

Étienne Fodor

Physics of Active Matter

Associate Professor, ATTRACT Fellow

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Dept of Physics and Materials Science (DPhyMS)

Univ of Luxembourg

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L-4362 Esch-sur-Alzette, Luxembourg

Scientific positions and education

Since 2025 **Associate Professor**, DPhyMS, Univ of Luxembourg
2020–25 **Assistant Professor**, DPhyMS, Univ of Luxembourg
2017–20 **Oppenheimer Research Fellow**, DAMTP, Univ of Cambridge
2016–17 **Postdoctoral Research Associate**, DAMTP, Univ of Cambridge (Supervisor: ME Cates)
2013–16 **PhD in Physics**, Univ Paris Diderot (Supervisors: P Visco, F van Wijland), summa cum laude
2012–13 **Masters (2nd year) in Physics**, École Normale Supérieure (ENS), Paris
2011–12 **Agrégation de Physique**, Training program for teaching in Physics Bachelors, ENS Cachan
2009–11 **Bachelors + Masters (1st year) in Physics**, ENS Lyon

Research, supervision, and teaching

Since 2022 **Masters course in Physics**, DPhyMS, Univ of Luxembourg | 14 weeks/year
Since 2020 **Group supervision**, DPhyMS, Univ of Luxembourg
8 Postdocs | LK Davis (20–22), A Manacorda* (21–24), T Banerjee[†] (22–26), WD Piñeros* (22–25),
UA Dattani (23–25), F Serafin (24–25), A Soriani (26–27), F Thewes (26–27)
*Marie-Curie Fellow (Horizon Europe), [†]CORE Junior Fellow (Luxembourg)
6 PhDs | Y Zhang (20–23), BN Radhakrishnan (21–25), L Casagrande (23–26), N Setzkorn (24–27),
IJC Miranda (24–27), M Antonioli (24–27)
3 Masters | L Casagrande (22–23), T Desaleux (22–23), N Setzkorn (23–24)
2024 **Masters course in Physics**, Dept of Physics, Univ of Liège | 10 hours, 1 week
2021 **Doctoral course in Physics**, DPhyMS, Univ of Luxembourg | 6 hours, 1 day
2016–20 **Student co-supervision**, DAMTP, Univ of Cambridge (Supervisor: ME Cates)
2 PhDs | ØL Borthne (17–20), T Ekeh (18–21)
3 Masters | D Martin (16–17), T Ekeh (17–18), JW Knight (19–20, best thesis prize)
2015–16 **Research visit**, YITP, Kyoto Univ (Host: H Hayakawa) | 2 months/year
2013–16 **Bachelors tutorials in Physics**, Univ Paris Diderot | 14 weeks/year
2013 **Research internship**, Univ Paris Diderot (Supervisors: P Visco, F van Wijland) | 16 weeks
2012–13 **Bachelors tutorials in Physics**, Lycée Fénélon, Paris | 30 weeks
2011 **Research intership**, Univ of Oxford (Supervisors: AS Wyatt, IA Walmsley) | 12 weeks
2010–11 **Bachelors tutorials in Physics**, Lycée la Martinière Monplaisir, Lyon | 30 weeks
2010 **Research internship**, Univ de Genève (Supervisors: L Bonacina, J-P Wolf) | 8 weeks

Funding, fellowships, and awards

2025–28 **Innovative training network**, Horizon Europe (Program lead: R Blythe) | 1 PhD
2024–27 **CORE grant**, Fonds National de la Recherche (FNR), Luxembourg | 830 kEUR
2021–26 **Doctoral training unit**, FNR (Program lead: M Esposito) | 1 PhD
2020–25 **ATTRACT Fellowship**, FNR | 1.5 MEUR
2017–20 **Oppenheimer Research Fellowship**, Univ of Cambridge | 160 kGBP
Junior Research Fellowship, St Catharine's College, Cambridge
2017 **PhD prize**, Institut des Systèmes Complexes, Paris
Best talk prize, SIAM-IMA Annual Conference, Univ of Cambridge
2015 **Best talk prize**, Active Liquids, Lorentz Center, Leiden
2013–16 **Teaching Assistantship**, Univ Paris Diderot + **PhD Scholarship**, ENS Cachan

