

Currently I am a postdoc and **E-STEEM fellow** in the group of Roberto Cerbino at the **SoMeX Lab @ University of Vienna**. I am interested in (hyper-)forces, intensities and correlations in soft matter. My research focuses on determining exact identities based on symmetries and correlations. I investigate their consequences on thermal and active many-body systems collaborating with experimentalists and exploit symmetries for developing analytic models.

<https://sites.google.com/view/sophie-hermann>

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Academic Background

E-STEEM Postdoctoral Researcher, University of Vienna – Vienna, Austria since 8/2026

with **Roberto Cerbino**: Exploring the similarities and differences between Differential Dynamic Microscopy (DDM) and the (intensity) countscope; connecting theoretical predictions with experimental measurements.

Marie Skłodowska Curie Fellow, Sorbonne University – Paris, France 08/2024 – 07/2026

with **Sophie Marbach**: Developing and validating the intensity countscope, quantifying dynamic properties (e.g. diffusion coefficients, velocities) from intensity correlations

Postdoc, University of Bayreuth – Bayreuth, Germany 12/2022 – 07/2024

with **Matthias Schmidt**: (1) Force correlations, hyperforce balance, and thermal Noether invariances for arbitrary observables; (2) Phase behaviour (gas, liquid, crystal) and particle number fluctuations of active Brownian based on power functional theory

PhD Thesis, University of Bayreuth – Bayreuth, Germany 04/2019 – 11/2022

graduated with summa cum laude 0.0

Supervisor **Matthias Schmidt**: Exploiting Noether's theorem within statistical mechanics; Study of its applications and consequences for active matter (including global polarization and interfacial tension)

PhD thesis: *Symmetries and forces in the statistical mechanics of active and thermal many-body systems*

Master Thesis, University of Bayreuth – Bayreuth, Germany 03/2018 – 03/2019

graduated with 1.0¹; resulted in publications [2,5]

Supervisor **Matthias Schmidt**: Bulk and interfacial analytic theory to describe motility induced phase separation based on power functional theory

Master thesis: *Superadiabatic forces and phase separation of active Brownian particles*

Bachelor Thesis, University of Bayreuth – Bayreuth, Germany 03/2017 – 08/2017

graduated with 1.0¹; resulted in publication [1]

Supervisor **Matthias Schmidt**: Analytic study of non-interacting active Brownian particles in a gravitational field

Bachelor thesis: *Active ideal gas sedimentation in two dimensions*

Education

Research stay, University of Fribourg – Fribourg, Switzerland 11/2021 – 12/2021

with **Joseph M. Brader**: Investigating the hard wall contact theorem in density functional theory. Resulted in [8].

Master Study of Physics, University of Bayreuth – Bayreuth, Germany 10/2017 – 03/2019

graduated with 1.0¹

Bachelor Study of Physics, University of Bayreuth – Bayreuth, Germany 10/2014 – 09/2017

graduated with 1.3¹

¹ Grades in Germany range from 1.0 (excellent) to 5.0 (insufficient).

Academic Responsibilities

Grant received, Sorbonne University – Paris, France 08/2024 – 07/2026
Marie Skłodowska Curie individual Fellowship (~200k€ research grant, funded by the European Union)

PhD Committee of Ana M. Montero, Universidad Extremadura – Badajoz, Spain 2025

Administrative Responsibilities, Sorbonne University – Paris, France 12/2024 – 07/2026
Co-organizer of the monthly Seminar “StatPhys@PHENIX”.

Referee since 2023

I am regular referee in several international journals (e.g. *Communications Physics*, *Physical Review E*, *Scientific Reports* and *PLOS ONE*) and have refereed a book chapter (*Artificial Intelligence and Intelligent Matter* [Springer, 2025]). I was part of the jury to select the poster prize winners at the Liquid Matter Conference (Mainz, 2024)

Teaching, Tutor at graduate level, École normale supérieure (ENS) – Paris, France 09/2025–01/2026

Course: *Advanced biophysics*

The teaching includes giving bi-weekly tutorials and being a contact person regarding the included research project.

Teaching, Tutor at undergraduate level, University of Bayreuth – Bayreuth, Germany 2017 –2024

Courses: *mathematical methods in physics*, *advanced mathematical methods in physics*, *classical mechanics*, *quantum mechanics* and *nonequilibrium statistical mechanics*

The teaching includes giving weekly tutorials for students and grading their exercise sheets. For some courses I was responsible for updating exercise sheets, providing their solutions, creating and grading the final exam and being a contact person for students.

Supervision, undergraduate level, Sorbonne University – Paris, France 05/2026 – 06/2026

Co-supervision (together with Adam Carter) of undergraduate student Kilian Garcia during his L3 internship (final year of Bachelor’s program) on the *influence of attractive interactions on the countoscope*.

