Samuel Lanthaler

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Personal Information

Citizenship: Switzerland

Address: California Institute of Technology
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Employment History

Postdoc **California Institute of Technology** **Aug 2022 – present**
Pasadena, CA, USA
- Mentor: Prof. Andrew M. Stuart

Postdoc/ Lecturer **ETH Zürich** **Dec 2021 – July 2022**
Zurich, Switzerland
- Mentor: Prof. Siddhartha Mishra

Education

PhD **Mathematics, ETH Zürich** **Nov 2018 – Nov 2021**
Zurich, Switzerland
- Advisor: Prof. Siddhartha Mishra

PhD **Physics, EPF Lausanne** **Aug 2015 – Aug 2020**
Lausanne, Switzerland
- Advisor: Prof. Jonathan P. Graves

MSc **Mathematics, ETH Zürich** **Sep 2013 – Mar 2015**
Zurich, Switzerland

BSc **Mathematics, ETH Zürich** **Sep 2010 – Sep 2013**
Zurich, Switzerland

Teaching Experience

Lecturer **Approximation Theory and Neural Networks** **Fall 2023**
California Institute of Technology

Lecturer **Numerical Methods for Hyperbolic PDEs** **Spring 2022**
ETH Zürich

Head assistant **Linear Algebra** **Fall 2019, Fall 2020, Fall 2021**
ETH Zürich
- Conducting and organizing examinations, **350 students**,
- Organization of exercise classes and exercises, **8 TAs**,

Teaching assistant

- in both **mathematics** and **physics**,
- Numerical Methods for Hyperbolic PDEs (ETHZ; 2019); Mathematical Methods for Physicists (EPFL; 2017, 2018); Advanced Physics (EPFL; 2017); Computational Physics (EPFL; 2015, 2016); Numerical Mathematics (ETHZ; 2013); Differential Geometry (ETHZ; 2012)

Supervisory and Mentoring Experience

Mentoring activity

Supervision

- **Undergraduate Summer research (Caltech):**
  Kieran Hale, 2023; Mario Solis, 2023.

Co-supervision

- **Master Theses (ETH Zurich):**
  Fabian Jin, 2021, *awarded ETH Medal*; Patrik Hadorn, 2021; Michael Prasthofer, 2021,
- **Semester Theses (ETH Zurich):**
  Fabian Jin, 2021; Patrik Hadorn, 2021.

Fellowships and Grants

SNSF **SNSF Postdoc.Mobility** **Aug 2022 – Aug 2024**
grant by the Swiss National Science Foundation *CHF 67'000/year*

ETH Zürich **Excellence Scholarship** **Sep 2013 – Jan 2015**
A special scholarship to cover the full study and living costs for the duration of master's degree, as well as specific supervision. *CHF 12'000/semester*

Awards and Honors

ETH Medal **ETH Zürich** **May 2022**
Awarded for outstanding doctoral thesis

GAMM **GAMM Junior Fellow** **Jan 2022 – Dec 2024**
Elected by the International Association of Applied Mathematics and Mechanics for outstanding work in doctoral thesis (10 junior fellows per year)

ETH Medal **ETH Zürich** **Jan 2015**
Awarded for outstanding master's thesis

Polya prize **ETH Zürich** **Dec 2013**
Awarded for best bachelor's degree in mathematics and physics.

Academic Service

Journal referee

- Nature Computational Science
- Journal of Scientific Computing
- IMA Journal of Numerical Analysis
- SIAM J. on Scientific Computing
- SIAM Journal on Numerical Analysis
- Inverse Problems
- Constructive Approximation
- Foundations of Data Science
- Comm. in Computational Physics
- Neural Networks
- Analysis and Applications
- Calcolo
- Vietnam Journal of Mathematics
- Connection Science
- Transactions on Machine Learning Research (TMLR)

Organization **Minisymposium ICIAM 2023, Tokyo, Japan** **Aug 2023**
"Theoretical foundations and algorithmic innovation in operator learning"

Organization **Minisymposium SIAM UQ 2024, Trieste, Italy** **Feb 2024**
"Recent Advances in Scalable Active Learning and Optimal Experimental Design"