Scientific events and committees

Invited conference talks

- 2025 **Statistical Physics of Living Systems**, CECAM, Lausanne
 International Discussion Meeting on Relaxations in Complex Systems, Barcelona
 Self-Organization Far From Equilibrium, APS March meeting, Anaheim
 Machine Learning for Enhanced Sampling of Atomistic Systems, Berkeley
- 2024 **The Many Faces of Active Mechanics**, KITP, Santa Barbara
 Nonequilibrium Statistical Physics of Complex Systems, Seoul
- 2023 **Computational Advances in Active Matter**, Lorentz Center, Leiden
 Frontiers in Nonequilibrium Physics: Active Matter, Topology and Beyond, Kyoto
 Conference on Statistical Mechanics, Sitges
 Physics of Dense and Active Disordered Materials, Kyoto
 Frontiers in Nonequilibrium Physics, Institute of Mathematical Sciences, Chennai
- 2022 **Statistical Mechanical Theories of Emergence in Biological Systems**, Edinburgh
 Numerical Techniques for Nonequilibrium Steady States, CECAM, Mainz
- 2020 **Symmetry, Thermodynamics and Topology in Active Matter**, KITP (online)
- 2018 **Why Measure Entropy Production?**, Princeton Univ
 Active Matter Session, Berkeley

Contributed conference talks

- 2025 **Multiscale modeling of chemically active mixtures**, CECAM, Lausanne
 StatPhys29, Out-of-equilibrium Statistical Physics, Florence
 From Flocking Birds to Migrating Cells: Recent Advances in Active Matter, Leiden
- 2024 **Dissipative Processes in Molecular Systems**, Padova
 Workshop on Stochastic Thermodynamics V (online)
 DPG Spring Meeting, Berlin
- 2023 **StatPhys28, Soft Matter**, Tokyo
 Bridge between Non-equilibrium Statistical Physics and Biology, Cambridge
 New Perspectives in Active Systems, Dresden
 From Soft Matter to Biophysics, Les Houches
- 2021 **Liquid Matter Conference**, Prague (online)
 Workshop on Stochastic Thermodynamics II (online)
- 2020 **Motile Active Matter Conference**, Bonn (online)
- 2019 **StatPhys27, Out-of-equilibrium aspects**, Buenos Aires
 International Soft Matter Conference, Edinburgh
 Statistical Physics of Complex Systems, Nordita, Stockholm
- 2018 **Nonequilibrium Collective Dynamics**, Technische Univ Berlin
 Fundamental Problems in Active Matter, Aspen Center for Physics
- 2017 **SIAM-IMA Annual Conference**, Univ of Cambridge
 Edwards Centre Mini Conference, Univ of Cambridge
 Open Statistical Physics, Milton Keynes
- 2016 **StatPhys26, Biological Physics**, Lyon
 Non-Gaussian Workshop, YITP, Kyoto
- 2015 **Active Liquids**, Lorentz Center, Leiden
- 2014 **Condensed Matter in Paris**, Univ Paris Descartes
 ESPCI, Journées de Physique Statistique, Paris

Invited seminars

- 2025 **Biophysics Seminar Series**, Massachusetts Institute of Technology
- 2024 **Dept of Chemistry**, Univ of California, Berkeley
 LPTMC, Sorbonne Univ, Paris
 Dept of Physics, Univ of Liège

