

Sophie Beck

Theoretical and Computational Condensed Matter Physics

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Theoretical condensed matter physicist working on strongly correlated quantum materials. I combine ab initio electronic structure calculations, effective low-energy models and many-body methods to compute transport and spectroscopic properties accurately enough for quantitative comparison with experiment – from the anomalous c-axis resistivity of Sr_2RuO_4 to the microscopic origin of the cuprate pseudogap. 31 publications (incl. Phys. Rev. Lett., Rev. Mod. Phys.), ~480 citations, in close collaboration with leading experimental groups. Co-developer of the TRIQS library; editorial board Phys. Rev. Research, editor at the Journal of Open Source Software.

Research experience

- 10/2025 - 08/2026 **Parental leave**, Vienna, Austria.
Birth of second child, following the end of the fixed-term appointment at TU Wien; ongoing collaborations and manuscripts continued on a reduced basis.
- 2024 - 2025 **Postdoctoral Research Associate**, E138 Institute of Solid State Physics, TU Wien, Vienna, Austria.
Position funded by a grant of the Simons Foundation International, awarded on a proposal I wrote as sole author (see *Third-party funding*)
Group leader: Prof. Dr. Alessandro Toschi
- 2023 - 2024 **Associate Research Scientist (Tenure Track)**, Center for Computational Quantum Physics, Flatiron Institute, New York, USA.
Supervisor: Prof. Dr. Antoine Georges
- 2020 - 2023 **Research Fellow**, Center for Computational Quantum Physics, Flatiron Institute, New York, USA.
Supervisor: Prof. Dr. Andrew J. Millis
Parental leave: 02/2023 - 04/2023
- 2016 - 2020 **Doctoral candidate**, Materials Theory, ETH Zürich, Zürich, Switzerland.
Thesis title: *Metal-insulator transitions in complex oxide heterostructures*
Supervisor: Prof. Dr. Claude Ederer
- 2014 - 2015 **Masters candidate**, Albert Ludwig University of Freiburg, Freiburg, Germany.
Thesis title: *Projection operator techniques in the quantum theory of electronic energy transfer*
Supervisor: Apl. Prof. Dr. Heinz-Peter Breuer
- 2014 - 2015 **Research assistant**, Albert Ludwig University of Freiburg, Freiburg, Germany.
Topic: *Investigation of protein aggregation at lipid membrane surfaces using MD simulations*
- 2013 **Bachelors candidate**, Albert Ludwig University of Freiburg, Freiburg, Germany.
Thesis title: *Master equation approach to the strong-coupling limit of the spin-boson model*
- Career breaks Cumulative parental leave for two children (born 2023 and 2025): approx. 14 months, 02/2023 – 04/2023 and 10/2025 – 08/2026. Net post-doctoral research time since the doctoral defence in June 2020: 5 years.

Education

- 2016 - 2020 **PhD Materials Science**, Materials Theory, ETH Zürich, Zürich, Switzerland.
- 2013 - 2015 **M.Sc. Physics**, Albert Ludwig University of Freiburg, Freiburg, Germany.
- 2013 - 2014 **Semester abroad**, National University of Singapore, Singapore, Singapore.
- 2010 - 2013 **B.Sc. Physics**, Albert Ludwig University of Freiburg, Freiburg, Germany.

Third-party funding

- 2024 - 2025 **Simons Foundation International**, *Next-generation methods for next-generation materials*, 122,776\$.
Sole author of the funded proposal; formally awarded to the host PI (Prof. Dr. A. Toschi, TU Wien) with myself as the designated researcher. The project advances the predictive power of DFT+DMFT for low-temperature phases of correlated quantum materials, with a focus on transport and two-particle response.

Honors and awards

- 2016 **Gustav-Mie-Preis**, *Dr.-Gerhard-Fritz-Stiftung*, 500€.
Awarded for the best master thesis
- 2013 **Baden-Württemberg-STIPENDIUM**, *Baden-Württemberg Foundation*, 3000€.
Scholarship for the semester abroad at the National University of Singapore

