

Alex Wolf

Data management for computational biology.

Previously, led building [Cellarity](#)'s compute platform, founded [Scanpy](#), co-created [anndata](#), and performed quite broad [research](#).

Summary

Since 2022 Data management for computational biology.

Since 2016 Founder & Advisor/ Lead Engineer (2016 – 2019) of the joint [Scanpy](#) & [anndata](#) OSS project^{P23,P33}

2018 – 2022 Head of Scientific Computing, 1st comp & 3rd overall employee, [Cellarity](#), Cambridge, MA

2015 – 2018 Postdoc & Team Lead (2017 – 2018) in Machine Learning for Biology at Helmholtz Munich^{P19-P32}

2013 – 2015 PhD in Computational Physics at LMU Munich, spring 2015 at Columbia U^{P12-P18}

2012 – 2013 PhD in Electrical Engineering, Bosch Research, Stuttgart^{P8-11}

2011 – 2012 Research Associate, Center of Electronic Correlations and Magnetism, Augsburg^{P6-P7}

2006 – 2011 Studies of Physics at U Augsburg, [ENS Paris](#) and Georgetown U^{P1-P5}

Awards, grants, scholarships

Also see this [thread of references for Scanpy](#).

- 11/2019 Scanpy selected an [Essential Open Source Software for Science](#) by CZI among 32 projects | along with giants such as Scipy, Numpy, Pandas, Matplotlib, scikit-learn, scikit-image/plotly, pip, jupyterhub/binder, Bioconda, Seurat, Bioconductor, and others; associated grant with F. J. Theis & P. Angerer, worth ~\$200k for software development funding
- 04/2018 CZI grant *Interactive identification of trajectories in scRNA-seq data* within [Collaborative computational tools for the Human Cell Atlas](#) | Co-PI with F. J. Theis, worth \$200k of research funding
- 05/2017 [7th prize in Data Science Bowl 2017 out of 2.4k teams](#): deep-learning-based diagnosis of lung cancer from 3d CT scans | among nearly [2.4k teams](#) and more than 10k participants, worth \$25k, shared with N. Köhler, J. Jungwirth, & M. Berthold; with \$1M of prize money, the so far highest endowed [machine-learning challenge](#)
- 11/2015 Grant for proposal *Machine learning in high-dimensional single-cell profiles* | worth 300k€ of research funding for 3 years (2016 – 2018), granted to 20 postdocs across the whole of Helmholtz Association, Germany's largest research organization with 15k scientists/postdocs and 8k PhD students
- 10/2015 [Arnold Sommerfeld PhD Prize 2015](#) for best thesis in Theoretical Physics at LMU Munich | the LMU Munich department of physics is consistently ranked #1 in Germany and #2 in all of continental Europe; worth 1k€, awarded once in 2015
- 06/2010 Sole representative of U Augsburg at the 60th Lindau Meeting of Nobel Laureates | among ~20k students at U Augsburg, which was ranked #3 in the top national ranking for teaching quality in physics in 2006
- 11/2008 Scholarship from the German National Merit Foundation | 2008 – 2011, top 1–2% percent of students in Germany, previously declined invitation to interview in 2006
- 06/2005 High school graduation as co-valedictorian, nation-wide Appolinaire prize for exceptional graduation in French, honors for musical engagement, had declined offers to skip years twice
- 03/2003 Mathematical Olympiad: state-wide (3rd) round | among three best participants aged 16 – 18 in Bavaria (population: 13M)

Experience

Cellarity, Cambridge, MA

Working with the founders as 1st employee in the computing team & 3rd employee overall, I led the build-up & application of the computational part of Cellarity's predictive drug discovery platform. The platform is based on targeting features learned from single-cell resolved omics data, deriving predictive capabilities across the entire drug discovery & development process. Cellarity raised \$50M in Series A and [\\$123M in Series B](#). I reported to founders, CDO & CEO while the company grew from 3 to ~100 employees during 3 years 9 months. Like Moderna, Cellarity was created by Flagship Pioneering. In 2021, Cellarity has ranked among the [top-15 Fierce Biotech](#) and [top-5 Scientist.com BioTech](#) startups.

SENIOR DIRECTOR, HEAD OF SCIENTIFIC COMPUTING 9 months · 05/2021 – 01/2022
 DIRECTOR, HEAD OF APPLIED MACHINE LEARNING 2 months · 03/2021 – 04/2021
 ASSOCIATE DIRECTOR, HEAD OF APPLIED MACHINE LEARNING 2 years · 03/2019 – 02/2021
 ASSOCIATE DIRECTOR, MACHINE LEARNING 6 months · 09/2018 – 02/2019
 CONSULTANT, MACHINE LEARNING 4 months · 05/2018 – 08/2018

