditions, Laboratory Directed Research and Development (LDRD) (Argonne National Laboratory, Lemont, IL, 2021).
18. **Rudi, J,** O'Neal, J, Wahib, M, Dubey, A & Weide, K. *CodeFlow: Code Generation System for FLASH-X Orchestration Runtime* tech. rep. ANL-21/17 (Argonne National Laboratory, Lemont, IL, 2021).
19. **Rudi, J.** *Global Convection in Earth's Mantle: Advanced Numerical Methods and Extreme-Scale Simulations* PhD thesis (University of Texas at Austin, 2018). doi:10.26153/tsw/1258.

20. **Rudi, J,** Stadler, G & Ghattas, O. *μ-BFBT Preconditioner for Stokes Flow Problems with Highly Heterogeneous Viscosity* unpublished competition paper, Winner of the Student Paper Competition at the 14th Copper Mountain Conference on Iterative Methods, Copper Mountain, Colorado, USA. 2016.
21. **Rudi, J.** *Parallel, Robust Geometric Multigrid for Adaptive High-Order Meshes and Highly Heterogeneous, Nonlinear Stokes Flow of Earth's Mantle* unpublished competition paper, Finalist at the 26th Robert J. Melosh Medal Competition, Duke University, Durham, North Carolina, USA. 2015.
22. **Rudi, J.** *Empirical Mode Decomposition via adaptiver Wavelet-Approximation* Diploma Thesis in German (Universität Paderborn). 2010.

Submitted | Preprints

23. Villalobos, G, **Rudi, J** & Mang, A. *Neural Networks for Bayesian Inverse Problems Governed by Nonlinear ODEs* (in preparation). 2024.
24. **Rudi, J,** Lee, Y, Chadha, AH, Wahib, M, Weide, K, O'Neal, JP & Dubey, A. *CG-Kit: Code Generation Toolkit for Performant and Maintainable Variants of Source Code Applied to Flash-X Hydrodynamics Simulations* (arXiv preprint arXiv:2401.03378, under revision at Future Generation Computer Systems). 2024.

Funding

Awarded External Funding

Collaborative Research: Bridging Short and Long Time Scales in Global Plate Tectonics through Solver Adaptivity — *NSF*

NSF EAR & MPS | $750,000 | my role: PI | lead PI: Mike Gurnis (he, California Institute of Technology) — *Sept. 2024 – Aug. 2027*

- NSF 22-563 Geophysics (Award # 2343865)

Femtoscale Imaging of Nuclei using Exascale Platforms — *DOE*

DOE SC-NE SciDAC | $1,347,000 | my role: Co-PI | PI: Ian Cloët (he, Argonne National Laboratory) — *Aug. 2022 – Aug. 2027*

- DOE SC-NE Scientific Discovery through Advanced Computing (SciDAC): Partnership in Nuclear Energy (FOA: DE-FOA-0002592)

Supercomputer-Based Models of Motoneurons for Estimating Their Synaptic Inputs in Humans — *NIH*

NIH R01 | $3,907,539 | my role: Co-Investigator | PI: Charles J. Heckman (he, Northwestern University) — *May 2022 – Feb. 2027*

- NIH Research Project Grant (R01) (FOA: PA20-183)

Great Earthquakes: Bridging Short and Long Time Scales in Global Plate Tectonics — *NSF Subaward*

The University of Texas at Austin | $299,150 | my role: PI — *April 2022 – Mar. 2024*

- Subaward of NSF grant "Characteristic Science Applications for the Leadership Class Computing Facility" (Award # 2139536)

Awarded Internal Funding

Faculty Mentoring Grant — *Virginia Tech*

Office of the Vice Provost for Faculty Affairs | $1,500 | my role: PI — *July 2023 – Aug. 2025*

Inference and UQ in Large-Scale Models of Earth's Mantle Convection — *Virginia Tech*

Academy of Data Science Discovery Fund | $12,461 | my role: PI — *Aug. 2022 – Aug. 2023*

Deep-Learning Inference for Nuclear Femtography on Exascale Platforms — *Argonne National Laboratory*

Argonne LDRD – Swift | $50,000 | my role: Co-PI | PI: Ian Cloët (he, Argonne National Laboratory) — *Jan. 2022 – Mar. 2022*

