Jakob Löber — Curriculum Vitae

PhD in Theoretical Physics | Data Science | Web Development | Augmented Reality

Gärtnerstraße 13, 10245 Berlin
📞 +49 1573 5586275
✉️ jakob@physik.tu-berlin.de
🗓️ Born: 1982-09-21 in Erfurt
💼 Status: single, Children: No
🎓 PhD physicist
🌐 GitHub: https://github.com/jakobatgithub

💼 Professional Background

since 02/2024

Fullstack Developer — Prosumio GmbH, Berlin

- Development of a Python backend for a web application using Django and Wagtail
- Implementation of REST APIs and Celery for asynchronous task management
- Integration of MQTT (EMQX) for real-time data processing
- Flutter for mobile app development on iOS and Android

01/2024 – 06/2024

Senior Data Scientist — Teraki GmbH, Berlin

- Object detection in LiDAR and camera data using modern deep learning techniques
- AWS EC2 and S3 for cloud computing and storage
- Spiking neural networks for real-time event camera data analysis

06/2023 – 12/2023

Augmented Reality Software Developer — BetaRoom UG, Berlin

- Developed the augmented reality application 'KIKI Games'
- Optimized 3D rendering performance for mobile devices
- Porting an AR application from iOS to Oculus Quest 2

05/2020 – 05/2023

Freelance Programmer — Freelance, Berlin

- Developed the augmented reality applications 'KIKI Games' and 'Augmented Berlin'
- Cross-platform development in Unity for iOS and Android
- Designed and implemented custom AR solutions for clients
- Collaborated with designers to create interactive AR experiences

12/2016 – 11/2018

Scientific Assistant — Max Planck Institute for the Physics of Complex Systems, Dresden

- Postdoc in the department 'Biological Physics'
- 13 peer-reviewed scientific publications
- \>20 presentations at conferences

07/2015 – 11/2016

Scientific Assistant — Technical University Berlin

- Postdoc in the research group 'Nonlinear Dynamics and Pattern Formation'

🎓 Education

2011 – 2015

PhD in Theoretical Physics — Technical University Berlin

Grade: summa cum laude

Title: Optimal Trajectory Tracking

2002 – 2010

Diploma in Physics — Technical University Berlin

Grade: 1.0

Focus: Statistical physics, Mathematical physics, Thermodynamics

1993 – 2001

High School Diploma — von-Bülow Gymnasium Neudietendorf

Grade: 1.8

🌟 Other Activities and Experiences

01/2022 – 04/2022

Data Science Bootcamp — Data Science Retreat, Berlin

12/2018 – 04/2020

Cycling trips through South America and Europe — Worldwide

01/2013 – 06/2013

Research stay with Igor Aronson — Argonne National Lab, Chicago

04/2016 – 07/2016

Tutor for 'Thermodynamics and Statistical Physics' — Institute for Theoretical Physics, TU Berlin

10/2015 – 02/2016

Tutor for 'Nonlinear Dynamics and Structure Formation' — Institute for Theoretical Physics, TU Berlin

02/2012 – 07/2012

Tutor for 'Nonequilibrium Statistical Physics' — Institute for Theoretical Physics, TU Berlin

10/2007 – 09/2009

Tutor for 'Physics for Engineers' — Institute for Solid State Physics, TU Berlin

07/2006 – 09/2007

Backpacking through Asia and Africa — Worldwide

🧰 Skills Overview

Programming Languages

Python	■■■■■■■■■□	C#	■■■■■□□□□□
Dart	■■■■■□□□□□	C/C++	■■■■□□□□□□
Java	■■■□□□□□□□	JSON	■■■□□□□□□□
JavaScript	■■□□□□□□□□	HTML	■□□□□□□□□□
CSS	■□□□□□□□□□		