- Led building & applying a production-grade predictive compute platform across computational biology, computational chemistry, and machine learning engineering. Predictive capabilities cover target discovery, disease modeling, perturbation modeling, chemistry optimization, and contextualization with clinical data. Also led data engineering in the first year, and led specific teams on computational disease modeling & computational chemistry in the last 9 months.
- Collaborated in a highly interdisciplinary environment with biologists, drug developers, medicinal chemists, sequencing experts, and project managers on drug discovery in 4 therapeutic areas: immuno-oncology, hematology, respiratory, metabolic.
- Am particularly grateful to my team: Since 04/2019 with Sunny Sun, since 06/2019 with Yuge Ji, and since 04/2020 with Sophie Tritschler (part-time since 05/2019). Since 12/2020 with Ragy Haddad & Youli Xia, and since 2021, with Volker Bergen (part-time since 09/2020), Yan Wu, James Gatter, Sam Markson, Stephan Sachs, Nathan Russell, and Vladimir Chupakhin.
- Two among numerous patent applications have published. [Pa1-Pa2](#)

The Scanpy & anndata open source software project

To date, Scanpy & anndata have become the most-widely used Python-based analytics and data management software packages for scRNA-seq with >600k downloads, >500 dependent packages, ~100 contributors, and the highly adopted file format h5ad. I started the open source software project, created Scanpy, and co-created anndata during my time in Fabian Theis's lab at Helmholtz Munich.

FOUNDER & ADVISOR Since 09/2019

- I advise Lead Engineer Isaac Virshup.
- In 2020, major institutions released [COVID-19 datasets](#) through the associated file format: h5ad.

FOUNDER & LEAD ENGINEER 3 years · 09/2016 – 08/2019

- Created [Scanpy](#) and led its development until v1.4.5. Engaged subsequent Lead Engineer Isaac Virshup and a team of key contributors (Philipp Angerer, Gökçen Eraslan, Fidel Ramirez, Sergei Rybakov), who would continue to develop the project.
- Scanpy is a toolkit of data science tools that would learn from an annotated data matrix in a modular & efficient fashion. In addition to implementation choices and the API design, the main contribution was to consolidate approaches in the field: visualization, clustering, trajectory inference, batch correction, and other tasks had typically been based off of different data representations. Scanpy implemented tool chains operating on one consistent representation.
- Co-created anndata. Introduced centering data science workflows around an initially unstructured annotated data object, designed the API, wrote tutorials and documentation until anndata v0.7, and implemented most of the early functionality, among others, reading & writing, the on-disk format h5ad, views, sparse data support, concatenation, backed mode.
- Supervised lead developers of tools in the ecosystem, like scVelo, scGen.
- Advised initiatives leveraging Scanpy, such as CZI's [cellxgene](#), the [GEAR gene expression portal](#), the HCA and EMBL-EBI portals and pipelines.

Helmholtz Munich, Institute of Computational Biology

ADJUNCT RESEARCHER Since 09/2018

- Continued advising PhD & master students and open source software projects. [P28-P31](#)

TEAM LEAD 1 year · 09/2017 – 08/2018

- Led machine learning team of 6 (3 PhD students, 1 master student, 2 student research assistants).
- Supervised and conceived Mohammad Lotfollahi's [scgen](#) on predicting cellular perturbation response using generative modeling. [P27](#)
- Supervised development of Volker Bergen's [scvelo](#) and co-supervised the associated project on scalable and robust estimation of RNA velocity in single cells. [P29](#)
- Supervised Niklas Köhler's work on meta learning. Niklas left academia to work on his own company.
- Advised on method for estimating batch effects. [P25](#)

POSTDOCTORAL FELLOW

2 years · 09/2015 – 08/2017

- Machine learning for biomedical data. With [Fabian Theis](#) in [Machine Learning Group](#).^{P19-P26}
- Won [grant](#), [competition](#), received [press](#) and [taught](#) as permanent visiting scholar at TU Munich.
- Developed scalable data science & machine learning toolkit for analyzing transcriptomic single-cell data: [Scanpy](#).^{P24} Grew the toolkit into a large open-software project and ecosystem, see *Scanpy Project*.
- Developed PAGA, a method for exploring data through topology-preserving maps — at the interface of manifold learning and topological data analysis.^{P26}
- Inferred the first lineage tree of a whole complex adult animal form data.^{P24}
- Showed how to use deep learning for reconstructing continuous biological processes for the examples of disease progression and cell cycle.^{P20}
- Developed several, yet unpublished, causal inference approaches in the first year of the postdoc.
- Contributed to diverse research projects with supervision:^{P19-P25} Manifold learning for measuring progression of cells during biological processes.^{P19} Pattern detection in CO₂ certificate transactions for fraud discovery in collaboration with [Umweltbundesamt](#). Machine Learning in collaboration with [Nanotemper](#), winner of the [German Innovation Award](#).