AI-Hardware for DNNs to Estimate Parameters in Deterministic and Statistical Models — *Argonne National Laboratory*

Argonne LDRD – Advanced Computing Expedition | $25,000 | my role: PI — *May 2021 – Sept. 2021*

Awarded Computational Resources

Cerebras Accelerated Deep Neural Networks for Parameter Estimation in Scientific Models — *Pittsburgh Supercomputing Center*

Neocortex | Access to Cerebras CS-2 | my role: PI — *May 2023 – Aug. 2024*

Numerical Methods and Parallel Algorithms for Tokamak Disruption Simulation — *Argonne National Laboratory*

Argonne LCRC Computing Allocation | 400,000 core-hours | my role: PI — *April 2020 – Sept. 2022*

Inverse Problems to Infer Parameters of Biological Neurons in the Spinal Cord — *Argonne National Laboratory*

Argonne LCRC Computing Allocation | 550,000 core-hours | my role: PI — *April 2020 – Sept. 2022*

Quantifying Uncertainties in Large-Scale Mantle Flow and Ice Sheet Models via Bayesian Inversion — *NSF XSEDE*

NSF XSEDE Supercomputer Allocation | 270,967 node-hours | my role: Co-PI | PI: Georg Stadler (he, New York University) — *Dec. 2019 – Dec. 2020*

Mentoring

Professional Mentoring

Harrison Goldwyn (he) — *National Renewable Energy Laboratory*

Data Scientist | my role: co-supervisor | main supervisor: Julie Bessac (she, NREL) — *01/2024–present*

- Topic: Probabilistic loss functions in superresolution deep learning models

Max Heldman (he) — *Virginia Tech*

Postdoctoral Appointee | my role: supervisor, funding PI — *01/2023–present*

- Topic: Great earthquakes – Bridging short and long time scales in global plate tectonics
- Funding source: The University of Texas Austin (subaward of NSF award # 2139536), NSF award # 2343865
- Awards: Virginia Tech Postdoc Travel Award
- Publications: [2]

Daniel Getter (he) — *Argonne National Laboratory*

Postbachalor Appointee | my role: co-supervisor | main supervisor: Julie Bessac (she, ANL) — *01/2022–07/2023*

- Topic: Statistical treatment of convolutional neural network super-resolution for subgrid-scale variability
- Publications: [3]

Graduate Student Mentoring

Achintya Sunil (he) — *Virginia Tech*

Ph.D. Student in Mathematics | my role: advisor — *08/2024–present*

- Area: Computational mathematics

Ghafirlia Istafa (she) — *Virginia Tech*

Ph.D. Student in Mathematics | my role: advisor, funding PI — *08/2023–present*

- Area: Computational mathematics
- GRA funding source: Startup, NSF award # 2343865

Aaron Pueschel (he) — *Virginia Tech*

M.S. Student in Mathematics | my role: advisor — *08/2023–present*

- Area: Computational mathematics

Arash Nouri (he) — *Virginia Tech*

M.S. Student in Computer Science | my role: co-advisor, funding PI, thesis committee | main advisor: Adrian Sandu (he) — *08/2023–present*

- Area: Computer science and statistics
- GRA funding source: DOE SciDAC (DE-FOA-0002592)

Anwesa Dey (she) — *University of Utah*

Ph.D. Student in Mathematics | my role: co-advisor, thesis committee | main advisor: Elena Cherkaev (she, U Utah) — *01/2022–present*

- Topic: Solving inverse problems with machine learning

German Villalobos (he) — *University of Houston*

Ph.D. Student in Mathematics | my role: co-advisor, thesis committee | main advisor: Andreas Mang (he, U Houston) — *10/2020–12/2023*

- Thesis: Scientific Machine Learning for Bayesian Inverse Problems Governed by the FitzHugh–Nagumo Model
- Publications: [23]

Undergraduate Student Mentoring

Aidan Chadha (he) — *Virginia Tech*

B.S. Student in CMDA | my role: supervisor — *08/2023–present*

- Projects: 1. Code generation for high-performance and hetergeneous computing, 2. Data representation for training of deep learning models
- Awards: CMDA Undergraduate Research Grant (1. Spring 2024, 2. Fall 2024)
- Publications: [24]