Supervision, undergraduate level, University of Bayreuth – Bayreuth, Germany 04/2023 – 10/2023

Co-supervision (together with Florian Sammüller and Matthias Schmidt) of undergraduate student Silas Robitschko during his Bachelor thesis: *Thermal Noether sum rules via many-body simulations of confined fluids*. Resulted in publication [16].

Awards

Prize of the City of Bayreuth (“Preis der Stadt Bayreuth”) 2023

Awarded annually to 3 outstanding dissertations written at the University of Bayreuth

Emil Warburg Research Award (“Emil Warburg Preis Wissenschaft”) 2023

Awarded annually for special research achievements within the dissertation written in the department of physics at the University of Bayreuth.

Golden chalk award (“Preis der goldenen Kreide”) 2020

Annual award to honour outstanding teaching awarded by the student body of the math, physics, and computer science faculty (MPI) of the University of Bayreuth. [Nominated in 2020, 2022, and 2023]

Promotion of Research and Outreach

Blog post at Physics Community (Nature): *May the Hyperforce be with you* 03/2024

Information event for high school pupils: *Studying science at university - differences to learning at school* 12/2023
(at the Johann-Andreas-Schmeller Gymnasium, Nabburg, Germany)

Video about my research during my PhD: *Sophie Hermann - Preis der Stadt Bayreuth* (in German) 11/2023

Blog post at Physics Community (Nature): *Variance of fluctuations from Noether invariance* 11/2021

List of Publications

Preprints

- [23] *The "Intensity" Countoscope: Measuring particle dynamics in real space from microscopy images*
[S. Hermann](#), S.S. Banaroei, A. Carter, C.A.S. Batista, and S. Marbach, [arXiv: 2604.02271](#) (2026).

Published in Peer-Reviewed Journals

- [22] *Gauge invariance and hyperforce correlation theory for equilibrium fluid mixtures*
J. Matthes, S. Robitschko, J. Müller, [S. Hermann](#), F. Sammüller, and M. Schmidt, *J. Chem. Phys.* **164**, 044903 (2026).
- [21] *Gauge invariance of equilibrium statistical mechanics*
J. Müller, [S. Hermann](#), F. Sammüller, and M. Schmidt, *Phys. Rev. Lett.* **133**, 217101 (2024). [Editors' Suggestion, Featured in Physics, Covered in Physics Today, PRL's collection of the year 2024]
- [20] *Neural force functional for non-equilibrium many-body colloidal systems*
T. Zimmermann, F. Sammüller, [S. Hermann](#), M. Schmidt, and D. de las Heras, *Mach. Learn.: Sci. Technol.* **5**, 035062 (2024).
- [19] *Hyperdensity functional theory of soft matter*
F. Sammüller, S. Robitschko, [S. Hermann](#), and M. Schmidt, *Phys. Rev. Lett.* **133**, 098201 (2024). [Editors' Suggestion]
- [18] *Noether invariance theory for the equilibrium force structure of soft matter*
[S. Hermann](#), F. Sammüller, and M. Schmidt, *J. Phys. A: Math. Theor.* **57**, 175001 (2024).
- [17] *Why neural functionals suit statistical mechanics*
F. Sammüller, [S. Hermann](#), and M. Schmidt, *J. Phys. Condens. Matter* **36**, 243002 (2024). [Invited Topical Review, Featured in **Celebratory Collection 2024**]
- [16] *Hyperforce balance via thermal Noether invariance of any observable*
S. Robitschko, F. Sammüller, M. Schmidt and [S. Hermann](#), *Commun. Phys.* **7**, 103 (2024). [See my blog post at [physicscommunity.nature](#)]
- [15] *Active crystallization from power functional theory*
[S. Hermann](#) and M. Schmidt, *Phys. Rev. E (Letter)* **109**, L022601 (2024).
- [14] *Neural functional theory for inhomogeneous fluids: Fundamentals and applications*
F. Sammüller, [S. Hermann](#), D. de las Heras, and M. Schmidt, *Proc. Natl. Acad. Sci.* **120**, e2312484120 (2023).
- [13] *Noether-constrained correlations in equilibrium liquids*
F. Sammüller, [S. Hermann](#), D. de las Heras, and M. Schmidt, *Phys. Rev. Lett.* **130**, 268203 (2023).
- [12] *Perspective: How to overcome dynamical density functional theory*
D. de las Heras, T. Zimmermann, F. Sammüller, [S. Hermann](#), and M. Schmidt, *J. Phys.: Condens. Matter* **35**, 271501 (2023). [Invited Perspective]
- [11] *Comparative study of force-based classical density functional theory*
F. Sammüller, [S. Hermann](#), and M. Schmidt, *Phys. Rev. E* **107**, 034109 (2023).
- [10] *Force balance in thermal quantum many-body systems from Noether's theorem*
[S. Hermann](#) and M. Schmidt, *J. Phys. A: Math. Theor.* **55**, 464003 (2022). [The Physics of Michael Berry]
- [9] *Variance of fluctuations from Noether invariance*
[S. Hermann](#) and M. Schmidt, *Commun. Phys.* **5**, 276 (2022). [See my blog post at [physicscommunity.nature](#)]
- [8] *Force density functional theory in- and out-of-equilibrium*
S. Tschopp, F. Sammüller, [S. Hermann](#), M. Schmidt, and J. M. Brader, *Phys. Rev. E* **106**, 014115 (2022).
- [7] *Why Noether's Theorem applies to Statistical Mechanics*
[S. Hermann](#) and M. Schmidt, *J. Phys.: Condens. Matter* **34**, 213001 (2022). [Invited as Topical Review]
- [6] *Noether's Theorem in Statistical Mechanics*
[S. Hermann](#) and M. Schmidt, *Commun. Phys.* **4**, 176 (2021).
- [5] *Phase separation of active Brownian particles in two dimensions: Anything for a quiet life*
[S. Hermann](#), D. de las Heras, and M. Schmidt, *Mol. Phys.* **119**, e1902585 (2021). [Findenegg Memorial Issue]
- [4] *Active interface polarization as a state function*
[S. Hermann](#) and M. Schmidt, *Phys. Rev. Research* **2**, 022003(R) (2020).