Python Ecosystem

NumPy	■■■■■■■■□□	matplotlib	■■■■■■■■□□

PyTorch	■■■■■■■□□□	pip	■■■■■■■□□□
Jupyter Notebook	■■■■■■■□□□	SciPy	■■■■■□□□□□
Conda	■■■■■□□□□□	scikit-learn	■■■■■□□□□□
virtualenv	■■■■■□□□□□	SymPy	■■■■■□□□□□
TensorFlow	■■■■■□□□□□	Pandas	■■■■□□□□□□
typing (type hints)	■■■■□□□□□□	Poetry	■■■■□□□□□□
Plotly	■■■□□□□□□□	seaborn	■■■□□□□□□□
PyTorch Lightning	■■■□□□□□□□	Keras	■■■□□□□□□□
h5py	■■□□□□□□□□		

Machine Learning & AI

CNNs	■■■■■■■■■□	Deep Learning	■■■■■■■□□□
Reinforcement Learning	■■■■■■■□□□	Numerical optimization	■■■■■■□□□□
Q-learning	■■■■■■□□□□	Copilot	■■■■■■□□□□
wandb	■■■■■□□□□□	Object Detection (YOLO)	■■■■■□□□□□
Modern Hopfield Networks	■■■■□□□□□□	Comet	■■■□□□□□□□

Scientific & Engineering Tools

Mathematica	■■■■■■■■■■	Lyx	■■■■■■■■□□
LaTeX	■■■■■■■□□□	LiDAR	■■■■■□□□□□
Matlab	■■■■□□□□□□	ROS	■■■□□□□□□□
LabView	■■□□□□□□□□		

Web Development & Backend

Django	■■■■■■■■■□	MQTT (EMQX)	■■■■■■■■□□
Wagtail	■■■■■■■□□□	REST APIs	■■■■■■□□□□

Celery	■■■■■■□□□□	PostgreSQL	■■■■■□□□□□
Firebase	■■■■■□□□□□	SQLite	■■■■■□□□□□
JWT	■■■■■□□□□□	Redis	■■■■□□□□□□
Nginx	■■□□□□□□□□	MySQL	■■□□□□□□□□
Jinja	■■□□□□□□□□		

DevOps, CI/CD & Tooling

Git	■■■■■■■■■□	Docker	■■■■■■■■□□
Bitbucket	■■■■■■□□□□	make	■■■■■□□□□□
Bitbucket CI/CD pipeline	■■■■■□□□□□	AWS	■■■■□□□□□□
Kubernetes	■■□□□□□□□□		

Testing & Code Quality

unittest	■■■■■■■■□□	TTD (Test-Driven Development)	■■■■■■■■□□
coverage.py	■■■■■■□□□□	pytest	■■■■□□□□□□
Ruff	■■■■□□□□□□	Black	■■□□□□□□□□

Mobile & Cross-Platform Development

Flutter	■■■■■■□□□□	iOS	■■■■■■□□□□
Android Studio	■■■■■□□□□□	Android	■■■■□□□□□□
Xcode	■■■□□□□□□□		

Visualization, UI & Graphics

OpenCV	■■■■■■■■□□	Unity	■■■■■■■■□□
Computer Vision	■■■■■■□□□□	3D Visualization	■■■■■■□□□□

Blender	■■■□□□□□□□	GIMP	■■■□□□□□□□
Inkscape	■■■□□□□□□□	Qt	■□□□□□□□□□

Operating Systems & Shell

Linux (Ubuntu, Debian)	■■■■■■■■■□	bash	■■■■■■■□□□
ssh	■■■■■■■□□□	GCC	■■■■■□□□□□
Putty	■■■■■□□□□□	Unix	■■■□□□□□□□

Project & Team Collaboration

Jira	■■■■■■■■□□	Slack	■■■■■■□□□□
Confluence	■■■■■□□□□□	Chrome	■■■■■□□□□□

Markup & Documentation

Lyx	■■■■■■■■■□	LaTeX	■■■■■■■■□□
Markdown	■■■■■■□□□□		

Soft Skills & Meta Skills

Scientific Writing	■■■■■■■■■□	Research Skills	■■■■■■■■■□
University Teaching	■■■■■■■■□□	Presentation Skills	■■■■■■■■□□
Mathematical Modeling	■■■■■■■■□□	Data Analysis	■■■■■■■□□□
Teaching	■■■■■■□□□□		

📚 Publications (21)

1. S. Alonso, J. Löber, M. Bär, H. Engel, “Wave propagation in heterogeneous bistable and excitable media”, Eur. Phys. J. Spec. Top. 187, 31 (2010).