- Institute of Physics, Univ of Leiden
Niels Bohr Institute, Univ of Copenhagen
- 2023 **Biological, Soft and Complex Materials and Theory Seminar**, Univ of Bristol
EMBL Theory Seminar, Heidelberg
- 2022 **Biological Physics and Physical Biology**, online
DAMTP, Soft Matter Seminar, Univ of Cambridge (online)
Mathematical Physics Seminar, Imperial College London (online)
- 2021 **Dept of Physics**, Guangdong Technion (online)
Quantum Science and Technology, Univ of Luxembourg (online)
Non-equilibrium Statistical Physics, Georg-August-Univ Göttingen (online)
Centre de Physique Théorique, Aix-Marseille Univ (online)
- 2020 **School of Physics and Astronomy**, Univ of Edinburgh (online)
Dept of Physics, Univ of Bath
- 2019 **ICTP, Quantitative Life Sciences Group**, Trieste
James Franck Institute, Dept of Chemistry, Univ of Chicago
Physics of Living Systems, Massachusetts Institute of Technology
Physics and Materials Science Research Unit, Univ of Luxembourg
Institute of Physics, Computational Soft Matter, Univ of Amsterdam
- 2018 **LiPhy Laboratory**, Univ Grenoble Alpes
Charles Coulomb Laboratory, Univ de Montpellier
ESPCI, Gulliver Laboratory, Paris
St Catharine's College, Graduate Research Seminars, Cambridge
Research Colloquium Series, California State Univ, Fullerton
- 2017 **DAMTP, Soft Matter Seminar**, Univ of Cambridge
DAMTP, BioLunch Seminar, Univ of Cambridge
- 2016 **School of Mathematical Sciences**, Queen Mary Univ of London
DAMTP, Soft Matter Seminar, Univ of Cambridge
MSC Laboratory Seminar, Univ Paris Diderot
Yukawa Institute for Theoretical Physics, Kyoto
- 2015 **LiPhy Laboratory**, Univ Grenoble Alpes
Physics-Biology Interface Seminar, Univ Paris Sud
DAMTP, Soft Matter Seminar, Univ of Cambridge
Yukawa Institute for Theoretical Physics, Kyoto
- 2014 **MSC Laboratory, Physique du vivant**, Univ Paris Diderot
MSC Laboratory, Theory Group, Univ Paris Diderot

Organized events

- 2025 **Nonequilibrium Systems Under Control**, Lorentz Center, Leiden | Workshop, 1 week
Co-organizers: TR Gingrich (Northwestern Univ), SAM Loos (Univ of Cambridge)
- 2024 **Energy, Information and Evolution in Biology**, Cargèse | Summer school, 2 weeks
Co-organizers: A Manacorda, M Esposito (Univ of Luxembourg)
Physics Meets Mathematics, Univ of Luxembourg | Workshop, 1 day
- 2018–20 **Statistical Physics and Soft Matter**, DAMTP, Univ of Cambridge | Weekly seminar
Co-organizers: ME Cates, RL Jack (Univ of Cambridge)
- 2019 **Colloids as a Toolbox for Statistical Mechanics**, Univ of Cambridge | Workshop, 1 day
Co-organizers: ME Cates, RL Jack (Univ of Cambridge)
- 2018 **Nonequilibrium Biophysics, World Congress of Biomechanics**, Dublin | Session, $\frac{1}{2}$ day
Co-organizer: D Mizuno (Kyushu Univ)

Outreach activities

- 2024 **Outreach lecture**, Institut d'Etudes Scientifiques, Cargèse
Chercheurs à l'école, Seminar in high schools, Luxembourg
- 2023 **Inaugural lecture**, Faculty of Science, Technology and Medicine, Univ of Luxembourg

2022 **Student fair**, DPhyMS, Univ of Luxembourg
 2021 **Open day**, DPhyMS, Univ of Luxembourg
 2021–24 **Internship supervision**, High-school students, Univ of Luxembourg | 1 week/year