Committee External expert for PhD candidacy exam (Physics, EPFL) **Nov 2022**

Outreach
- Judge at Los Angeles Science Fair **Mar 2023**
- Tour guide for TCV tokamak (EPF Lausanne) **2015 – 2018**

Languages

GERMAN: Native
ENGLISH: Fluent (C2)
FRENCH: Advanced (C1)
KOREAN: Intermediate (B1)

Presentations

Feb 2024 Minisymposium on *"Operator Learning in Uncertainty Quantification"*, SIAM UQ24, Trieste, Italy

Feb 2024 Brin MRC workshop *"Scientific Machine Learning: Theory and Algorithms"*, University of Maryland, College Park, MD

Jan 2024 Minisymposium on *"Scientific Machine Learning to Advance Modeling and Decision Support"*, Joint Mathematics Meeting, JMM 2024, San Francisco, CA

Aug 2023 Minisymposium on *"Theoretical foundations and algorithmic innovation in operator learning"*, 10th International Congress on Industrial and Applied Mathematics, ICIAM 2023, Tokyo, Japan

July 2023 Keynote speaker at minisymposium on *"Recent developments in operator learning"*, 17th U. S. National Congress on Computational Mechanics, USNMCC17, Albuquerque, NM

Nov 2022 *Applied Math Seminar*, UC Berkeley

Oct 2022 Seminar at University of Pennsylvania

Sep 2022 Minisymposium on "Provable Guarantees for Learning Dynamical Systems", SIAM MD22, San Diego, CA

Apr 2022 Minisymposium on "Operator Learning in PDEs, Inverse Problems, and UQ", SIAM UQ22, Atlanta, GA

Mar 2022 Minisymposium on "Recent Advances on Analysis and Numerics of Multidimensional Compressible Flows", SIAM PD22 (virtual)

Sep 2021 *Swiss Numerics Day 2021*, EPF Lausanne, Switzerland

Research stays

Nov 2022 Week long research stay at *UC Berkeley* (invited by F. Weber)

June 2022 Two-week long research stay at *Duke University* (invited by T. Elgindi)

April 2016 Two-week long research stay at *Centre for Fusion Energy*, Culham, UK

Publications and Preprints

1. "Operator Learning: Algorithms and Analysis", N. Kovachki, S. Lanthaler, A. M. Stuart, *arXiv:2402.15715* (2024), *to appear in Handbook of Numerical Analysis*
2. "The Parametric Complexity of Operator Learning", S. Lanthaler, A. M. Stuart, *arXiv:2306.15924* (2024), *submitted to IMA Journal of Numerical Analysis*
3. "The Nonlocal Neural Operator: Universal Approximation", S. Lanthaler, Z. Li, A. M. Stuart, *arXiv:2304.13221* (2023), *submitted to Constructive Approximation*
4. "Error Bounds for Learning with Vector-Valued Random Features", S. Lanthaler, N. H. Nelsen, *Advances in Neural Information Processing Systems, NeurIPS* (2023)
5. "Neural Oscillators are Universal", S. Lanthaler, T. K. Rusch, S. Mishra, *Advances in Neural Information Processing Systems, NeurIPS* (2023)
6. "Operator learning with PCA-Net: upper and lower complexity bounds", S. Lanthaler, *Journal of Machine Learning Research*, **24**(318):1-67 (2023)
7. "On concentration in vortex sheets", S. Lanthaler, Partial Differ. Equ. Appl., **4**(13) (2023)
8. "Nonlinear Reconstruction for Operator Learning of PDEs with Discontinuities", S. Lanthaler, R. Molinar, P. Hadorn, S. Mishra, *The Eleventh International Conference on Learning Representations, ICLR* (2023)
9. "On Bayesian data assimilation for PDEs with ill-posed forward problems", S. Lanthaler, S. Mishra, F. Weber, (2022), *Inverse Problems*, **38**(8):085012 (2022)
10. "Error estimates for DeepONets: A deep learning framework in infinite dimensions", S. Lanthaler, S. Mishra, G.E. Karniadakis, *Trans Math Appl*, **6**(1), (2022), tnac001,
11. "On universal approximation and error bounds for Fourier neural operators", N. Kovachki, S. Lanthaler, S. Mishra, *Journal of Machine Learning Research*, **22**(290), (2021), 1-76
12. "On the approximation of functions by tanh neural networks", T. De Ryck, S. Lanthaler, S. Mishra, *Neural Networks*, **143**, (2021), 732-750
13. "Statistical solutions of the incompressible Euler equations", S. Lanthaler, S. Mishra, C. Parés-Pulido, *Math. Models Methods Appl. Sci.* (M^3AS), **31**(2), (2021), 223-292
14. "On the conservation of energy in two-dimensional incompressible flows", S. Lanthaler, S. Mishra, C. Parés-Pulido, *Nonlinearity*, **34**(2), (2021), 1084
15. "On the convergence of the spectral viscosity method for the two-dimensional incompressible Euler equations with rough initial data", S. Lanthaler, S. Mishra, *Found Comput Math*, **20**, (2020), 1309–1362
16. "Guiding-centre theory for kinetic-magnetohydrodynamic modes in strongly flowing plasmas", S. Lanthaler, J. P. Graves, D. Pfefferlé, W. A. Cooper, *Plasma Phys. Control. Fusion*, **61**, (2019), 074006