LMU Munich, Department of Physics

PHD CANDIDATE

2 years 4 months · 04/2013 – 07/2015

- Computational many-body physics at the interface of quantum information and quantum field theory. With [U. Schollwöck](#) in Theoretical Nanophysics Group.^{P12-P18}
- Won [prize](#) and [taught](#) at LMU Munich.
- Developed algorithms for modeling correlated materials and addressing fundamental questions on emergent behavior in quantum many-body systems. For the first time, we successfully combined two of the most widely used numerical techniques in this context: tensor networks, in particular matrix product states, and dynamical mean-field theory.

Columbia University, Department of Physics

VISITING SCHOLAR

3 months · 03/2015 – 05/2015

- Computational physics with [A. J. Millis](#): Developed imaginary-time matrix product state impurity solver.^{P18}

Bosch Research, Stuttgart

PHD CANDIDATE

1 year 2 months · 02/2012 – 03/2013

- Electrical engineering and applied physics of solar cells. In Materials Simulation Group in cooperation with Bosch Solar Energy in Arnstadt, and P. Pichler at the University of Erlangen-Nuremberg, and the Fraunhofer IISB Institute in Erlangen.^{P8-P11}
- Modeled chemistry of solar cell materials.
- Wrote software that was the only project to be transferred to Bosch Solar Energy out of the photovoltaics department with >50 scientists at Bosch Research within the year.

Center for Electronic Correlations and Magnetism, Augsburg

RESEARCH ASSOCIATE

4 months · 10/2011 – 01/2012

- Theoretical physics on basic quantum mechanics with D. Braak.^{P6,P7}
- Modeled the dynamics of a q-bit coupled to a decoherence-generating bath – the [quantum Rabi Model](#). Discovered Schrödinger cat-like states.

U Augsburg

MASTER STUDIES OF PHYSICS

2 years · 08/2009 – 07/2011

- Minor Mathematics. Published 5 papers, among which one Phys. Rev. Lett. and one highly cited (270 citations in 2019).^{P1-P5}

MASTER'S THESIS

5 months · 02/2011 – 06/2011

- Theoretical condensed matter physics with T. Kopp.^{P5}
- Modeled the [effect of grain boundaries on supercurrent](#) in high-temperature superconductors.

ENS Paris

VISITING STUDENT

5 months · 09/2010 – 01/2011

- Second year MSc programme *Parcours Physique Théorique*.^{courses}
- University that produces [highest fraction of Nobel Laureates](#), worldwide.
- With travel scholarship by the German National Merit Foundation.

Georgetown U, Washington, D.C.

STUDENT RESEARCHER

5 months · 02/2010 – 06/2010

- [Computational, non-equilibrium quantum many-body physics](#) with M. Rigol.^{P2,P4}
- Uncovered law and simulated for collapse-and-revival oscillations between coherent and incoherent bosonic states.^{P2}
- Developed software for simulating matter-wave lasers and co-supervised project.^{P4}

- o Employed with PhD student salary. Declined offer to continue with actual PhD position.

U Augsburg

TUTOR 4 months · 10/2009 – 01/2010

- Tutor for Statistical Physics.

STUDENT RESEARCHER 3 months · 08/2009 – 10/2009

- Theoretical quantum many-body physics with [M. Kollar](#).^{P1,P3}
- o Contributed central calculation to a highly cited paper showing that thermalization of a quantum many-body system is preceded by a prethermalized state for which a statistical theory applies.

BACHELOR STUDIES OF PHYSICS 2 years 10 months · 10/2006 – 07/2009

- Minors Mathematics, Computer Science and Philosophy.

BACHELOR'S THESIS 4 months · 03/2009 – 06/2009

- Theoretical quantum many-body physics with [M. Kollar](#).
- o Hubbard model in the Gutzwiller approximation.

STUDENT RESEARCHER 5 months · 02/2008 – 06/2008

- Experimental bio-physics with [M. Schneider](#).
- o Metastasis, blood clotting, von Willebrand factor, thermodynamic properties of lipid membranes, construction of sensor for measuring surface pressures.

Agnes Kunzel Society, Dehra Dun, India

INTERNSHIP 2 months · 08/2006 – 09/2006

- Assistant teacher for Music and English in the aid project *Hope Project* of the NGO Agnes Kunze Society.

Wendelstein Werkstätten, Rosenheim

CIVILIAN SERVICE 9 months · 09/2005 – 05/2006

- Assistant and stand-in group leader in a work and care center for people with mental disabilities.

Degrees

- 10/2015 PhD in Computational Physics, LMU Munich
grade 1.0, summa cum laude, award for best thesis at theoretical physics department — the LMU Munich department of physics is consistently ranked #1 in Germany and #2 in all of continental Europe^{award,O6,P12-P18}
- 06/2014 PhD in Electrical Engineering, U Erlangen-Nuremberg
grade 1.09, magna cum laude, threshold to summa was 1.05^{O5,P8-P11}
- 07/2011 MSc in Physics, U Augsburg
grade 1.05, top of class, minor Mathematics, 390 of 300 required ECTS across BSc and MSc — U Augsburg was ranked #3 in the top national ranking for teaching quality in physics^{O4,P1-P6}
- 07/2009 BSc in Physics, U Augsburg
grade 1.50, top of class, minors Mathematics, Computer Science, Philosophy

Selected press

External press.

