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Postdoctoral Researcher, Scientist

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Yunfei-Huang0

Google Scholar

Education

Biophysics (Ph.D.) — **03/2017 – 03/2021**
University of Cologne, Germany

Advanced Data Analysis • Traction Force Microscopy • Physical Governing Equations
PhD's thesis: "Advanced data analysis for traction force microscopy and data-driven discovery of physical equations". (**Prof. Benedikt Sabass** & **Prof. Gerhard Gompper**)

Solid Mechanics (M.Sc.) — **09/2014 – 09/2015**
Ecole Polytechnique, France

Multiscales • Multiphysics • Modeling of Materials and Structures
Master's thesis: "Modeling and numerical simulation of the path of a single crack in an elastic material submitted to a stress gradient". (**Dr. Henry Hervé**)

Geo-mechanics (M.Sc.) — **09/2013 – 07/2014**
University Joseph Fourier-Grenoble 1, France

Continuum Mechanics • X-ray Tomography • Image Analysis
Master's thesis: "Consolidation modelling of second grade porous media by homogenization". (**Prof. Denis Caillerie**)

Geo-technical Engineering (M.Sc.) — **09/2010 – 07/2013**
Lanzhou University, China

Soil Mechanics • Rock Mechanics
Master's thesis: "A numerical simulation study of the stability of loess slopes.". (**Prof. Wenwu Chen**)

Civil Engineering (B.Sc.) — **09/2006 – 07/2010**
Anhui Xinhua University, China

Theoretical Mechanics • Structural Mechanics • Mechanics of Materials • Fluid Mechanics

Work Experience

Scientist | Postdoctoral Researcher — **06/2025 - Today**
Technical University Dortmund, Germany

My current research focuses on developing robust **deep learning** models for 2D & 3D traction force microscopy. (**Prof. Benedikt Sabass**)

Scientist | Postdoctoral Researcher — **03/2025 - 05/2025**
Ludwig Maximilian University of Munich, Germany

My research focused on **machine learning** models and stochastic automatic differentiation for Monte Carlo processes. (**Prof. Benedikt Sabass**)

Scientist | Postdoctoral Researcher — **10/2021 - 01/2025**
Helmholtz-Zentrum Hereon, Germany

The study concentrated on hard-constrained physical and symmetry-equivariant **machine learning** models for solving partial differential equations. This work was published at **ICML 2025**, a top-tier machine learning conference. (**Website of Project**) (**Dr. David S. Greenberg**)

Research Assistant — **09/2015 – 12/2016**
Karlsruhe Institute of Technology, Germany

My research focused on studied crack propagation using phase-field modeling within solid mechanics. (**Prof. Britta Nestler**)

Research Experience

- **Traction Force Microscopy (TFM)**
  - Developed robust 2D & 3D Vision Transformer (Vit)+UNet deep learning models for TFM
  - Created software packages for 2D & 3D TFM analysis
  - Demonstrated that elastic-net regularization provides an optimal inverse approach for TFM
  - Designed advanced non-parametric Bayesian algorithms for TFM
  - Performed image analysis including cell and particle tracking
- **Machine Learning for Solving PDEs**
  - Developed unsupervised and supervised methods for solving PDEs
  - Created group-equivariant symmetry constraints for CNN architectures
  - Built robust neural networks incorporating physical symmetry constraints
  - Designed hybrid models that combine machine learning with numerical solution methods
- **Theoretical Machine Learning**
  - Explored regularization techniques and convex optimization methods
  - Applied Bayesian inference approaches, including Bayesian regularization
  - Performed total and local uncertainty quantification for model evaluation
  - Applied umbrella sampling and feedback control methods in learning frameworks
  - Developed Bayesian sparse learning algorithms

- **Data-driven Discovery of Governing Equations**
  - Discovered physical equations (ODEs, PDEs, and SDEs) using data-driven approaches
  - Applied automatic thresholding in sparse Bayesian learning frameworks
  - Implemented iterative sampling optimization techniques for efficient model training
  - Developed active learning methods to improve data utilization
- **Continuum & Statistical Physics**
  - Analyzed crack instability using phase-field modeling
  - Modeled consolidation of second-grade porous media by homogenization
  - Studied Langevin and Fokker–Planck equations for stochastic physical systems