17. "Higher order Larmor radius corrections to guiding-centre equations and application to fast ion equilibrium distributions", S. Lanthaler, D. Pfefferlé, J. P. Graves, W. A. Cooper, *Plasma Phys. Control. Fusion*, **59**, (2017), 044014

18. "Statistical solutions of hyperbolic conservation laws I: Foundations", U. S. Fjordholm and S. Lanthaler and S. Mishra, *Arch. Ration. Mech. An.*, **226**(2), (2017), 809–849

19. "Computation of measure-valued solutions for the incompressible Euler equations", S. Lanthaler, S. Mishra, *Math. Models and Methods Appl. Sci.*, **25**, (2015), 2043-2088

Other co-authored papers (authors ordered by contribution)

20. "Three-dimensional magnetohydrodynamic equilibrium of quiescent H-modes in tokamak systems", W. A. Cooper, J. P. Graves, B. P. Duval, O. Sauter, J. M. Faustin, A. Kleiner, S. Lanthaler, H. Patten, M. Raghunathan, T.-M. Tran, *Pasma Phys. Control. Fusion*, **58**, (2016) 064002

21. "Modelling of advanced three-ion ICRF heating and fast ion generation scheme for tokamaks and stellarators", J. M. Faustin, J. P. Graves, W. A. Cooper, S. Lanthaler, L. Villard, D. Pfefferlé, J. Geiger, Ye O. Kazakov, D. Van Eester, *Pasma Phys. Control. Fusion*, **59**, (2017) 084001

22. "The DEMO wall load challenge", R. Wenninger, R. Albanese, R. Ambrosino, F. Arbeiter, J. Aubert, C. Bachmann, L. Barbato, T. Barrett, M. Beckers, W. Biel, L. Boccaccini, D. Carralero, D. Coster, T. Eich, A. Fasoli, G. Federici, M. Firdaouss, J. Graves, J. Horacek, M. Kovari, S. Lanthaler, V. Loschiavo, C. Lowry, H. Lux, G. Maddaluno, F. Maviglia, R. Mitteau, R. Neu, D. Pfefferlé, K. Schmid, M. Siccinio, B. Sieglin, C. Silva, A. Snicker, F. Subba, J. Varje and H. Zohm, *Nuclear Fusion*, **57**, (2017) 046002

23. "Stellarator nonlinearly saturated periodicity-breaking ideal magnetohydrodynamic equilibrium states", W. A. Cooper, D. López-Bruna, M. A. Ochando, F. Castejón, J. P. Graves, A. Kleiner, S. Lanthaler, H. Patten, M. Raghunathan, J. M. Faustin and the TJ-II Team, *Nuclear Fusion*, **58**, (2018) 124002

24. "Reduced models for parallel magnetic field fluctuations and their impact on pressure gradient driven MHD instabilities in axisymmetric toroidal plasmas", J. P. Graves, D. Zullino, D. Brunetti, S. Lanthaler, C. Wahlberg, *Pasma Phys. Control. Fusion*, **61**, (2019) 104003