Ansel Huffman (he) — *Virginia Tech*

B.S. Student in CMDA/Mathematics | my role: co-supervisor | main supervisor: Max Heldman — *05/2023–08/2023*

- Project: Particle-based reaction-diffusion simulation
- Awards: CMDA Undergraduate Research Grant (Summer 2023)

Joel Gujjarlamudi (he) *Virginia Tech*

B.S. Student in CMDA/Computer Science | my role: supervisor, funding PI *05/2023–12/2023*

- Project: Data analysis and information extraction from numerical simulations
- Funding source: DOE SciDAC (DE-FOA-0002592)

Bohan Zhang (he) *Virginia Tech*

B.S. Student in CMDA | my role: supervisor, funding PI *01/2023–08/2023*

- Project: Deep learning and artificial intelligence
- Funding source: DOE SciDAC (DE-FOA-0002592)

Gianna Rowe (she) *Virginia Tech*

B.S. Student in CMDA/Computer Science/Mathematics | my role: supervisor, funding PI *01/2023–05/2023*

- Project: Parallel programming, high-performance and heterogeneous computing
- Funding source: DOE SciDAC (DE-FOA-0002592)

Internship Mentoring (Graduate-Level Research)

Arindam Khanda (he, Missouri University of Science and Technology) *Argonne National Laboratory*

W.J. Cody Associate | my role: co-supervisor | main supervisor: Getnet Betrie (he) *05/2022–07/2022*

- Project: Scalable inverse modeling algorithm for dynamic large-scale brain networks

Anwesa Dey (she, University of Utah) *Argonne National Laboratory*

NSF Mathematical Sciences Graduate Internship (MSGI) | my role: supervisor | co-supervisor: Getnet Betrie (he) *06/2021–08/2021*

- Project: Solving inverse problems of dynamical systems with techniques from machine learning

Trevor Teolis (he, University of Illinois at Chicago) *Argonne National Laboratory*

NSF Mathematical Sciences Graduate Internship (MSGI) | my role: co-supervisor | main supervisor: Paul Manns (he) *05/2021–07/2021*

- Project: Neural network-based regularizers for PDE-constrained mixed integer optimization

Max Heldman (he, Boston University) *Argonne National Laboratory*

Research Aide | my role: supervisor *06/2020–05/2021*

- Project: Numerical PDE solvers using the PETSc library for Fokker–Planck–Boltzmann simulation
- Publications: [2]

Gideon Idumah (he, Case Western Reserve University) *Argonne National Laboratory*

NSF Mathematical Sciences Graduate Internship (MSGI) | my role: supervisor *06/2020–08/2020*

- Project: Statistical inverse problems governed by nonlinear ODEs in neuroscience
- Publications: [6]

Max Heldman (he, Boston University) *Argonne National Laboratory*

NSF Mathematical Sciences Graduate Internship (MSGI) | my role: supervisor *05/2019–08/2019*

- Project: Nonlinear multigrid methods

Stephen Guffey (he, University of Memphis) *Argonne National Laboratory*

NSF Mathematical Sciences Graduate Internship (MSGI) | my role: co-supervisor | main supervisor: Sven Leyffer (he) *04/2019–07/2019*

- Project: Optimization with PDE constraints

Teaching

Graduate Courses

Computational Inference of Uncertain Model Parameters *Virginia Tech*

5000-level course | topics course in applied mathematics *Spring 2023*

- Numerical methods for inverse problems governed by physical models, where the models are systems of partial and ordinary differential equations
- Ill-posedness, regularization, deterministic and statistical/Bayesian inference, variational methods
- Focus on large-scale computational solution algorithms for inverse problems

Undergraduate Courses

Computer Science Foundations for Computational Modeling & Data Analytics

Virginia Tech

3000-level course

Falls of 2022, 2023

- Survey of computer science concepts and software tools that enable computational science and data analytics
- Design and analysis of data structures and algorithm performance
- Introduction to high-performance computer architectures and parallel programming
- Evaluating performance in large-scale computational modeling and data analytics

Tutorials

Tutorial Lecture About Version Control with GIT for Programming Productivity

Virginia Tech

1000-level undergraduate course | Guest lecture in Discovering Computational Modeling & Data Analytics