2. F.J. Schmitt, H. Südmeyer, J. Börner, J. Löber, K. Olliges, K. Reineke, I. Kahlen, P. Hätti, H.J. Eichler, H.J. Cappius, “Handheld device for fast and non-contact optical measurement of protein films on surfaces”, Opt. Laser. Eng. 49, 1294 (2011).

3. J. Löber, M. Bär, H. Engel, “Front propagation in one-dimensional spatially periodic bistable media”, Phys. Rev. E 86, 066210 (2012).

4. J. Löber, H. Engel, “Analytical approximations for spiral waves”, Chaos 23, 043135 (2013).

5. P.V. Paulau, J. Löber, H. Engel, “Stabilization of a scroll ring by a cylindrical Neumann boundary”, Phys. Rev. E 88, 062917 (2013).

6. J. Löber, F. Ziebert, I.S. Aranson, “Modeling crawling cell movement on soft engineered substrates”, Soft Matter 10, 1365 (2014).

7. J. Löber, H. Engel, “Controlling the position of traveling waves in reaction-diffusion systems”, Phys. Rev. Lett. 112, 148305 (2014).

8. J. Löber, “Stability of position control of traveling waves in reaction-diffusion systems”, Phys. Rev. E 89, 062904 (2014).

9. J. Löber, R. Coles, J. Siebert, H. Engel, E. Schöll, “Control of chemical wave propagation”, Engineering of Chemical Complexity II, pp. 185-207, World Scientific (2014).

10. I.S. Aranson, J. Löber, F. Ziebert, “Phase-field description of substrate-based motility of eukaryotic cells”, Engineering of Chemical Complexity II, pp. 93-104, World Scientific (2014).

11. J. Löber, S. Martens, H. Engel, “Shaping wave patterns in reaction-diffusion systems”, Phys. Rev. E 90, 062911 (2014).

12. S. Martens, J. Löber, H. Engel, “Front propagation in channels with spatially modulated cross section”, Phys. Rev. E 91, 022902 (2015).

13. J. Löber, F. Ziebert, I.S. Aranson, “Collisions of deformable cells lead to collective migration”, Sci. Rep. 5, 9172 (2015).

14. J. Löber, “Optimal trajectory tracking”, Ph.D. thesis, Technical University Berlin (2015).

15. C. Ryll, J. Löber, S. Martens, H. Engel, F. Tröltzsch, “Analytical, Optimal, and Sparse Optimal Control of Traveling Wave Solutions to Reaction-Diffusion Systems”, Control of Self-Organizing Nonlinear Systems, pp. 189-210, Springer (2016).

16. F. Ziebert, J. Löber, I.S. Aranson, “Macroscopic model of substrate-based cell motility”, Physical Models of Cell Motility, pp. 1-67, Springer (2016).

17. J. Löber, “Optimal Trajectory Tracking of Nonlinear Dynamical Systems”, Springer, ISBN 978-3-319-46573-9 (2017).

18. J. Löber, “Exactly realizable desired trajectories”, arXiv:1603.00611 (2016).

19. S. Molnos, J. Löber, J.F. Totz, H. Engel, “Control of transversal instabilities in reaction-diffusion systems”, New J. Phys. 20, 053034 (2018).

20. J. Löber, “Linear structures in nonlinear optimal control”, arXiv:1604.01261 (2016).

21. D.A. Kulawiak, J. Löber, M. Bär, H. Engel, “Oscillatory Motion in an Active Poroelastic Two-Phase Model”, PLOS ONE 14, e0217447 (2019).

