David Martin

CNRS researcher

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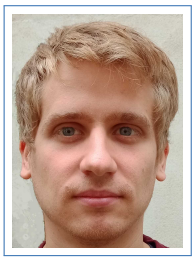

Higher education – Diploma

2017–2021 **PhD in theoretical physics**, *Université Paris Cité*, France
Thesis entitled "Nonequilibrium signatures and phase transitions in active matter and beyond".

2014–2016 **ICFP Master of theoretical physics with highest honors**, *Ecole Normale Supérieure*, Paris, France

2013–2014 **BSc in physics**, *Ecole Normale Supérieure*, Paris, France
Admitted as Normalien at the ENS after the 2013 nationwide competitive exam.

2011–2013 **prep school, section Physics and Chemistry**, *Lycée Blaise Pascal*, Orsay, France

Scientific experiences

11/2024–now **CNRS researcher (CRCN)**, *LPTMC lab, Sorbonne University*, Paris, France
I am working on the statistical modelling of supply chains to probe their resilience with respect to exogenous shocks. I am also developing unsupervised machine learning approaches to predict the binding between T-cell receptors and epitopes. Finally, I am deriving renormalization flows in minimal models of measurement-induced phase transitions.

11/2021–10/2024 **Kadanoff Postdoctoral Fellow**, *Kadanoff Center for Theoretical Physics and Enrico Fermi Institute, University of Chicago*, USA
In the group of Prof. Vincenzo Vitelli, I studied the impact of nonreciprocity on both equilibrium and nonequilibrium statistical mechanic systems. Together with Dr. Daniel Seara, we also developed a data-driven pipeline for analyzing socio-economic systems at large scale by leveraging hydrodynamic descriptions. Beside, in collaboration with Dr. Tony Jin, I worked on measurement-induced phase transitions and their renormalization flows in minimal models, classical and quantum ones alike.

10/2017–10/2021 **PhD student in theoretical physics**, *Université de Paris*, France
With the guidance of my advisor Prof. Julien Tailleur, I studied collective phenomena in active matter systems. We discovered the possibility of active solidification in flocks and brought solid arguments showing the emergence of collective motion to fall in the class of fluctuation-induced first order transition. We further derived exact formulas for activity-induced phenomenon such as the birth of "ratchet" current or the entropy production rate.

04/2017–09/2017 **Fellowship in statistical physics**, *Hugef*, via Nizza 52, Torino, Italy | 6 months
Theoretical work on the physicist approach to perceptron and to neural networks. Under the guidance of my supervisors Prof. Riccardo Zecchina, Dr. Carlo Lucibello and Dr. Carlo Baldassi, I used replica techniques to tackle sparse teacher/student problems. Explore-exploit models were also studied with Dr. Thomas Gueudré.

11/2016–03/2017 **Soft and active matter at DAMTP**, *CMS*, Cambridge, United Kingdom | 5 months
Under the supervision of Prof. Mike Cates, Dr. Cesare Nardini and Dr. Etienne Fodor, I studied stochastic thermodynamics and applied it to a trapped active particle.

09/2016–11/2016 **Start-up *LightOn***, *Agoranov*, Paris | 3 months
Prototyping and developing machine learning algorithms for the four founders: Igor Carron, Laurent Daudet, Florent Krzakala and Sylvain Gigan. Details are confidentials. LightOn develops an optical CPU capable of performing very fast mathematical operations frequently used in machine learning.

06/2016–08/2016 **CERN summer student**, *équipe CMS-TOTEM*, CERN, Geneva | 2 months
TOTEM is the collaboration devising two extra detectors, whose role are to detect proton deflected close to the LHC beam. With my advisor Michele Quinto, we engineered an experimental upgrade to measure the time of flight of these protons.

01/2016–03/2016 **Strongly correlated electrons**, Collège de France, Paris | 3 months
With Dr. Michel Ferrero and Prof. Antoine Georges as advisors, I studied numerically a new theoretical model for cuprates supraconductors in order to describe their experimental fermi surface.

02/2015–07/2015 **ADS/CFT correspondence**, *CONICET*, instituto de fisica de La Plata, Argentina | 5 months

With Dr. Gianni Tallarita and Prof. Fidel Schaposnik, my supervisor, we studied a new coupled Lagrangian with symmetry breaking describing type-2 superconductors.

07/2014 **SWASI: an astrophysical experiment**, *Laboratory of astrophysics*, CEA Saclay, France | 5 weeks

With Dr. Thierry Foglizzo, we worked on the experimental fountain SWASI which mimics hydrodynamic flows during a supernovae.