Review and editorial service

Since 2025 **Editorial board member**, Journal of Statistical Mechanics
 Since 2016 **Reviewer for scientific journals and agencies** | ca 30 reviews/year
 Journals | Commun Phys, Entropy, EPL, EPJE, J Chem Phys, J Phys A, J Stat Mech,
 Nat Commun, Nat Phys, New J Phys, Phys Rev (E, Lett, Res, X), PNAS, Science,
 Science Adv, Soft Matter
 Agencies | ANR (France), DFG (Germany), DOE (USA), FRS-FNRS (Belgium), ISF (Israel)
 2025–26 **Guest editor**, Physical Review E | Special topics: “Controlling stochastic dynamics across scales”
 2025–26 **Guest editor**, New Journal of Physics

PhD committees

2026 DPhyMS, Univ of Luxembourg (Student: A Kabylda, Supervisor: A Tkatchenko)
 Univ of Barcelona (Student: Y Rouzaire, Supervisor: D Levis)
 2025 DPhyMS, Univ of Luxembourg (Student: SGM Srinivas, Supervisor: M Esposito)
 Univ of Mons (Student: G Palumbo, Supervisor: P Damman)
 DPhyMS, Univ of Luxembourg (Student: M Puleva, Supervisor: A Tkatchenko)
 DPhyMS, Univ of Luxembourg (Student: BN Radhakrishnan, Supervisor: TL Schmidt)
 2024 Univ Grenoble Alpes (Student: L Guislain, Supervisor: E Bertin)
 Univ Paris Cité (Student: A Dinelli, Supervisor: J Tailleur)
 DPhyMS, Univ of Luxembourg (Student: N Carabba, Supervisor: A del Campo)
 DPhyMS, Univ of Luxembourg (Student: L Dupays, Supervisor: A del Campo)
 2023 Imperial College, London (Student: Z Zhang, Supervisor: G Pruessner)
 2022 DPhyMS, Univ of Luxembourg (Student: D Forastiere, Supervisor: M Esposito)
 DPhyMS, Univ of Luxembourg (Student: E Penocchio, Supervisor: M Esposito)
 DPhyMS, Univ of Luxembourg (Student: V Vassilev Galindo, Supervisor: A Tkatchenko)
 2021 Luxembourg Centre for Systems Biomedicine (Student: S Martina, Supervisor: A Skupin)
 DPhyMS, Univ of Luxembourg (Student: J Ekström, Supervisor: TL Schmidt)

Scientific production

Main publications: Phys Rev Lett [40][35][34][32][7], Phys Rev X [36][25][18][17][9], Reviews [28][24][13]

- [48] **Contraction waves in pulsating active liquids: From pacemaker to aster dynamics**
 T Banerjee, T Desaleux, J Ranft, and ÉF, arXiv:2509.19024
- [47] **Irreversibility in scalar active turbulence: The role of topological defects**
 BN Radhakrishnan,* F Serafin,* TL Schmidt, and ÉF, arXiv:2507.06073
- [46] **Entropy production rate in thermodynamically consistent flocks**
 T Agranov, RL Jack, ME Cates, and ÉF, arXiv:2505.13117
- [45] **Control of active field theories at minimal dissipation**
 A Soriani, E Tjhung, ÉF, and T Markovich, arXiv:2504.19285
- [44] **Hydrodynamics of pulsating active liquids**
 T Banerjee, T Desaleux, J Ranft, and ÉF, arXiv:2407.19955
- [43] **Quantifying dissipation in flocking dynamics: When tracking internal states matters**
 K Proesmans, G Falasco, A Tanaji Mohite, M Esposito, and ÉF, Phys Rev E **112**, 024103 (2025)
- [42] **Diffusive oscillators capture the pulsating states of deformable particles**
 A Manacorda and ÉF, Phys Rev E **111**, L053401 (2025)
- [41] **Species interconversion of deformable particles yields transient phase separation**
 Y Zhang, A Manacorda, and ÉF, New J Phys **27**, 043023 (2025)