- 12/2020 Nature Biotechnology cover: *RNA velocity fully solved* | the scVelo paper^{P28} on the cover^{tweet}
- 08/2020 Genome Biology: *Celebrating 20 Years of Genome Biology* | selected the Scanpy paper^{P23} for the year 2018 among 20 papers for 20 years of Genome Biology
- 05/2020 Nature Biotechnology: *Active machine learning helps drug hunters tackle biology* | features Cellarity among a handful of startups that aim at re-defining drug discovery through active learning
- 02/2020 Nature Biotechnology: *Single-cell RNA-seq analysis software providers scramble to offer solutions* | mentioning Scanpy^{P23} along with Seurat as the two major open source software packages for single-cell analysis, [pdf](#)
- 04/2019 Nature Biotechnology: *A comparison of single-cell trajectory inference methods* | reviews more than 70 TI tools and ranks PAGA^{P26} as the best graph-based trajectory inference method, and overall, among the top 3
- 12/2018 Science “Breakthrough of the Year 2018”: *Development cell by cell* | mentioning^{P24} among 5 papers

- 04/2018 Broad Institute News: *Researchers post genetic profiles of half a million human immune cells on Human Cell Atlas online portal* | mentioning Scanpy^{P23} and no other single-cell analysis tool
- 04/2018 Helmholtz Germany: *Befreundete Zellen* | on Scanpy^{P23}
- 03/2018 Laborwelt (national German life science magazin): *Big Data? – Kein Problem!* | on Scanpy^{P23}
- 02/2018 Healthcare Analytics News: *The Data Toolkit That Can Analyze More Than 1M Cells* | on Scanpy^{P23}
- 02/2018 Genome Web: *German Researchers Develop New Software Tool for Gene Expression Data Analysis* | on Scanpy^{P23}
- 01/2018 Nature News: *Deep learning sharpens views of cells and genes* | mentioning expertise for deep learning on biological images

Press releases of affiliated institutions.

- 12/2019 Helmholtz Munich: *Scanpy on the rise: Helmholtz Munich expands single-cell platform with new Chan Zuckerberg Initiative funding* | on Scanpy
- 08/2019 Helmholtz Munich: *AI-powered tool predicts cell behaviors during disease and treatment* | on scGen^{P27}
- 04/2019 Helmholtz Munich: *Clear sight in the data fog with PAGA* | on PAGA^{P26}
- 05/2018 MDC Berlin: *A complete cell atlas and lineage tree of the immortal flatworm* | on first lineage tree of whole animal,^{P24} mentioning PAGA^{P26}
- 02/2018 Helmholtz Munich: *The Scanpy software processes huge amounts of single-cell data* | on Scanpy^{P23}
- 09/2017 Helmholtz Munich: *Paint by numbers: Algorithm reconstructs processes from individual images* | on P20
- 05/2017 Helmholtz Munich: *Machine Learning Outperforms Doctor – Helmholtz Scientists Successful in Competition* | on Data Science Bowl 2017
- 06/2016 Helmholtz Munich Comp Bio: *Alex Wolf receives Arnold Sommerfeld PhD Prize 2015* | on PhD Prize
- 01/2016 Helmholtz Munich Comp Bio: *Alex Wolf receives grant from Helmholtz Postdoc Programme* | on Postdoc Grant
- 06/2010 U Augsburg: *Zwischen Washington D. C. und Paris nach Lindau* | on Lindau Nobel Laureates participation

Interests and activities

- Science Drug Discovery, Machine Learning, Data Infrastructure, Single-Cell Genomics, Causal Inference, Emergence, Statistical Physics, Tensor Networks, Many-Body Physics
- Leadership Enabling efficient & effective R&D, enabling an AI-augmented scientific platform.
- Reviewing Journal of Machine Learning Research, Nature Methods, Nature Machine Intelligence, Genome Biology, [Annalen der Physik](#), [Entropy](#), Bioinformatics. See [Publons](#) for a subset of reviews. Several reviews for Fabian Theis for Nature, Cell, Nature Methods, Nature Communications.
- Community Kaggle Hackathon judge for [HubMAP Kidney Segmentation 2020](#)
- Languages German (mother tongue), English (excellent), French (fluent)
- Social work Mentor of refugee for [integro e.V.](#) (01/2016 – 12/2016), group lead assistant care center for people with mental disabilities (09/2005 – 05/2006), assistant music teacher (08/2005 – 09/2006)

Software

See falexwolf.me/software. Scanpy & anndata were downloaded >1 million times and provide a backbone for a global ecosystem of single-cell data related tools.

