

Currently a **Marie Curie Fellow and permanent CNRS research @Sorbonne University**, I am interested in **non-equilibrium transport processes in soft matter**. I study micro to nanoscale systems where exotic phenomena emerge. I elaborate ideas to harvest them for macroscopic transport and applications for filtration and biomedicine. I develop advanced analytic and simulation models based on first principles and confront them with experiments, together with intense experimental collaborations.

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RESEARCH - harvesting non-equilibrium forces for fluidic transport and more



Marie Sklodowska Curie Fellow - New York & Sorbonne University Since June 2020

Self driven 3 year research plan called "Molecular Control" for tunable molecular or ionic transport in non-equilibrium systems driven by electric or chemical gradients. Collaborations with **David Pine, Benjamin Rotenberg, Aleksandar Donev, Miranda Holmes-Cerfon**.



Courant Instructor - New York University - New York, USA 2019- 2020

with **Aleksandar Donev, Miranda Holmes-Cerfon** : (1) **Non-equilibrium transport of ions and molecules in fluctuating nano-environments**. (2) **Transport of particles via sticky** attaching and detaching **feet**, application to cell locomotion and growth of artificial materials.



Post-Doc - Ecole normale supérieure - Paris, France 2018 - 2019

with L. Bocquet: How to define **transport quantities beyond equilibrium** ? applied to osmosis.



PhD THESIS - Ecole normale supérieure - Paris, France 2015 - 2018

Supervised by **Lydéric Bocquet** : **Nanofluidic transport for filtration and dialysis**. Exploration of biomimetic ideas. Introduction of the concept of **non-equilibrium sieving** with dynamic pores, that are more energy efficient and more selective.



Total - Paris, France, *Research & Development* 2015

Silicon solar cells, growth and high temperature **transport** of oxygen defects.



Master's THESIS (#2) - Institut Curie - Paris, France 2014

Supervisor **Jean-François Joanny** : Model to describe of a key step in cellular **motility**.



Master's THESIS (#1) - Harvard University - United-States 2013

Supervisor **Michael P. Brenner** : Optimal doping of silicon cells via sulfur **transport**.

Main International Collaborations



Technische Universität München - Munich, Germany, Since 2013

with **Karen Alim** : Unraveling the **crucial role of non-equilibrium driven flows** for nutrient transport and growth of **biological organisms**. (2 publications + 1 preprint)



Cambridge University - United Kingdom, Since 2021

with **Alice Thorneywork** : Deciphering **noise signatures on nanoscale transport**.

ACADEMIC BACKGROUND



Diploma from École Normale Supérieure 2011 - 2015

Master's degree in fundamental physics, with honors
Bachelor in Maths and Bachelor in Physics (two Bachelors acquired at the same time)
Bronze Medal at the International Physics Olympiads

TEACHING and SUPERVISING



Student supervision

Since 2020

Tanya Wang (co-mentored with Ruben Zakine), Summer program 2020 + 1 year, publication in writing.
Jeana A. Zheng (co-mentored with David J Pine), PhD subprojects, 2 publications + 1 in writing
Johanna Mc Combs (co-mentored with Brennan Sprinkle), Summer program 2021



Undergraduate level, New York University

2019 - 2020

Teaching: general math classes: Calculus II, 2 semesters



Undergraduate level, École Normale Supérieure & Lycée Louis-le-Grand

2013 - 2018

Teaching: Physics classes for France's top students (among the 200 best) in Electromagnetism, Relativity and Orders of Magnitude; General maths and physics tutoring.

AWARDS



Outstanding referee APS (2021) <https://journals.aps.org/OutstandingReferees>

(1 of the 161 outstanding referees nominated for 2021 / 70 000 active referees at the APS)



Rising Stars in Soft and Biological Soft Matter (2020)

(Junior research award from University of Chicago)



l'Oréal-UNESCO grant for Women in Science (2017)

(15 000 euros granted by an independent academic jury from the French Science Academy)



1st national prize at Falling Walls Lab (2017)

(Public outreach/entrepreneurship presentation)



Jean-Pierre Aguilar grant from the CFM Foundation (2015-2018)

(Highly paid and very selective PhD grant from the Foundation of Jean-Philippe Bouchaud)

ACADEMIC RESPONSIBILITIES

Grants received

- **Marie Skłodowska Curie individual Fellowship (received 2019, started 2020-2023)**
(~250 k€ personal research grant for a collaboration between NYU and Paris Sorbonne)
- **Recipient of 1,000 k hours grant on a national super cluster (2018)**
- Recipient of 750 k hours on a national cluster for simulations (2017 + 2018)

Committees

- **PhD committees:** Nicole Timmerhuis (2022, University of Twente)
- **Scientific committee member**, Scientific projects awards at **École Polytechnique (2022)**