Falls of 2022, 2023

Introductory Lecture Series and Reading Group

Argonne National Laboratory

Professional-level laboratory researchers

2019 – 2021

- Introductory lectures on partial differential equations, optimization, and statistics
- Reading group on inverse problems under uncertainty governed by partial differential equations

Introduction to Partial Differential Equations and Inverse Problems

Argonne National Laboratory

Professional-level laboratory researchers

Nov. 2019

Project Highlights

Current Projects

- **Simulation, Inference, and Uncertainty Quantification in Large-Scale Earth Mantle Models**. Collaborators: Caltech (M. Gurnis), Courant NYU (G. Stadler), SUSTech–China (J. Hu). Role: I develop methods for extreme-scale Bayesian inverse problems in Earth's mantle convection and plate tectonics, In order to systematically study strengths of tectonic plate couplings and to constrain uncertain parameters in the constitutive relation of the Earth's mantle. I develop and implement adjoint-based scalable solvers.
- **Numerical Methods and Parallel Algorithms for Large-Scale Tokamak Disruption Simulation**. Collaborators: Los Alamos National Lab (X. Tang, Q. Tang), Argonne National Lab (E. Constantinescu), Boston University (M. Heldman). Role: I develop new parallel large-scale solvers for simulating dynamics of runaway electrons governed by Fokker–Planck PDEs, solutions to which exhibit contrasts of over 20 orders of magnitude. My focus is enabling aggressive mesh adaptivity (over 3 orders of magnitude difference in cell sizes) and dynamic evolution of parallel adaptive meshes.
- **Code Generation and Transformation for Portable HPC Software**. Collaborators: Argonne National Lab (A. Dubey, J. O'Neil), AIST–Japan (M. Wahib), University of Chicago (K. Weide). Role: I design new cyberinfrastructure tools for large complex simulation codes, where the emphasis is on maintainability and portability of an HPC code. My work consists of code analysis tools as well as code generation and transformation tools.
- **Deep Neural Network-Based Inverse Maps for Estimating Parameters in Deterministic and Statistical Models**. Collaborators: Argonne National Lab (J. Bessac, A. Lenzi), University of Houston (A. Mang, G. Villalobos). Role: I develop parameter estimation techniques using dense and convolutional artificial neural networks for inference with deterministic models based on differential equations and/or stochastic processes.
- **Inverse Problems to Recover Parameters in Models of Biological Neurons in the Spinal Cord**. Collaborators: Northwestern (M. Chardon, N. Sinha, C.J. Heckman), California State L.A. (C. Wang). Role: I explore and develop mathematical methods and algorithms to solve inverse problems in neuroscience; Focus on Markov chain Monte Carlo methods.

Completed Projects

- **Newton Methods for Nonlinear Viscoplastic Fluids**. Collaborators: Courant NYU (G. Stadler, Y. Sigh). Role: I designed new nonlinear solvers based on Newton's method for strong nonlinearities occurring in viscoplastic flows governed by Stokes equations, for instance, in geodynamic applications.
- **Scalable and Coefficient-Robust Preconditioner for the Schur Complement of Stokes PDEs**. Collaborators: Courant NYU (G. Stadler), UT Austin (O. Ghattas). Role: I derived a new preconditioner that approximates the inverse Schur complement of a Stokes saddle-point system; Focus on robustness with respect to highly heterogeneous coefficients and efficiency on large parallel supercomputers.
- **Parallel Extreme-Scale PDE Solvers for Earth's Mantle Convection**. Collaborators: Courant NYU (G. Stadler), UT Austin (O. Ghattas), Caltech (M. Gurnis), Georgia Tech (T. Isaac), IBM–Zurich (C. Malossi, P. Staar, Y. Ineichen, C. Bekas, A. Curioni), Role: I developed numerical methods and implemented parallel algorithms for extreme-scale implicit solvers for simulation of Earth's mantle convection; Focus on spectral and geometric multigrid for high-order finite elements and adaptive meshes distributed in parallel.