- [40] **Biased ensembles of pulsating active matter**
WD Piñeros and ÉF, Phys Rev Lett **134**, 038301 (2025) | Editors' suggestion
- [39] **Nonequilibrium thermodynamics of non-ideal reaction-diffusion systems: Implications for active self-organization**
F Avanzini, T Aslyamov, ÉF, and M Esposito, J Chem Phys **161**, 174108 (2024)
- [38] **Controlling active matter: The need for thermodynamic consistency**
ÉF, Europhys News **55**, 20 (2024)
- [37] **Thermodynamically consistent flocking: From discontinuous to continuous transitions**
T Agranov, RL Jack, ME Cates, and ÉF, New J Phys **26**, 063006 (2024)
- [36] **Active matter under control: Insights from response theory**
LK Davis, K Proesmans, and ÉF, Phys Rev X **14**, 011012 (2024) | Highlight in Physics 17, 20 (2024)
- [35] **Pulsating active matter**
Y Zhang and ÉF, Phys Rev Lett **131**, 238302 (2023)
- [34] **Non-ideal reaction-diffusion systems: Multiple routes to instability**
T Aslyamov, F Avanzini, ÉF, and M Esposito, Phys Rev Lett **131**, 138301 (2023)
- [33] **Towards a liquid-state theory for active matter**
YI Li, R Garcia-Millan, ME Cates, and ÉF, EPL **142**, 57004 (2023)
- [32] **Thermodynamic control of activity patterns in cytoskeletal networks**
A Lamtyugina, Y Qiu, ÉF, AR Dinner, and S Vaikuntanathan, Phys Rev Lett **129**, 128002 (2022)
- [31] **From predicting to learning dissipation from pair correlations of active liquids**
G Rassolov, L Tociu, ÉF, and S Vaikuntanathan, J Chem Phys **157**, 054901 (2022)
- [30] **Mean-field theory for the structure of strongly interacting active liquids**
L Tociu, G Rassolov, ÉF, and S Vaikuntanathan, J Chem Phys **157**, 014902 (2022)
- [29] **Power fluctuations in sheared amorphous materials: A minimal model**
T Ekeh, ÉF, SM Fielding, and ME Cates, Phys Rev E **105**, L052601 (2022)
- [28] **Irreversibility and biased ensembles in active matter: Insights from stochastic thermodynamics**
ÉF, RL Jack, and ME Cates, Annu Rev Condens Matter Phys **13**, 215 (2022)
- [27] **Stochastic hydrodynamics of complex fluids: Discretisation and entropy production**
ME Cates, ÉF, C Nardini, T Markovich, and E Tjhung, Entropy **24**, 254 (2022) | Editor's choice
- [26] **Optimal power and efficiency of odd engines**
ÉF and A Souslov, Phys Rev E **104**, L062602 (2021)
- [25] **Thermodynamics of active field theories: Energetic cost of coupling to reservoirs**
T Markovich, ÉF, E Tjhung, and ME Cates, Phys Rev X **11**, 021057 (2021)
- [24] **Active engines: Thermodynamics moves forward**
ÉF and ME Cates, EPL **134**, 10003 (2021)
- [23] **Statistical mechanics of active Ornstein-Uhlenbeck particles**
D Martin, J O'Byrne, ME Cates, ÉF, C Nardini, J Tailleur, and F van Wijland, Phys Rev E **103**, 032607 (2021)
- [22] **Collective motion in large deviations of active particles**
Y-E Keta, ÉF, F van Wijland, ME Cates, and RL Jack, Phys Rev E **103**, 022603 (2021)
- [21] **Time-reversal symmetry violations and entropy production in field theories of polar active matter**
ØL Borthne, ÉF, and ME Cates, New J Phys **22**, 123012 (2020)
- [20] **Thermodynamic cycles with active matter**
T Ekeh, ME Cates, and ÉF, Phys Rev E **102**, 010101(R) (2020)

