Tobias Kühn

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OVERVIEW

I am a theoretical physicist working on applications of statistical physics to neuroscience at the Institut de la Vision (Sorbonne) in Paris. During my PhD at the Research Centre Jülich, I have focused on the adaptation of techniques from statistical physics to neuroscience, as well as their further development. During my postdoctoral phase, I have continued this theme at ENS, Paris, and broadened my scope towards different applications, notably soft-matter physics, at Université Paris, before joining the Institut de la Vision to work on electrophysiological data from the retina.
I am fascinated by how theoretical physics connects seemingly desparate phenomena and thereby deepens their understanding, as I am experiencing myself, for example, working on field-theory for non-Gaussian theories. Furthermore, seeing that these methods can be useful to describe phenomena in the real world, like retinal recordings, is very intriguing. It always excites me to find even more links to diverse areas, which would be invisible without theory.
In parallel to my scientific career, I was regularly involved in teaching and supervision and I am always happy when I succeed in conveying some of this fascination of theoretical physics to students.

APPOINTMENTS

Postdoctoral Fellow Apr. 2022 - Now
Institut de la Vision - Sorbonne Université

Postdoctoral Fellow (fellowship by DAAD) Sept. 2021 - Mar. 2022
LPENS, Paris

ATER Sept. 2020 - Aug. 2021
Laboratoire Matière et Systèmes Complexes, Université de Paris

Postdoctoral Fellow Oct. 2019 - Aug. 2020
Laboratoire de Physique - Ecole Normale Supérieure (LPENS), Paris

Postdoctoral Fellow Apr. 2019 - Sep. 2019
Institute for Computational and Systems Neuroscience - Research Centre Jülich

EDUCATION

PhD in Physics (Dr. rer. nat.) Sept. 2014 - Dec. 2019
RWTH Aachen University and Research Centre Jülich (Germany)

"Path integral methods for correlated activity in neuronal networks"
Advisor: M. Helias

Master of Science in Physics Oct. 2011 - May 2014
RWTH Aachen University (Germany)

Bachelor of Science in Mathematics Oct. 2009 - Sept. 2011
RWTH Aachen University (Germany)
Bachelor of Science in Physics Oct. 2008 - Sept. 2011
RWTH Aachen University (Germany)

PAPERS, PRE-PRINTS AND MANUSCRIPTS [statistics]

" * " = Authors contributed equally.

8. TK, R. Monasson, "Information content in continuous attractor neural networks is preserved in the presence of moderate disordered background connectivity.", *HAL, hal-04076584* 2023
7. TK, F. van Wijland, "Diagrammatics for the inverse problem in spin systems and simple liquids.", *Journal of Physics A* **56** 11 2023
6. L. Tiberi*, J. Stapmanns*, TK, T. Luu, D. Dahmen, H. Helias, "Gell-Mann-Low criticality in neural networks.", *Physical Review Letters* **128** 16 2022
5. A. van Meegen, TK, M. Helias, "Large-Deviation approach to random recurrent neuronal networks: parameter inference and fluctuation-induced transitions.", *Physical Review Letters* **127** 15 2022
4. C. Keup*, TK*, D. Dahmen, M. Helias, "Transient chaotic dimensionality expansion by recurrent networks.", *Physical Review X* **11** 2 2021
3. J. Stapmanns*, TK*, D. Dahmen, T. Luu. C. Honerkamp, M. Helias, "Self-consistent formulations for stochastic nonlinear neuronal dynamics.", *Physical Review E* **101** 4 2020
2. TK, M. Helias, "Expansion of the Effective Action around Non-Gaussian Theories.", *Journal of Physics A* **51** 37 2018
1. TK, M. Helias, "Locking of correlated neural activity to ongoing oscillations.", *PLoS Computational Biology* **13 (6),** e1005534 2017

QUALIFICATIONS

- Qualification for Maître-de-Conférence positions in section 26 (Applied mathematics and applications of mathematics)
- Qualification for Maître-de-Conférence positions in section 28 (Dense media and materials)
- Qualification for Maître-de-Conférence positions in section 29 (Elementary constituents)
- Qualification for Maître-de-Conférence positions in section 69 (Neuroscience)

TEACHING

In total, I have taught about **340h** in tutorials and lectures for undergradute students and I was a tutor at a summer school for graduate students.
During my own undergraduate studies, I have taught in german, later almost exclusively in english and in french. The language is indicated for every course description.

- 2021: **Cours-TDs "Outils mathématiques pour la physique" (introduction to mathematical methods, 46h)**
  Bachelor in Physics, Université de Paris, french

- 2021: **Traveaux pratiques (TP, programming tutorials) "Signaux et Systèmes" (signal treatment with matlab, 30h)**
  Engineer's diploma, Université de Paris, french

- 2020: **Tutorials (TDs) for the Lecture "Statistical physics" (9h)**
  Master 2 ICFP, Université de Paris, Sorbonne Université, Université Paris-Saclay, Ecole Normale Supérieure, Ecole Polytechnique, english

- 2020: **TDs for the Lecture "Physics for physicians" (15h)**
  Medicine diploma (equivalent to Bachelor), Université de Paris, french

- 2020: **Tutorials/lectures (Cours-TDs) "Interactions Maths-Physique" (introduction to mathematical methods, 27h)**
  Bachelor in Mathematics/Mathematics and Computer Science (1st year), Université de Paris, french