Professional Activities

Conferences

Program committee member:

- SIAM Conference on Parallel Processing for Scientific Computing (PP24) program committee
- International Parallel & Distributed Processing Symposium (IPDPS'24) papers
- ISC High Performance (ISC 23) papers
- Supercomputing 2022 (SC'22) papers
- ISC High Performance 2022 (ISC 22) papers
- International Conference on Parallel Processing 2021 (ICPP 2021) papers
- Supercomputing 2021 (SC'21) workshops

Symposium organizer:

- SIAM Conference on Parallel Processing for Scientific Computing (PP24), together with Pi-Yueh Chuang (he, Virginia Tech), Emil Vatai (he, RIKEN–Japan), Mohamed Wahib (he, RIKEN–Japan), Mar. 2024.
- SIAM Southeastern Atlantic Sectional Meeting (SEAS), together with Max Heldman (he, Virginia Tech), Julie Bessac (she, National Renewable Energy Laboratory), Mar. 2023.
- SIAM Conference on Computational Science and Engineering (CSE23), together with Andreas Mang (he, U Houston), Tan Bui-Thanh (he, UT Austin), Feb. 2023.
- SIAM Conference on Uncertainty Quantification (UQ22), together with Jon Wittmer (he), Krish Giri (he), Hai Nguyen (he), Tan Bui-Thanh (he, UT Austin), April 2022.
- SIAM Conference on Parallel Processing for Scientific Computing (PP22), together with Mohamed Wahib (he, AIST–Japan), Anshu Dubey (she, ANL), Feb. 2022.
- SIAM Conference on Mathematical and Computational Issues in the Geosciences (GS21), together with Lukas Holbach (he, Uni Mainz), Omar Ghattas (he, UT Austin), and Georg Stadler (he, NYU), June 2021.

Peer Reviews

- ACM Transactions on Mathematical Software (TOMS)
- ACM Transactions on Parallel Computing (TOPC)
- Computer Methods in Applied Mechanics and Engineering (CMAME)
- International Journal of High Performance Computing Applications (IJHPCA)
- Numerical Linear Algebra with Applications (NLA)
- SIAM Journal on Scientific Computing (SISC)

Software Development

- Main developer of application, *Rhea* (C, MPI, OpenMP), for simulation and inference of geophysical phenomena, featuring large-scale parallel Stokes solvers, preconditioner, and adaptive meshes.
- Main developer of package, *CG-Kit* (Python), a code generation toolkit for algorithmic and performance portability.
- Main developer of application, *Runaway* (C, MPI), for dynamics of runaway electrons in tokamak disruption simulations requiring dynamic adaptive mesh refinement.
- Main developer of library unit as part of PETSc, *DMBF* (C, MPI), for data management for discretizations on parallel adaptive meshes (via p4est library).
- Co-developer of scalable open source software library, *mangll* (C, MPI, OpenMP), for continuous and discontinuous finite elements.
- Contributor to scalable open source software library, *p4est* (C, MPI), for parallel adaptive mesh refinement.
- Contributor to scalable open source software library, *PETSc* (C, MPI), for scalable linear and nonlinear solvers.

Presentations

2024

- **National High Performance Computing Conference**, invited talk, Darmstadt, Germany, September 10, 2024.
- **Conference on Computational and Mathematical Biomedical Engineering (CMBE24)**, invited talk, Arlington, Virginia, June 24, 2024.
- **SIAM Conference on Mathematics of Planet Earth (MPE24)**, poster, Portland, Oregon, June 10, 2024.
- **Numerical Analysis Seminar at the University of Maryland**, invited seminar talk, College Park, Maryland, April 23, 2024.
- **SIAM Conference on Parallel Processing for Scientific Computing (SIAM PP24)**, invited talk, Baltimore, Maryland, March 5, 2024.

2023

- **Applied Numerical Analysis Seminar at Virginia Tech**, talk, Blacksburg, Virginia, September 29, 2023.
- **DOE SciDAC PI Meeting**, poster, Rockville, Maryland, September 12–14, 2021.
- **SIAM Southeastern Atlantic Section Annual Meeting (SEAS)**, invited talk, Blacksburg, Virginia, March 25, 2023.
- **Tokamak Disruption Simulation Webinar at Los Alamos National Laboratory**, invited seminar talk, virtual, March 10, 2023.
- **SIAM Conference on Computational Science and Engineering (CSE23)**, invited talk, Amsterdam, Netherlands, March 2, 2023.