Publications

- **Huang, Y.** & Vorst, E. V. & Richard, A. & Sabass, B. (2026). "Combining Microscopy Data and Metadata for Reconstruction of Cellular Traction Forces Using a Hybrid Vision Transformer–U-Net". In: *arXiv preprint arXiv:2603.13400*, 2026.
- **Huang, Y.** & Greenberg, D. (2025). "Geometric and Physical Constraints Synergistically Enhance Neural PDE Surrogates". In: *Proceedings of the 42nd International Conference on Machine Learning (**ICML**)*, 2025. (**A top-tier machine learning conference.**) (**Website**)
- **Huang, Y.** & Mabrouk, Y. & Gompper, G. & Sabass, B. (2024). "Author Correction: Sparse inference and active learning of stochastic differential equations from data". In: *Scientific reports*, 14(1), 7503, 2024.
- **Huang, Y.** & Greenberg, D. (2024). "Symmetry Constraints Enhance Long-term Stability and Accuracy in Unsupervised Learning of Geophysical Fluid Flows". In: *Authorea Preprints*, 2024.
- **Huang, Y.*** & Mabrouk, Y.* & Gompper, G. & Sabass, B. (2022). "Sparse inference and active learning of stochastic differential equations from data". In: *Scientific reports*, 12(1), 2169, 2022.
- **Huang, Y.** (2021). "Advanced data analysis for traction force microscopy and data-driven discovery of physical equations". In: *PhD Thesis at Universität zu Köln*, 2021.
- **Huang, Y.** & Gompper, G. & Sabass, B.(2020). "A Bayesian traction force microscopy method with automated denoising in a user-friendly software package". In: *Computer Physics Communications*, 107313, 2020.
- **Huang, Y.** & Schell, C. & Huber, T. B. & Şimşek, A. N. & Hersch, N. & Merkel, R. & Gompper, G. & Sabass, B. (2019). "Traction force microscopy with optimized regularization and automated Bayesian parameter selection for comparing cells". In: *Scientific reports*, 9(1), 539, 2019. (This publication is one of the **Top 100 downloaded** from Scientific Reports articles in Cell and Molecular Biology of 2019!)
- Simsek, A. N. & Bräutigam, A. & Koch, M. D. & Shaevitz, J. W. & **Huang, Y.** & Gompper, G. & Sabass, B. (2019). "Substrate-rigidity dependent migration of an idealized twitching bacterium". In: *Soft Matter*, 15(30), 6224-6236, 2019.
- Schneider, D. & Schoof, E. & **Huang, Y.** & Selzer, M. & Nestler, B. (2016). "Phase-field modeling of crack propagation in multiphase Systems". In: *Computer Methods in Applied Mechanics and Engineering*, 312, 186-195, 2016.
- Nestler, B. & Schneider, D. & Schoof, E. & **Huang, Y.** & Selzer, M. (2016). "Modeling of crack propagation on a mesoscopic length scale". In: *GAMM-Mitteilungen*, 39 (1), 78-91, 2016.

- **Huang, Y.** (2015). "Modeling and numerical simulation of the path of a single crack in an elastic material submitted to a stress gradient". In: *Master Thesis at Ecole Polytechnique, France*, 2015.
- **Huang, Y.** (2014). "Consolidation modelling of second grade porous media by homogenization". In: *Master Thesis at University Joseph Fourier-Grenoble 1, France*, 2014.

Awards

- Travel Grant — German Physical Society Conference (DPG), Germany (2018)
- Excellent Master Scholarship — LabEx Tec21 Pre-doctoral Program, France (2013–2014)
- First-Class Scholarship (**Three times**) — Lanzhou University, China (2010–2013)
- Outstanding Graduate Award — Anhui Xinhua University, China (2010)
- Third-Class Scholarship — Anhui Xinhua University, China (2008-2009)
- "Bronze Award" — Third Contest of Anhui University Students' Career Planning, Anhui, China (2008)
- School Award — "Challenge Cup" Student Innovation Competition, Anhui Xinhua University, China (2007)

Conferences & Seminars

- Poster — DPG Spring Meeting of the Condensed Matter Section, Dresden, Germany (2026)
- Poster Presentation — International Conference on Machine Learning (ICML), Vancouver, Canada (2025)
- Invited Talk — Helmholtz AI FFT Monthly Seminar (Online) (2024)
- Project Participant — CENTURI Hackathon ("EmbryoFlowTracker"), Marseille, France (2024)
- Talk — Helmholtz AI Conference, Hamburg, Germany (2023)
- Poster Presentation — Institute of Coastal Systems Retreat (Hereon) (2022, 2023, 2024)
- Ph.D. Defense Talk — University of Cologne, Germany (2020)

Teaching Experience

- Advance: Practical Deep Learning with Climate Data (Exercise sessions), University of Hamburg, (2024)
- Practical Deep Learning with Climate Data (Exercise sessions), University of Hamburg, (2023)

Skills

- **Programming Languages:** Python • Julia • Matlab • C/C++ • Fortran • R
- **Frameworks & Libraries:** PyTorch • TensorFlow • Keras • JAX • NumPy
- **Software Tools:** ImageJ • ParaView • Gnuplot • Inkscape • LaTeX • Github

- **Scientific Methods:** Deep Learning • Statistical Data Analysis • Bayesian Inference • Optimisation Algorithms • Particle Image Velocimetry (PIV) • Finite Element Method (FEM) • Finite Difference Method (FDM) • Boundary Element Method (BEM) • Fourier Analysis • X-ray Tomography

References

- **Dr. David S. Greenberg**, Helmholz Centre Hereon — **Email:** david.greenberg@hereon.de
- **Prof. Dr. Benedikt Sabass**, LMU München — **Email:** b.sabass@lmu.de