Academic Theses

Doctoral Thesis

Title: Optimal trajectory tracking

Supervisors: Prof. Harald Engel, Prof. Alexander S. Mikhailov, Prof. Fredi Tröltzsch

Date of Defence: July 2015

Defence Talk: Optimal trajectory tracking

Abstract: This thesis investigates optimal trajectory tracking of nonlinear dynamical systems with affine controls. The control task is to enforce the system state to follow a prescribed desired trajectory as closely as possible. The concept of so-called exactly realizable trajectories is proposed. For exactly realizable desired trajectories exists a control signal which enforces the state to exactly follow the desired trajectory. For a given affine control system, these trajectories are characterized by the so-called constraint equation. This approach does not only yield an explicit expression for the control signal in terms of the desired trajectory, but also identifies a particularly simple class of nonlinear control systems. Systems in this class satisfy the so-called linearizing assumption and share many properties with linear control systems. For example, conditions for controllability can be formulated in terms of a rank condition for a controllability matrix analogously to the Kalman rank condition for linear time invariant systems. Furthermore, exactly realizable trajectories, together with the corresponding control signal, arise as solutions to unregularized optimal control problems. Based on that insight, the regularization parameter is used as the small parameter for a perturbation expansion. This results in a reinterpretation of affine optimal control problems with small regularization term as singularly perturbed differential equations. The small parameter originates from the formulation of the control problem and does not involve simplifying assumptions about the system dynamics. Combining this approach with the linearizing assumption, approximate and partly linear equations for the optimal trajectory tracking of arbitrary desired trajectories are derived. For vanishing regularization parameter, the state trajectory becomes discontinuous and the control signal diverges. On the other hand, the analytical treatment becomes exact and the solutions are exclusively governed by linear differential equations. Thus, the possibility of linear structures underlying nonlinear optimal control is revealed. This fact enables the derivation of exact analytical solutions to an entire class of nonlinear trajectory tracking problems with affine controls. This class comprises, among others, mechanical control systems in one spatial dimension and the FitzHugh-Nagumo model with a control acting on the activator.

📕 Diploma Thesis

Title: Nonlinear Excitation Waves in Spatially Heterogeneous Reaction-Diffusion Systems

Supervisors: Prof. Harald Engel, Prof. Markus Bär

Abstract: Wave propagation in one-dimensional heterogeneous bistable media is studied for the Schlögl model. Starting from the analytically known traveling wave solution for the homogeneous medium, non-localized, spatially periodic variations in kinetic parameters as the excitation threshold, for example, are taken into account perturbatively. Two different multiple scale perturbation methods are applied to derive a differential equation for the position of the front under perturbations. All analytical results are compared to the results of numerical simulations.

🗣️ Scientific Presentations (44)

1. Velocity of Fronts in Heterogeneous Reaction-Diffusion Systems — Harz seminar, February 2009, Hahnenklee

2. Chemical Master Equations and Fluctuation Theorem — Group Seminar, February 2011, TU Berlin

3. Control of traveling waves and analytical approximations for spiral waves — GRK Kolloquium, July 2012, TU Berlin

4. Controlling the position of traveling waves — SFB Symposium, November 2012, TU Berlin

5. Stochastic reaction-diffusion systems — Group Seminar, January 2013, TU Berlin

6. Analytical approximations for spiral waves — Harz seminar, February 2013, Hahnenklee

7. Controlling the position of fronts — Spring conference of the German Physical Society, March 2013, Regensburg

8. Controlling the position of traveling fronts — APS March Meeting, March 2013, Baltimore, USA

9. Controlling the position of fronts — IMACS Conference on Nonlinear Waves, March 2013, Athens, Georgia, USA

10. Controlling the position and shape of traveling waves — BCSCCS conference, June 2013, Warnemünde

11. Controlling the position of traveling waves in reaction-diffusion systems — DDays Berlin Brandenburg, October 2013, TU Berlin

12. Modeling crawling cell movement — GRK Kolloquium, October 2013, Graal-Müritz

13. Stability of position control of traveling waves — Group seminar, October 2013, TU Berlin

14. Controlling the position of traveling waves in reaction-diffusion systems — Dynamics Days US 2014, January 2014, Georgia Tech, Atlanta, USA