Publications

1. **"Sociohydrodynamics: data-driven modelling of social behavior"**
   DS. Seara, J. Colen, M. Fruchart, Y. Avni, D. Martin, V. Vitelli
   In press at PNAS, ArXiv *2312.17627* (August 2025)
2. **"Quorum sensing of light-activated colloids in nematic liquid crystals"**
   A. Tavera-Vázquez, D. Martin, H. Ren, S. Rubin, A. Córdoba, R. Zhang, V. Vitelli, J. J. de Pablo
   Under review at Nature Materials, ArXiv *2507.10866* (July 2025)
3. **"The transition to collective motion in nonreciprocal active matter: coarse graining agent-based models into fluctuating hydrodynamics"**
   D. Martin, D. Seara, Y. Avni, M. Fruchart, and V. Vitelli
   In press at PRX , ArXiv *2307.08251* (July 2025)
4. **"The non-reciprocal Ising Model"**
   Y. Avni, M. Fruchart, D. Martin, D. Seara, V. Vitelli
   Phys. Rev. Lett. 134, ArXiv *2311.05471* (March 2025)
5. **"Dynamical phase transitions in the nonreciprocal Ising model"**
   Y. Avni, M. Fruchart, D. Martin, D. Seara, V. Vitelli
   Physical Review E 111, ArXiv *2409.07481* (March 2025)
6. **"Measurement-induced phase transition in a single-body tight-binding model"**
   T. Jin, D. Martin
   Physical Review B 110, ArXiv *2309.15034* (August 2024)
7. **"Fluctuation-Induced First Order Transition to Collective Motion"**
   D. Martin, G. Spera, H. Chaté, C. Duclut, C. Nardini, J. Tailleur, F. van Wijland
   J. Stat. Mech. 084003, ArXiv *2402.05078* (August 2024)
8. **"KPZ physics and phase transition in a classical single random walker under continuous measurement"**
   T. Jin, D. Martin
   Phys. Rev. Lett. 129, 260603 (December 2022), ArXiv *2204.00070*
9. **"AOUP in the presence of Brownian noise: a perturbative approach"**
   D. Martin, T. Arnoulx de Pirey
   J. Stat. Mech. 043205 (April 2021), ArXiv *2009.13476*
10. **"Statistical Mechanics of Active Ornstein Uhlenbeck Particles"**
    D. Martin, J. O'byrne, M. E. Cates, E. Fodor, C. Nardini, J. Tailleur, F. Van Wijland
    Phys. Rev. E 103, 032607 (March 2021), ArXiv *2008.01397*
11. **"Fluctuation-induced phase separation in metric and topological models of collective motion"**
    D. Martin, H. chaté, C. Nardini, A. Solon, J. Tailleur, F. Van Wijland
    Phys. Rev. Lett. 126, 148001 (April 2021), ArXiv *2008.12972*
12. **"Freezing a Flock: Motility-Induced Phase Separation in Polar Active Liquids"**
    G. Geyer, D. Martin, J. Tailleur and D. Bartolo
    Phys. Rev. X 9, 031043 (September 2019), ArXiv *1903.01134*
13. **"The balance of growth and risk in population dynamics"**
    T. Gueudré, D. Martin.
    EPL 121, 68005 (May 2018), ArXiv *1712.00979*. Selected as editor's choice.
14. **"Extracting maximum power from active colloidal heat engines"**
    D. Martin, C. Nardini, M.E. Cates and E.Fodor
    EPL 121, 60005 (May 2018), ArXiv *1803.01620*. Selected as editor's choice.

Talks, Conferences and Summer Schools

2025 **Les Gustins summer school**, Aiguebelette-le-lac | seminar

StatPhys29, University of Firenze | contributed talk

APS March Meeting, Los Angeles | invited talk

2024 **Harvard University**, group of David Nelson and Sunghan Ro | lab seminar

CNRS, section 02 and 05 | job interview

LPS, Paris-Saclay University | job interview

LPTHE, Paris Sorbonne University | job interview

Centre for Neuroscience, Radboud University | job interview

Rudolf Peierls Centre, University of Oxford | job interview

Rudolf Peierls Centre, University of Oxford | department seminar

L2C, Université de Montpellier | lab seminar

2023 **LPENS**, Ecole Normale Supérieure | lab seminar

LIPhy, Université Grenoble Alpes | lab seminar

LOMA, Université de Bordeaux | lab seminar

SPEC, CEA Saclay | lab seminar

ILM, Université Claude Bernard | lab seminar

LPTMS, Université d'Orsay | lab seminar

LPTMC, Sorbonne Université | lab seminar

Les Gustins summer school, Aiguebelette-le-lac | seminar

StatPhys 28, University of Tokyo | contributed talk

Frontiers in nonequilibrium physics: active matter, topology and beyond, Yukawa Institute for Theoretical Physics, Kyoto | contributed talk

University of Santa Barbara - group meeting, Cristina Marchetti's group | seminar

University of Edinburgh - teaching and research proposals, Institute for Condensed Matter and Complex Systems | job interview