Teaching

- 2018 Teaching Assistant, Seminar, *Deep Learning*, TU Munich, with F. J. Theis and N. Köhler | organized and held seminar
- 2016 – 2017 Teaching Assistant, Seminar, *Deep Learning*, TU Munich, with F. J. Theis | organized and held seminar
- 2015 Supervisor, Master Practical, *Bioinformatics*, TU Munich, with H. W. Mewes | supervised three-month software project on diffusion maps and gene regulation inference

- 2015 – 2016 Teaching Assistant, Lecture, *Statistical Learning*, TU Munich, with F. J. Theis
- 2015 – 2016 Teaching Assistant, Lecture, *Topics in Computational Biology*, TU Munich, with F. J. Theis | mere organization of the lecture series
- 2014 – 2015 Tutor and Supervisor, Lecture, *Computational Physics*, LMU Munich, with L. Pollet | tutored and supervised three two-month research projects on neural networks and financial market simulation
- 2014 Teaching Assistant and Tutor, Lecture, *Advanced Statistical Physics*, LMU Munich, with U. Schollwöck
- 2013 Teaching Assistant and Tutor, Lecture, *Statistical Physics*, LMU Munich, with U. Schollwöck
- 2013 Supervisor, Seminar, *Applied Statistical Physics*, LMU Munich, with U. Schollwöck | supervision of talks on Black-Scholes and Monte Carlo simulations
- 2011 – 2012 Tutor, Lecture, *Theoretical Condensed Matter Physics*, U Augsburg, with T. Kopp
- 2009 – 2010 Tutor, Lecture, *Statistical Physics*, U Augsburg, with A. Kampf

Supervision of theses

- 2018 – 2019 Isaac Virshup, Ph.D. Bioinformatics, U Melbourne: *anndata, single-cell, ...* (advisor, supervision through Christine Wells).
- 2018 – 2019 Sergei Rybakov, MSc Mathematics, TU Munich: *Learning Latent Representations with Prior Information Using Autoencoders*.
- 2017 – 2020 Mohammad Lotfollahi,^{P27,P29} TU Munich, PhD Mathematics: *Deep generative models for modeling single cell perturbation response*.
- 2017 – 2020 Volker Bergen^{P28} TU Munich, PhD Mathematics: *Modeling stochastic RNA velocity*.
- 2017 – 2018 Niklas Köhler, TU Munich, PhD Mathematics: *Meta learning for structured data (prelim. title)*.
2017 Volker Bergen, TU Munich, MSc Mathematics: *Modeling stochastic RNA velocity*.
- 2015 – 2016 Bettina Schmidt, TU Munich, MSc Mathematics: *Inferring Carousel Fraud from Transaction Data*.
- 2015 – 2016 Niklas Köhler,^{P20} LMU Munich, MSc Physics: *Automatic Measurement of the ejection fraction of the human heart with deep learning algorithms on the basis of magnetic resonance imaging*.
- 2015 – 2016 Philipp Eulenberg,^{P20} LMU Munich, MSc Physics: *Extraction of morphological features with artificial neural networks and their relation to the Renormalization Group*.
2014 Jorge A. Justiniano,^{P14} LMU Munich, BSc Physics: *Computing spectral densities of large matrices using Chebyshev polynomials*.
- 2010 Marc Jreissaty,^{P4} Georgetown University, BSc Physics: *Expansions of Bose-Hubbard Mott insulators in optical lattices* (cosupervision with M. Rigol).

Academic collaborations

Listed are collaborations in the context of publications that I managed between 2009 and 2018.

- MDC Berlin (M Plass, N Rajewsky)^{P24,P26}
- U Cambridge (F Hamey, B Göttgens)^{P26}
- Broad Institute at Harvard and MIT (AC Carpenter, P Rees)^{P20}
- Newcastle U (A Filby)^{P20}
- Columbia U (AJ Millis, A Go)^{P18}
- MPI for the Structure and Dynamics of Matter, Hamburg (M Eckstein)^{P16}
- LMU Munich (U Schollwöck)^{P12-P18}
- U Hannover (J Krügener)^{P11}
- Institut für Solare Energieforschung Hameln (R Peibst)^{P11}
- Fraunhofer IISB, Erlangen (P Pichler)^{P8-P11}
- Bosch Research, Stuttgart (A Martinez-Limia)^{P8-P11}
- Georgetown U, Washington, D.C. (M Rigol)^{P2-P4}
- U Augsburg (D Braak, M Kollar, T Kopp)^{P1-P7}

Talks

See falexwolf.me/talks.

Publications

See falexwolf.me/publications & [google scholar](https://scholar.google.com/) for further information. Among the 31 reviewed articles are 13 first-author, 7 last-author, 4 second-author and 5 third-author. * indicates co-first, ** co-second, and † co-last author.