15. Position and shape control of nonlinear waves — Harz seminar, February 2014, Hahnenklee

16. Modeling crawling cell movement — Group seminar, April 2014, TU Berlin

17. Controlling the position of traveling waves in reaction-diffusion systems — Nonlinear Dynamics of Deterministic and Stochastic Systems: Unraveling Complexity, May 2014, Saratov, Russia

18. Modeling crawling cell motility — BCSCCS Seminar, June 2014, FHI Berlin

19. Modeling crawling cell motility — Seminar, July 2014, HU Berlin

20. Modeling crawling cell motility — Mini-Symposium on cell motility, July 2014, TU Berlin

21. Controlling the position of traveling waves in reaction-diffusion systems — SIAM Nonlinear Waves and Coherent Structures, August 2014, Cambridge, UK

22. Modeling crawling cell motility — Dynamics Days Europe, September 2014, Bayreuth

23. Trajectory controllability, optimal trajectory tracking, exact linearization, and all that — Group seminar, October 2014, TU Berlin

24. Analytical approximations for nonlinear optimal trajectory tracking problems — SFB Symposium, February 2015, TU Berlin

25. Modeling crawling cell motility — Spring conference of the German Physical Society, March 2015, TU Berlin

26. Modeling crawling cell motility — BCSCCS conference, June 2015, Munich

27. Optimal trajectory tracking — Ph.D. thesis defence, July 2015, TU Berlin

28. Modeling crawling cell motility — NECD15 conference, October 2015, Potsdam

29. Free boundary problems and phase field methods — Group seminar, November 2015, TU Berlin

30. Modeling crawling cell motility — Harz seminar, February 2016, Hahnenklee

31. Thermodynamics of mechanochemical reactions — Group seminar, June 2016, TU Berlin

32. Poroelastic two-phase model for Physarum polycephalum with free boundaries — Group seminar, November 2016, TU Berlin

33. Poroelastic two-phase model for Physarum polycephalum with free boundaries — MPIPKS Biophysics Group Retreat, January 2017, Oberwiesenthal

34. Phase separation via Density Functional Theory — Droplet Meeting, March 2017, Dresden

35. Cross-linked Gels — Droplet Meeting, July 2017, Dresden

36. Cross-linked Gels — Cortex Day, August 2017, Lichtenhain

37. Rheology of cross-linked polymer networks — Group seminar, September 2017, Dresden

38. Thermorheology of polymer gels — Internal seminar, October 2017, Dresden

39. Rheology of polymer networks: chain length distribution — Droplet Meeting, October 2017, Dresden

40. Thermomechanical Manipulation of Gels — Droplet Meeting, December 2017, Dresden

41. Polymer gels and the two-fluid model — Group seminar, January 2018, Berlin

42. Phase separation in polyelectrolytes — MPIPKS Biophysics Group Retreat, January 2018, Oberwiesenthal

43. Transport through and chemical reactions at membranes — Droplet Meeting, February 2018, Dresden

44. Two-fluid model for crawling cell motility — Harz seminar, February 2018, Hahnenklee

Posters (11)

1. Velocity of Fronts in Periodic-Heterogeneous Reaction Diffusion Systems — spring conference of the German Physical Society, March 2009, Dresden

2. Kinematic Theory of Spiral Waves — BCSCCS conference, June 2011, Berlin

3. Controlling the position of a front — GRK conference, October 2012, Potsdam

4. Analytical approximations for spiral waves — GRK conference, October 2012, Potsdam

5. Curvature-dependent feedback control of two-dimensional excitation waves — DPG conference, March 2013, Regensburg

6. Analytical approximations for spiral waves — GRK defence, June 2013, TU Berlin

7. Controlling the position of a front — Dynamics Days Europe, September 2014, Bayreuth

8. Front propagation in three-dimensional corrugated reaction-diffusion media — Dynamics Days Europe, September 2014, Bayreuth

9. Modeling cell movement on heterogeneous substrates — Model systems for understanding biological processes, February 2015, Bad Honnef

10. Linear structures in nonlinear optimal control — Control of Complex Systems and Networks, September 2016, Heringsdorf

11. Position Control of Traveling Spots — Control of Complex Systems and Networks, September 2016, Heringsdorf