- [3] *Non-negative interfacial tension in phase-separated active Brownian particles*
S. Hermann, D. de las Heras, and M. Schmidt, **Phys. Rev. Lett.** **123**, 268002 (2019).
- [2] *Phase coexistence of active Brownian particles*
S. Hermann, P. Krinninger, D. de las Heras, and M. Schmidt, **Phys. Rev. E** **100**, 052604 (2019).
- [1] *Active ideal sedimentation: exact two-dimensional steady states*
S. Hermann and M. Schmidt, **Soft Matter** **14**, 1614-1621 (2018).

Scientific Dissemination

40 events [27 international conferences (15 talks, 12 posters), 11 invited seminars, 3 schools]. Selected list below:

Selected international conferences with oral contribution:

- 29th International Conference on Statistical Physics **STATPHYS** – Florence, Italy (2025).
Revisiting the fundamentals of sDFT: Approximations and Applications
- Longtime Behaviour of Stochastic Processes – Clermont-Ferrand, France (2025).
Noether's theorem and hyperforces in statistical physics – invited talk
- 12th **Liquid Matter Conference** – Mainz, Germany (2024).
Noether's theorem and hyperforces in liquid matter
- IntCha24 (Interdisciplinary challenges in non-equilibrium physics: from soft to active, biological and complex matter) – Dresden, Germany (2024)
Noether-constrained correlations and hyperforces in soft matter – invited talk
- Active Days EUTOPIA - Challenges in Active Matter – Paris, France (2022).
Active freezing from power functional theory
- 6th International **Soft Matter Conference** (ISMC) – Poznań, Poland (2022).
Noether's theorem in statistical mechanics
- New frontiers in liquid matter – Paris, France (2022).
Noether's theorem in statistical mechanics
- 11th **Liquid Matter Conference** – Prague, Czech Republic (2021).
Non-negative interfacial tension in phase-separated active Brownian Particles
- BMC-BAMC – Glasgow, Great Britain (2021).
Mini-Symposium: Mathematical aspects of non-equilibrium statistical mechanics
Non-negative interfacial tension in phase-separated active Brownian Particles – invited talk

Selected invited Seminar talks:

- Condensed Matter Seminar – Chalmers University of Technology, Gothenburg, Sweden (2025).
Noether's theorem and hyperforces in statistical mechanics – invited talk
- Institute for Advanced Scientific Computing Seminar – University of Extremadura, Badajoz, Spain (2025).
Noether's theorem and hyperforces in statistical mechanics – invited talk
- DAMTP Statistical Physics and Soft Matter Seminar– University of Cambridge, Cambridge, Great Britain (2025).
Noether's theorem and hyperforces in statistical mechanics – invited talk
- Soft Matter Seminar – University of Oxford, Oxford, Great Britain (2025).
Noether's theorem and hyperforces in statistical mechanics – invited talk
- Theory of condensed matter seminar - (Broken) Symmetries in Soft Matter – Leipzig University, Leipzig (2022).
Noether's theorem in statistical mechanics – invited talk
- Group Meeting at MPI – Max Planck Institute for Intelligent Systems, Stuttgart (2021).
Noether's theorem in statistical mechanics – invited talk
- Theory and Simulation meeting – Utrecht University, Utrecht, Netherlands (2019).
Phase coexistence in active Brownian particles – invited talk