- [19] **Dissipation controls transport and phase transitions in active fluids: Mobility, diffusion and biased ensembles**
ÉF, T Nemoto, and S Vaikuntanathan, New J Phys **22**, 013052 (2020)
- [18] **Autonomous engines driven by active matter: Energetics and design principles**
P Pietzonka, ÉF, C Lohrmann, ME Cates, and U Seifert, Phys Rev X **9**, 041032 (2019)
- [17] **How dissipation constrains fluctuations in nonequilibrium liquids: Diffusion, structure and biased interactions**
L Tociu, ÉF, T Nemoto, and S Vaikuntanathan, Phys Rev X **9**, 041026 (2019)
- [16] **Driven probe under harmonic confinement in a colloidal bath**
V Démery and ÉF, J Stat Mech **2019**, 033202 (2019)
- [15] **Optimizing active work: Dynamical phase transitions, collective motion and jamming**
T Nemoto, ÉF, ME Cates, RL Jack, and J Tailleur, Phys Rev E **99**, 022605 (2019)
- [14] **Non-Gaussian noise without memory in active matter**
ÉF, H Hayakawa, J Tailleur, and F van Wijland, Phys Rev E **98**, 062610 (2018)
- [13] **The statistical physics of active matter: From self-catalytic colloids to living cells**
ÉF and MC Marchetti, Physica A **504**, 106 (2018)
- [12] **Extracting maximum power from active colloidal heat engines**
D Martin, C Nardini, ME Cates, and ÉF, EPL **121**, 60005 (2018) | Editor's choice
- [11] **Active mechanics reveal molecular-scale force kinetics in living oocytes**
WW Ahmed,* ÉF,* M Almonacid,* M Bussonnier, NS Gov, M-H Verlhac, P Visco, F van Wijland, and T Betz, Biophys J **114**, 1667 (2018)
- [10] **Spatial fluctuations at vertices of epithelial layers: Quantification of regulation by Rho pathway**
ÉF,* V Mehandia,* J Comelles, R Thiagarajan, NS Gov, P Visco, F van Wijland, D Riveline
Biophys J **114**, 939 (2018)
- [9] **Entropy production in field theories without time-reversal symmetry: Quantifying the non-equilibrium character of active matter**
C Nardini, ÉF, E Tjhung, F van Wijland, J Tailleur, and ME Cates, Phys Rev X **7**, 021007 (2017)
- [8] **Nonequilibrium dissipation in living oocytes**
ÉF,* WW Ahmed,* M Almonacid,* M Bussonnier, NS Gov, M-H Verlhac, T Betz, P Visco, and F van Wijland, EPL **116**, 30008 (2016)
- [7] **How far from equilibrium is active matter?**
ÉF, C Nardini, ME Cates, J Tailleur, P Visco, and F van Wijland, Phys Rev Lett **117**, 038103 (2016)
Editor's suggestion | Highlight in Physics 9, s76 (2016)
- [6] **Active cage model of glassy dynamics**
ÉF, H Hayakawa, P Visco, and F van Wijland, Phys Rev E **94**, 012610 (2016)
- [5] **Modeling the dynamics of a tracer particle in an elastic active gel**
E Ben Isaac, ÉF, P Visco, F van Wijland, and NS Gov, Phys Rev E **92**, 012716 (2015)
- [4] **Active cell mechanics: Measurement and theory,**
WW Ahmed, ÉF, and T Betz, Biochimica et Biophysica Acta - Mol Cell Res **1853**, 3083 (2015)
- [3] **Activity-driven fluctuations in living cells**
ÉF,* M Guo,* NS Gov, P Visco, DA Weitz, and F van Wijland, EPL **110**, 48005 (2015)
Editor's choice | Highlight in Europhysics News 46/5 (2015)
- [2] **Generalized Langevin equation with hydrodynamic backflow: Equilibrium properties**
ÉF, DS Grebenkov, P Visco, and F van Wijland, Physica A **422**, 107 (2015)
- [1] **Energetics of active fluctuations in living cells**
ÉF, K Kanazawa, H Hayakawa, P Visco, and F van Wijland, Phys Rev E **90**, 042724 (2014)

* Equal contribution of these authors to this work