Teaching and supervision

- 2022, 2024 **Lecturer**, *International summer school on computational quantum materials*, Sherbrooke, Canada.
Two lectures for master's and doctoral students: *Introduction to Wannier functions for materials simulations*; *Ab initio description of strongly correlated materials: combining density functional theory and dynamical mean-field theory*. Also tutor in the hands-on sessions.
- 2023 **Lecturer**, *TRIQS Summer School 2023*, Saint-Lambert, France.
Lecture *Ab initio description of strongly correlated materials: combining density functional theory and dynamical mean-field theory*; contributed the AbinitioDMFT tutorial to the TRIQS teaching material.
- 2022 **Lecturer**, *Wannier summer school*, ICTP, Trieste, Italy.
Lecture *Correlation effects and realistic materials modeling with DFT+DMFT* (recording publicly available); tutor in the hands-on sessions.
- 2022 - 2024 **Supervision of research interns**, *Center for Computational Quantum Physics, Flatiron Institute*, New York, USA.
Four undergraduate and graduate interns, each on an independent ten-week research project: Matthew Shammami (2024), *Origin of the anomalous c-axis resistivity in Sr_2RuO_4 from DFT+DMFT*; Collins Munene Kariuki (2023), *Analytical tight-binding expressions from first-principles calculations*; Lorenzo Van Muñoz (2022), *AutoBZ.jl: adaptive Brillouin zone integration package*; Shonel Rahim (2022), *FermiSee: web app for electronic structure visualization and phenomenology*. The AutoBZ.jl project led to two peer-reviewed publications with the intern as first author (J. Open Source Softw. **9**, 7080 (2024); Phys. Rev. B **111**, 195162 (2025)); the 2024 project contributed to a further manuscript currently in review.
- 2016 - 2020 **Supervision of bachelor and master theses**, *Materials Theory, ETH Zürich*, Zürich, Switzerland.
Students supervised: Felix Gast (2018), Yuki Meier (2019); project definition, day-to-day supervision and examination support.
- 2016 - 2020 **Teaching assistant**, *ETH Zürich*, Zürich, Switzerland.
Class: *Programming techniques in materials science*
Completed the ETH Zürich teaching qualification course "Learning to Teach" (2016).
- 2014 - 2016 **Teaching assistant**, *Albert Ludwig University of Freiburg*, Freiburg, Germany.
Classes: *Classical mechanics and special relativity*; *physics practicum for medical students*
- Languages of instruction German (native) and English

Invited talks

- 2024 **IFP seminar**, *Institute of Solid State Physics, TU Wien*, Vienna, Austria.
Quasiparticles through the seasons: theoretical insights from electronic Raman spectroscopy, ARPES and optical spectroscopy
- 2024 **Physics Colloquium**, *The City College of New York*, New York, USA.
Quasiparticles and their signatures in Sr_2RuO_4 : recent insights from electronic Raman spectroscopy and ARPES experiments
- 2023 **Lennard-Jones Centre Discussion Group**, *University of Cambridge*, Cambridge, England.
Advances in realistic materials modeling with the DFT+DMFT approach

- 2022 **Condensed Matter Theory Seminar**, *Dresden University of Technology*, Dresden, Germany.
A DFT+DMFT perspective on correlated oxide interfaces
- 2022 **CECAM Webinar, Mixed-Gen Season 2**, virtual.
Ab initio description of strongly correlated materials: combining density functional theory and dynamical mean-field theory
- 2022 **18th ETSF Young Researchers' Meeting**, *Aix-Marseille University*, Marseille, France.
Correlation effects and realistic materials modeling with DFT+DMFT
- 2022 **Workshop on Recent Developments in Electronic Structure ES22**, *Columbia University*, New York, USA.
Realistic materials modeling with charge self-consistency in DFT+DMFT
- 2022 **APS March Meeting (invited session)**, Chicago, USA.
A DFT+DMFT perspective on correlated oxide interfaces

Contributed conference talks

- 2025 **Psi-k Conference**, Lausanne, Switzerland.
- 2025 **Joint Annual Meeting of ÖPG and SPS**, Vienna, Austria.
- 2022 **Psi-k Conference**, Lausanne, Switzerland.
- 2021 **APS March Meeting**, virtual.
- 2020 **CMD2020 / GEFES**, virtual.
- 2019 **APS March Meeting**, Boston, USA.
- 2019 **Joint Annual Meeting of SPS and ÖPG**, Zurich, Switzerland.
- 2018 **DPG Spring Meeting**, Berlin, Germany.
- 2018 **25th International Workshop on Oxide Electronics**, Les Diablerets, Switzerland.
- 2017 **SPS Joint Annual Meeting**, Geneva, Switzerland.
- 2017 **DPG Spring Meeting**, Dresden, Germany.