2022

- **Applied Numerical Analysis Seminar at Virginia Tech**, talk, Blacksburg, Virginia, October 28, 2022.
- **SIAM Conference on Uncertainty Quantification (UQ22)**, talk, virtual, April 15, 2022.
- **SIAM Conference on Parallel Processing for Scientific Computing (SIAM PP22)**, talk, virtual, February 26, 2022.
- **Virginia Tech**, invited seminar talk, Blacksburg, Virginia, February 7, 2022.
- **Portland State University**, invited seminar talk, Portland, Oregon, January 20, 2022.

2021

- **Karlsruher Institut für Technologie**, invited seminar talk, virtual, September 13, 2021.
- **Mathematical and Scientific Machine Learning (MSML21)**, invited talk, virtual, August 19, 2021.
- **SIAM Conference on Mathematical & Computational Issues in the Geosciences (GS21)**, talk, virtual, June 23, 2021.
- **Florida Institute of Technology**, invited seminar talk, virtual, April 2, 2021.
- **Flatiron Institute**, invited seminar talk, virtual, March 11, 2021.
- **SIAM Conference on Computational Science and Engineering (CSE21)**, invited talk, virtual, March 5, 2021.
- **SIAM Conference on Computational Science and Engineering (CSE21)**, poster, virtual, March 2, 2021.

2020

- **SIAM Conference on Parallel Processing for Scientific Computing (PP20)**, poster, Seattle, Washington, USA, February 13, 2020.
- **Seminar at Argonne National Laboratory**, seminar talk, January 22, 2020.

2019

- **AGU**, invited talk, San Francisco, California, USA, December 11, 2019.
- **Preconditioning 2019**, invited talk, Minneapolis, Minnesota, USA, July 3, 2019.
- **Argonne National Laboratory**, seminar talk, May 1, 2019.
- **SIAM Conference on Mathematical & Computational Issues in the Geosciences (GS19)**, invited talk, Houston, Texas, USA, March 12, 2019
- **SIAM Conference on Computational Science and Engineering (CSE19)**, poster, Spokane, Washington, USA, February 26, 2019.
- **Dynamics Days 2019**, poster, Northwestern University, Evanston, Illinois, USA, January 4, 2019.

2018

- **SIAM Conference on Parallel Processing for Scientific Computing (PP18)**, invited talk, Tokyo, Japan, March 10, 2018.
- **Seminar at Argonne National Laboratory**, invited seminar talk, January 24, 2018.

2017

- **SIAM Conference on Computational Science & Engineering (CSE17)**, invited talk, Atlanta, Georgia, USA, March 3, 2017.

2016

- **International Supercomputing Conference 2016 (ISC16)**, invited talk, Frankfurt, Germany, June 22, 2016.
- **SIAM Conference on Parallel Processing for Scientific Computing (PP16)**, invited talk, Paris, France, April 13, 2016.
- **14th Copper Mountain Conference on Iterative Methods**, invited talk, Copper Mountain, Colorado, USA, March 24, 2016.

2015

- **26th Robert J. Melosh Medal Finalist Symposium**, invited talk, Duke University, Durham, North Carolina, USA, April 24, 2015.
- **SIAM Conference on Computational Science & Engineering (CSE15)**, poster, Salt Lake City, Utah, USA, March 16, 2015.

2014

- **SC'14: The International Conference for High Performance Computing, Networking, Storage and Analysis**, poster, New Orleans, Louisiana, USA, November 18, 2014.
- **ICES Student Forum at The University of Texas at Austin**, seminar talk, November 14, 2014.
- **SIAM Annual Meeting (AN14)**, invited talk, Chicago, Illinois, USA, July 7, 2014.

2013

- **SIAM Conference on Computational Science & Engineering (CSE13)**, poster, Boston, Massachusetts, USA, February 26, 2013.

2009

- **19th Rhein-Ruhr-Workshop on Applied Analysis, Approximation Theory, CAGD and Numerical Mathematics**, talk, Mühlheim an der Ruhr, Germany, February 6, 2009.

Skills

Programming	C/C++, Python, Matlab, JAVA
Parallel Computing	MPI, OpenMP, CUDA, HIP, OpenACC
Libraries/Frameworks	PETSc, PyTorch, TensorFlow/Keras, Stan
Web Development	PHP, MySQL, HTML, XML, CSS, JavaScript
Languages	English, German (native language), and Russian

References

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