Preprints

P33 *anndata: Annotated data*

I Virshup, S Rybakov, FJ Theis, P Angerer†, [FA Wolf†](#)
[bioRxiv \(2021\)](#)

P32 *Compositional perturbation autoencoder for single-cell response modeling*

M Lotfollahi*, A Klimovskaia*, CD Donno**, Y Ji**, IL Ibarra, [FA Wolf](#), N Yakubova, FJ Theis†, D Lopez-Paz†
[bioRxiv \(2021\)](#)

Reviewed articles

P31 *Machine learning for perturbational single-cell omics*

Y Ji, M Lotfollahi, [FA Wolf](#), FJ Theis
[Cell Systems \(2021\)](#)

P30 *Learning interpretable latent autoencoder representations with annotations of feature sets*

S Rybakov, M Lotfollahi, FJ Theis†, [FA Wolf†](#)
[Machine Learning in Computational Biology \(2020\)](#)

P29 *Conditional out-of-distribution generation for unpaired data using transfer VAE*

M Lotfollahi, M Naghipourfar, FJ Theis†, [FA Wolf†](#)
[Bioinformatics \(2020\)](#)

P28 *Generalizing RNA velocity to transient cell states through dynamical modeling*

V Bergen, M Lange, S Peidli, [FA Wolf†](#), FJ Theis†
[Nature Biotechnology \(2020\)](#)

P27 *scGen predicts single-cell perturbation responses*

M Lotfollahi, [FA Wolf†](#), FJ Theis†
[Nature Methods \(2019\)](#)

P26 *PAGA: graph abstraction reconciles clustering with trajectory inference through a topology preserving map of single cells*

[FA Wolf](#), F Hamey, M Plass, J Solana, JS Dahlin, B Göttgens, N Rajewsky, L Simon, FJ Theis
[Genome Biology \(2019\)](#)

P25 *A test metric for assessing single-cell RNA-seq batch correction*

M Büttner*, Z Miao*, [FA Wolf](#), SA Teichmann†, FJ Theis†
[Nature Methods \(2018\)](#)

P24 *Cell type atlas and lineage tree of a whole complex animal by single-cell transcriptomics*

M Plass*, J Solana*, [FA Wolf](#), S Ayoub, A Misios, P Glažar, B Obermayer, FJ Theis, C Kocks, N Rajewsky
[Science \(2018\)](#)

P23 *Scanpy: large-scale single-cell gene expression data analysis*

[FA Wolf](#), P Angerer, FJ Theis
[Genome Biology \(2018\)](#)

P22 *Single cells make big data: New challenges and opportunities in transcriptomics*

P Angerer, L Simon, S Tritschler, [FA Wolf](#), D Fischer, FJ Theis
[Current Opinion in Systems Biology \(2017\)](#)

P21 *Model-based branching point detection in single-cell data by K-Branches clustering*

NK Chlis, [FA Wolf](#), FJ Theis
[Bioinformatics \(2017\)](#)

P20 *Reconstructing cell cycle and disease progression using deep learning*

P Eulenberg*, N Köhler*, T Blasi, A Filby, AE Carpenter, P Rees, FJ Theis†, [FA Wolf†](#)
[Nature Communications \(2017\)](#)

P19 *Diffusion pseudotime robustly reconstructs branching cellular lineages*

L Haghverdi, M Büttner, [FA Wolf](#), F Buettner, FJ Theis

Nature Methods (2016)