- 2018: **Tutorials the lecture „Statistical Physics“ (summer term 2018, 4.5h)**
  MSc Physics, RWTH Aachen University (Germany), english

- 2017: **Lecture "Theoretical Neuroscience: Correlation structure of neuronal networks" (3h)**
  MSc Physics, RWTH, english

- 2016: **Tutor at the second „Advanced Computational Neuroscience School“**
  MPI for Dynamics and Self-organization, Göttingen, english

- 2016 - 2018: **Tutorials the lecture „Theoretical Neuroscience: Correlation structure of neuronal networks“ (summer terms 2016, 2017 and 2018, 27h in total, 27h in total)**
  MSc Physics, RWTH, english

- 2016 - 2018: **Tutorials the lecture „Statistical Mechanics of Neuronal Networks“ (winter terms 2016/17 and 2017/18, 18h in total)**
  MSc Physics, RWTH, english

- 2015 - 2018: **Tutorials the lecture „Computational Neuroscience“ (winter terms 2015/16, 2016/17 and 2017/18, 4.5h)**
  MSc Physics and Biology, RWTH, english

- 2010 - 2014: **Tutor for diverse lectures, in mathematics for non-mathematicians (physicists, electrical engineers, chemists,...) and introduction to theoretical physics (150h in total)**
  diverse BSc in sciences and engineering, RWTH, german

SUPERVISION

- 2019: **Co-supervision of of Jan Bauer, together with M. Helias**
  Learning effective data representations with restricted Boltzmann machines, Bachelor Thesis, RWTH Aachen
- 2016 - 2017: **Co-supervision of of Christian Keup, together with M. Helias**
  A neuron-model-independent path-integral explored via binary assemblies, Master thesis, RWTH Aachen; contributed to the publication of Keup, Kühn et al. 2021, PRX, see above

INVITED TALKS

- Mathematical Biology Seminar at the Czech Academy of Science, Prague, 2023, Invited.
- QBio Seminar, Centre de biologie quantitative de l'ENS-PSL, Paris 2022,Invited.
- CENTURI Turing Center for Living Systems, Marseille, 2020, Invited.
- PhD-seminar „Cold Quantum Coffee", Theoretical Physics Department, University of Heidelberg, 2016, Invited.

CONFERENCE AND WORKSHOP CONTRIBUTIONS

- Spring Meeting of the German Physical Society, Dresden, 2023, Talk and poster.
- Journées de Physique Statistique of l'ENS, Paris, 2023, Short talk.
- Bernstein Conference, Berlin, 2022, Poster.
- Workshop „Building population models for large-scale neural recordings", Edinburgh, 2022, Poster.
- Journées de Physique Statistique of l'ENS, Paris, 2022, Short talk.
- Annual Meeting of the DPG, online, 2021, Poster
- Spring Meeting of the German Physical Society, online, 2021, Talk.
- Journées de Physique Statistique of l'ENS, Paris, 2020, Short talk.
- Bernstein Conference, Berlin, 2019, Poster.
- Spring Meeting of the German Physical Society, Regensburg, 2019, Talk.
- Bernstein Conference, Berlin, 2018, Poster.
- Workshop InSpire – New Insights on Complex Neural Dynamics, Cergy-Pontoise, 2018, Poster.

- Spring Meeting of the German Physical Society, Berlin, 2018, Talk.
- Bernstein Conference, Göttingen, 2017, Poster.
- CNS Conference, Antwerp, 2017, Poster.
- CRCNS Conference, Paris, 2016, Poster.
- Bernstein Conference, Berlin, 2016, Poster.
- 9th Bernstein Sparks Workshop, Göttingen, 2016, Poster.
- Spring Meeting of the German Physical Society, Regensburg, 2016, Talk.

FUNDINGS

- Short-term postdoc fellowship of the German Academic Exchange Service (Deutscher Akademischer Austauschdienst, DAAD) for **2021/2022**
- Support of M. Helias and C. Honerkamp in writing proposals („Facing the multi-scale problem in neuroscience by the functional renormalization group“ and „Dynamic phase transitions in cortical networks“) for the acquisition of „Exploratory Research Space“-seed funds of RWTH Aachen in **2016 and 2017**

OTHER ACTIVITIES

- Reviewer for Journal of Physics A: Mathematical and Theoretical, Physical Review E, **since 2019**
- Support of M. Helias to review for PloS Comput Biology, SIAM Journal of Applied Mathematics, Journal of Statistical Mechanics: Theory and Experiment, Journal of Physics A: Mathematical and Theoretical, **since 2016**
- Internship in the editorial department of the german newspaper „Süddeutsche Zeitung“, department „Wissen“ (Science), **January to March 2019**

REFERENCES

- Ulisse Ferrari Institut de la Vision, Sorbonne Université, INSERM, CNRS, Paris, France
- Rémi Monasson Laboratoire de Physics, ENS, Paris, France
- Frédéric van Wijland Laboratoire Matière et Systèmes Complexes, Université Paris Cité, France
- Moritz Helias INM-6, Research Centre Jülich and RWTH Aachen University, Germany
- Carsten Honerkamp Institute for Solid State Physics, RWTH Aachen University, Germany