Collaboration and community meetings

- 2022 - 2025 **TRIQS developer meeting**, *Collège de France*, Paris, France.
- 2024 **QUAST Workshop**, *Flatiron Institute*, New York, USA.
- 2023 **CIFAR programme meeting**, *Flatiron Institute*, New York, USA.
- 2023 **Flatiron-Wide Autumn Meeting**, *Flatiron Institute*, New York, USA.
- 2023 **Wannier developer meeting**, Daresbury, England.
- 2017 **NCCR MARVEL Review and Retreat**, Lausanne, Switzerland.

Organization

- 2025 **Co-organizer**, *TRIQS Summer School 2025*, Centre Port Royal, Saint-Lambert, France.
- 2023 **Co-organizer**, *TRIQS Summer School 2023*, Centre Port Royal, Saint-Lambert, France.
- 2023 **Co-organizer**, *Wannier Developers 2023*, Daresbury, Daresbury, England.
- 2023 **Co-organizer**, *Flatiron Wide Autumn Meeting*, Flatiron Institute, New York, USA.
- 2019 **Co-organizer**, *Summer School "Advanced Electronic Structure Methods in Condensed Matter Physics"*, EPFL, Lausanne, Switzerland.

Other professional activities

- 2025 - present **Member of Editorial Board**, *Physical Review Research*.
- 2023 - present **Editor**, *Journal of Open Source Software (JOSS)*.
- 2019 - present **Peer-reviewer**, *Nature*, *Physical Review journals*.
- 2025 **Science communication**, *Interview on the physics behind Hyper Human, an installation by M. Triandafellos, publicly exhibited in New York.*
maria.nyc/commissions/hyper-human

2020 - 2024 **Committee member**, *Diversity, Equity and Inclusion committee*, Flatiron Institute, New York, USA.

Technical skills

- Proficient in **programming** in Python, Bash, MPI, Fortran, and Julia, with experience developing efficient, scalable scientific software
- Skilled in **data analysis, post-processing, and visualization** using the scientific Python stack (NumPy, SciPy, Jupyter, Matplotlib, Plotly, Dash); developed interactive visualization tools (e.g. github.com/TRIQS/FermiSee)
- Experienced user and developer of **electronic structure codes** (e.g. Quantum ESPRESSO, Wannier90, TRIQS); experienced user of HPC facilities
- Strong background in **analytical derivations** to support and interpret numerical results

Publications - selection

- [1] **S. Beck** and A. Ramires, "Structural reconstruction as the origin of the cuprate pseudogap," *arXiv preprint arXiv:2511.02508*, 2025. (in review at Nature).
- [2] **S. Beck**, M. Shammami, L. V. Muñoz, J. Kaye, A. Georges, and J. Mravlje, "Insulating transport in anisotropic metals: breakdown of Drude transport and the puzzling *c*-axis resistivity of Sr_2RuO_4 and other layered oxides," *Phys. Rev. Lett.*, 2026. (accepted for publication; arXiv:2510.03756).
- [3] L. Van Muñoz, J. Kaye, A. Barnett, and **S. Beck**, "High-order and adaptive optical conductivity calculations using Wannier interpolation," *Phys. Rev. B*, vol. 111, p. 195162, May 2025.
- [4] A. Hunter, **S. Beck**, E. Cappelli, F. Margot, M. Straub, Y. Alexanian, G. Gatti, M. D. Watson, T. K. Kim, C. Cacho, N. C. Plumb, M. Shi, M. Radović, D. A. Sokolov, A. P. Mackenzie, M. Zingl, J. Mravlje, A. Georges, F. Baumberger, and A. Tamai, "Fate of quasiparticles at high temperature in the correlated metal Sr_2RuO_4 ," *Phys. Rev. Lett.*, vol. 131, p. 235602, Dec 2023.
- [5] **S. Beck**, A. Hampel, O. Parcollet, C. Ederer, and A. Georges, "Charge self-consistent electronic structure calculations with dynamical mean-field theory using Quantum ESPRESSO, Wannier90 and TRIQS," *Journal of Physics: Condensed Matter*, vol. 34, p. 235601, apr 2022.

Google scholar scholar.google.ch/citations?user=KWgx604AAAAJ&hl=en&oi=ao

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Languages

German	native language
English	full professional proficiency
French, Spanish	basic

References

Prof. Dr. Andrew J. Millis
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Vienna, August 28, 2026,

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