- P18 *Imaginary-time matrix product state impurity solver for dynamical mean-field theory*
[FA Wolf](#), A Go, IP McCulloch, AJ Millis, U Schollwöck
[Physical Review X](#) (2015)
- P17 *How to discretize a quantum bath for real-time evolution*
 Id Vega, U Schollwöck, [FA Wolf](#)
[Physical Review B](#) (2015)
- P16 *Non-thermal melting of Neel order in the Hubbard model*
 K Balzer, [FA Wolf](#), IP McCulloch, P Werner, M Eckstein
[Physical Review X](#) (2015)
- P15 *Strictly single-site DMRG algorithm with subspace expansion*
 C Hubig, IP McCulloch, U Schollwöck, [FA Wolf](#)
[Physical Review B](#) (2015)
- P14 *Spectral functions and time evolution from the Chebyshev recursion*
[FA Wolf](#), JA Justiniano, IP McCulloch, U Schollwöck
[Physical Review B](#) (2015)
- P13 *Solving nonequilibrium dynamical mean-field theory using matrix product states*
[FA Wolf](#), IP McCulloch, U Schollwöck
[Physical Review B](#) (2014)
- P12 *Chebyshev matrix product state impurity solver for dynamical mean-field theory*
[FA Wolf](#), IP McCulloch, O Parcollet, U Schollwöck
[Physical Review B](#) (2014)
- P11 *Electrical and structural analysis of crystal defects after high-temperature rapid thermal annealing of highly boron ion-implanted emitters*
 J Krügener, R Peibst, [FA Wolf](#), E Bugiel, T Ohrdes, F Kiefer, C Schollhorn, A Grohe, R Brendel, HJ Osten
[IEEE Journal of Photovoltaics](#) (2014)
- P10 *Diffusion and segregation model for the annealing of silicon solar cells implanted with phosphorus*
[FA Wolf](#), A Martinez-Limia, D Grote, D Stichtenoth, P Pichler
[IEEE Journal of Photovoltaics](#) (2014)
- P9 *Modeling the annealing of dislocation loops in implanted c-Si solar cells*
[FA Wolf](#), A Martinez-Limia, D Stichtenoth, P Pichler
[IEEE Journal of Photovoltaics](#) (2014)
- P8 *A comprehensive model for the diffusion of boron in silicon in presence of fluorine*
[FA Wolf](#), A Martinez-Limia, P Pichler
[Solid-State Electronics](#) (2013)
- P7 *Dynamical correlation functions and the quantum Rabi model*
[FA Wolf](#), F Vallone, G Romero, M Kollar, E Solano, D Braak
[Physical Review A](#) (2013)
- P6 *Exact real-time dynamics of the quantum Rabi model*
[FA Wolf](#), M Kollar, D Braak
[Physical Review A](#) (2012)
- P5 *Supercurrent through grain boundaries in the presence of strong correlations*
[FA Wolf](#), S Graser, F Loder, T Kopp
[Physical Review Letters](#) (2012)
- P4 *Expansion of Bose-Hubbard Mott insulators in optical lattices*
 M Jreissaty, J Carrasquilla, [FA Wolf](#), M Rigol
[Physical Review A](#) (2011)
- P3 *Generalized Gibbs ensemble prediction of prethermalization plateaus and their relation to nonthermal steady states in integrable systems*
 M Kollar, [FA Wolf](#), M Eckstein
[Physical Review B](#) (2011)
- P2 *Collapse and revival oscillations as a probe for the tunneling amplitude in an ultra-cold Bose gas*
[FA Wolf](#), I Hen, M Rigol
[Physical Review A](#) (2010)
- P1 *New theoretical approaches for correlated systems in nonequilibrium*

M Eckstein, A Hackl, S Kehrein, M Kollar, M Moeckel, P Werner, [FA Wolf](#)
[The European Physical Journal Special Topics \(2009\)](#)

Patents

Pa2 *Molecule design*

U Eser, [FA Wolf](#), NM Plugis
[Patent \(2020\)](#)

Pa1 *Methods of analyzing cells*

A Kahvejian, NM Plugis, MR Retchin, [FA Wolf](#), P Hosseini
[Patent \(2019\)](#)

Other publications

O7 *Predicting cancer from three dimensional computer tomography scans of the lung*

N Köhler, J Jungwirth, M Berthold, [FA Wolf](#)
[Report \(2017\)](#)

O6 *Solving dynamical mean-field theory using matrix product states*

[FA Wolf](#)
[PhD Thesis \(2015\)](#)

O5 *Modeling of annealing processes for ion-implanted single-crystalline silicon solar cells*

[FA Wolf](#)
[PhD Thesis \(2014\)](#)

O4 *Supercurrent through grain boundaries in the presence of strong correlations*

[FA Wolf](#)
Master's Thesis (2011)

O3 *Collapse and revival oscillations as a probe for the tunneling amplitude in an ultra-cold Bose gas*

[FA Wolf](#)
Report (2010)

O2 *Orbital order in a spin-polarized two-band Hubbard model*

[FA Wolf](#)
Bachelor's Thesis (2009)

O1 *Sartre à Stammheim: son existentialisme et l'idéologie de la fraction armée rouge*

[FA Wolf](#)
High School Thesis (2005)

Courses during studies

Coming from an interest and activities in the arts and the social sciences as a teenager, it took me a while to develop intuition for maths and physics during undergrads.

In summer 2006, U Augsburg was ranked among the top five universities for studying physics in Germany, with higher rankings in the category “teaching” than the top-ranked TU Munich and LMU Munich. During bachelor studies, we had 5 fellow students with scholarships from *Studienstiftung* or *Max Weber Programm*.

Notes on reading the table: All ECTS marked with an “*” are *additional* courses that were not required for the BSc and MSc degrees. For these courses, exams have been taken for fun without preparation. ‘P’ stands for ‘participation’.

Summary

Grades: BSc in Physics 1.50 and MSc in Physics 1.05 | *top of class for both degrees*
 ECTS: 390 of required 300 ECTS | *of which BSc 180 + MSc 120 + additional 90*
at the faculties Phys 284 + Math 62 + Phil 24 + Comp Sc 22

Master of Science in Physics Grade 1.05, ECTS 161 of which MSc 97 + additional 64