2022 **Prix de thèse des systèmes complexes**, Paris | award talk

Journées de la Matière Condensée, Lyon | contributed talk

Les Gustins summer school, Aiguebelette-le-lac | seminar

APS March Meeting, Chicago | contributed talk

2021 **Institut Curie - group meeting**, Pierre Sens' group and collaborators | seminar

Liquid Matter Conference, online | poster

Les Gustins summer school, Aiguebelette-le-lac | seminar

Glassy systems and inter-disciplinary applications summer school, Cargèse | poster

EPFL Lausanne - group meeting, Matthieu Wyart's group | seminar

2020 **University of Chicago - group meeting**, Vincenzo Vitelli's group | seminar

Microswimmers International Conference SPP 1726, Bonn | contributed talk

Les Gustins summer school, Aiguebelette-le-lac | seminar

Journées de la physique statistique, ENS Paris | contributed talk

2019 **ESPCI - active matter seminar**, Gulliver lab | seminar

Heraeus-Seminar "Novel Physics in Living Systems?", Roscoff | poster

Paris Diderot University - theory group, MSC lab | seminar

Bangalore School on Statistical Physics - X, ICTP

2018 **Active matter and non-equilibrium statistical physics school**, Les Houches | poster

Leuven school on nonequilibrium physics, KU Leuven

Correlations, fluctuations and anomalous transport in systems far from equilibrium, Weizmann Institute of Science

Fellowships/Prizes/Grants

- April 2023 - Recipient of SLiM-Ex Scientist Exchange Award (3k$) for a research stay at University of Santa Barbara with Prof. Cristina Marchetti.
- October 2022 - Recipient of the PhD award "Prix de thèse des systèmes complexes" (1k$).
- 2021 - 2024 - Independent Kadanoff Postdoctoral Fellowship at the University of Chicago.
- 2021 - 2022 - Joint grant FACCTS of 25k$ with Vincenzo Vitelli at the University of Chicago.
- September 2019 - Best poster prize awarded for the WE-Heraeus-Seminar "Novel Physics in Living Systems?" held in Roscoff.

Review service

Physical Review E, Physics Letters A, Journal of Statistical Mechanics, Journal of Statistical Physics, Physical Review Letters, Soft Matter, SciPost Physics

Teaching

10/2018–10/2021 **Teaching assistant for first-year medical students**, *Université Paris Cité*, 30 h/years
Exercise classes covering topics in electrostatics, hydrodynamics and thermodynamics for the competitive exam.

10/2018–10/2021 **Teaching assistant for third-year pharmacy students**, *Université Paris Cité*, 34 h/years
Exercise classes of geometrical and wave optics. Practical work session of goniometry and rheometry. Under the supervision of Jean-François Gaucher and Mohamed Selkti, I helped designing the experimental set-ups that were used within the teaching unit.

2015–2016 **Physics tutorials "Colles"**, *Lycée Henri IV*, 30 hours
Individual oral examinations of prep school students.

2013–2018 **Private lessons in physics for prep school students**, 100 hours

Collective responsabilities and outreach

2020-now Organization and treasurer of *Les Gustins summer school*, a yearly gathering of young physicists and mathematicians.

09/2023-now Co-supervision of undergraduate student Antti Eero Asikainen (20%), *Prof. Julien Tailleur's group*, MIT, USA

05/2022-now Co-supervision of graduate student Soshana Chipman (20%), *Prof. Vincenzo Vitelli's group*, University of Chicago, USA

01/2022-now Writing of grant proposals as well as funding reports, *Prof. Vincenzo Vitelli's group*, University of Chicago, USA

05/2018–06/2019 Organization of doctoral and postdoctoral seminars with Camille Gaulon, *Laboratoire Matière et Systèmes Complexes*, Paris, France

Languages and skills

Languages **French** (mother tongue), **English** (fluent), **Italian** (fluent), **Spanish** (fluent), German (notions), Japanese (notions)

Programming Julia, C++, C, python, Mathematica, Matlab

Edition LaTeX, Beamer, photoshop

Numerical methods

Integration of PDEs and SPDEs using semi-spectral and semi-implicit schemes. Simulations of particle-based models using coupled Langevin equations. Numerical implementation of Borel-Padé resummation. Training of Teacher-Student models and neural nets for machine learning applications. High performance computing using optimized libraries such as MPI or BLAS/LAPACK.

Theoretical methods

Field-theoretic approaches, path-integral formalism and quasi-linear renormalization. Coarse-graining procedures using Doi-Peliti formalism. Stochastic calculus and replica technics. Perturbative solution of Fokker-Planck equations.

Hobbies

Drawing	Charcoal sketches, pencil drawing, watercolours...
Sailing	Practice with sailing dinghies and cruise ships.
Biking	Travelling and commuting around.

Academic references

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