Course name	Grade	ECTS
Summer term 2011 (10th semester, ECTS 34 / MSc 34)		
Master’s thesis	1.0	26
Master’s thesis defense	1.7	4
Theory of interacting electrons (U Eckern, Phys)	P	4
Winter term 2010 (9th semester, ECTS 40 / add 40) <i>within the “Parcours Théorique” – 2nd year theoretical physics master program at ENS Paris – these are all additional courses, translated French titles</i>		
Computational physics (W Krauth, Phys)	18.0 ⁴	6*
Statistical physics and applications (H Hilhorst, Phys)	12.5	6*
Statistical field theory (F David, J Jespersen, Phys)	11.0	6*
Group theory and symmetries (J-B Zuber, Phys)	8.25	6*
Quantum field theory (A Bilal, Phys)	10.3	6*
Summer term 2010 (8th semester, ECTS: 51 / MSc 27 + add 24) <i>02.10 - 06.10: Student researcher, Georgetown U, validated as practical</i>		
Statistical physics far from equilibrium II (M Kollar, Phys)	1.0	4
Theory of magnetism (T Kopp, Phys)	1.0	8
<i>Additional courses</i>		
Complex analysis (Wendland, Math)	1.3	8*
Linear Algebra II (Ulm, Math)	3.3	8*
Linear Algebra I (Hackenberger, Math)	4.0	8*
Winter term 2009 (7th semester, ECTS 36 / MSc 36) <i>10.09 - 01.10: Tutor “Statistical physics and Thermodynamics”</i>		
Relativistic quantum field theory (T Kopp, Phys)	1.0	8
Theoretical condensed matter physics (D Vollhardt, Phys)	1.0	8
Ordinary differential equations (F Colonius, Math)	1.0	8
Theory of phase transitions (K Ziegler, Phys)	1.0	8
Statistical physics far from equilibrium I (E Lutz, Phys)	1.0	4

³All grades of this semester on a scale 0 (worst) to 20 (best), exams taken for fun without preparation. All courses officially 6 ECTS in Paris, but would correspond to 8 ECTS in Augsburg.

Bachelor of Science in Physics Grade 1.50, ECTS 239 of which BSc 180 + MSc 23 + additional 36

Course name	Grade	ECTS
Summer term 2009 (6th semester, ECTS 63 / BSc 24 + MSc 23 + add 16)		
<i>07.09 - 10.09: Student researcher, U Augsburg, validated as practical</i>	P	15 (MSc)
Bachelor Thesis (D Vollhardt and M Kollar, Phys)	1.0	12
Electrodynamics and classical field theory (P Haenggi, Phys)	1.7	8
Particular problems of quantum theory (U Eckern, Phys)	P	4
<i>Additional courses</i>		
Numerics II (Hoppe, Math)	1.3	8 (MSc)
Theoretical condensed matter physics II (A Kampf, Phys)	P	8*
History of the philosophy of the present (C Schroer, Phil)	1.7	4*
Current problems of many-body theory (D Vollhardt, Phys)	P (no record)	4*
Winter term 2008 (5th semester, ECTS 40 / BSc 28 + add 12)		
Statistical physics and Thermodynamics (D Vollhardt, Phys)	1.0	8
Applied optics (B Stritzker, Phys)	1.3	8
Advanced practical	1.0	12
<i>Additional courses</i>		
Wittgenstein: Philosophische Untersuchungen (Tatjevskaya, Phil)	P	4*
Introduction to Logic (Tatjevskaya, Phil)	1.0	4*
History of the philosophy of the modern age (C Schroer, Phil)	P (no record)	4*
Summer term 2008 (4th semester, ECTS 34 / BSc 34)		
<i>02.08 - 06.08: Student researcher, U Augsburg</i>		
Quantum Mechanics (D Vollhardt, Phys)	1.3	8
Condensed matter physics (J Mannhart, Phys)	1.0	8
Numerics for physicists (Hoppe, Math)	1.0	6
Beginners practical II	1.0	8
Introduction to Latex (G Hammerl, Phys)	P	4
Winter term 2007 (3rd semester, ECTS 38 / BSc 30 + add 8)		
Classical Mechanics (I Goychuk, Phys)	2.3	8
Atom and molecular physics (J Mannhart, Phys)	1.0	8
Design of electronic systems (S Uhrig, Comp)	1.0	6
Beginners practical I	1.3	8
<i>Additional courses</i>		
Introduction to philosophy (Hofweber, Phil)	P	4*
Introduction to philosophy of science (W Pietsch, Phil)	P (no record)	4*
Summer term 2007 (2nd semester, ECTS: 32)		
Mathematics for physicists II (G Ingold, Phys)	1.7	8
General physics II (F Haider, Phys)	2.0	8
Computer Science II (Kießling, Comp) <i>ranked 3rd out of 200</i>	2.0	8
Analysis II (D Blömker, Math)	2.0	8
Winter term 2006 (1st semester, ECTS: 32)		
Mathematics for physicists I (G Ingold, Phys)	1.0	8
General physics I (F Haider, Phys) <i>ranked 3rd out of 160</i>	2.0	8
Computer Science I (Kießling, Comp) <i>among top 10 out of 200</i>	3.0	8
Analysis I (D Blömker, Math)	2.3	8