Peer-review contributions

Regular Referee for several major international journals (~15/year)

- Physical review: **PRL, PRE, PRX, PRF**
- **Proceedings of the National Academy of Science**, EPL, EPJE
- **Nature Physics, Nature Chemistry Reviews**, Communications Chemistry, Scientific Reports
- **Chemical Reviews, Journal of Chemical Physics, Journal of Fluid Mechanics**

Administrative responsibilities

- Co-organizer of the Applied Math Seminar at the Courant Institute (1 year)
- Organizer of several social events (team building days, lunches, happy hours)
- Responsible for the full set up of a research wet lab (with at least 5 people at work)



LIST OF PUBLICATIONS

- (**) Network architecture determines vein fate during spontaneous reorganization, with a time delay
S Marbach*, N. Ziethen*, L. Bastin, F. Baeuerle, K. Alim, *under review at eLife*, (2022)
<https://doi.org/10.1101/2021.12.29.47440>
- (22) Electroosmosis in nano pores: Computational methods and technological applications
A. Gubbiotti, M. Baldelli, G. Di Muccio, P. Margaretti, S. Marbach, M. Chinappi, *Advances in Physics: X*, 7 (1), 2036638 (2022)
- (21) Mass changes the diffusion coefficient of particles with ligand-receptor contacts in the over damped limit, S Marbach, M. Holmes-Cerfon, *Phys. Rev. Lett.*, 129 (4), 048003 (2022)
- (20) Comprehensive view of microscopic interactions between DNA-coated colloids
F. Cui*, S. Marbach*, J. A. Zheng, M. Holmes-Cerfon, D. J. Pine, *Nature Comm.*, 13 (1), 1-10 (2022)
- (19) The Nanocaterpillar's random walk: diffusion with ligand-receptor contacts
S Marbach, J. A. Zheng, M. Holmes-Cerfon, *Soft Matter*, 18 (16), 3130-3146 (2022)
- (18) The carbon footprint of meat and dairy proteins: a practical perspective to guide low carbon footprint dietary choices. R. Gaillac, S Marbach, *J. Clean. Prod.*, 321, 128766 (2021)
- (17) Intrinsic fractional noise in nanopores: The effect of reservoirs
S Marbach, *J. Chem. Phys.*, 892 (2021)
- (16) Local and global force balance for diffusiophoretic transport
S Marbach, H Yoshida, L Bocquet, *J. Fluid. Mech.*, 892 (2020)
- (15) Resonant osmosis across active switchable membranes
S Marbach, N Kavokine, L Bocquet, *J. Chem. Phys.*, 152, 054704 (2020)
- (14) Active control of dispersion within a channel with flow and pulsating walls
S Marbach, K Alim, *Phys. Rev. F.*, 4, 114202 (2019)
- (13) Ionic Coulomb blockade as a fractional Wien effect
N Kavokine, S Marbach, L Bocquet, *Nature Nano.*, (2019)
- (12) Osmosis, from molecular insights to large scale applications
S Marbach, L Bocquet, *Chem. Soc. Rev.*, 48 (11) 3102-3144 (2019)
- (11) Transport and dispersion across wiggling nanopores
S Marbach, D. Dean, L Bocquet, *Nature Phys.*, (2018)
- (10) Active sieving across driven nanowire for tunable selectivity
S Marbach, L Bocquet, *J. Chem. Phys.*, 147 (15) 154701 (2017)
- (9) The Landau-Squire plume
E Secchi, S Marbach, A Niguès, A Siria, L Bocquet, *J. Fluid. Mech.* 826(2018)
- (7-8) Osmotic and diffusio-osmotic flow generation at high solute concentration. I. And II.
S Marbach, H Yoshida, L Bocquet, *J. Chem. Phys.* 146 (19), 194701 (2017)
- (6) Massive radius-dependent flow slippage in carbon nanotubes
E Secchi, S Marbach, A Niguès, D Stein, A Siria, L Bocquet, *Nature* 537 (7619), 210-213 (2016)
- (5) Active Osmotic Exchanger for Efficient Nanofiltration Inspired by the Kidney
S Marbach, L Bocquet, *Phys. Rev. X* 6 (3), 031008 (2016)
- (4) Pruning to Increase Taylor Dispersion in *Physarum polycephalum* Networks
S Marbach, K Alim, N Andrew, A Pringle, MP Brenner, *Phys. Rev. Lett.* 117 (17), 178103 (2016)
- (3) Theoretical study of actin layers attachment and separation
S Marbach, A L Godeau, D Riveline, J-F Joanny, J Prost, *Euro. Phys. J. E* 38 (11) 122 (2015)

(2) Femtosecond-laser hyperdoping silicon in an SF6 atmosphere: Dopant incorporation mechanism
M-J Sher, N Mangan, M Smith, Y-T Lin, [S Marbach](#), T Schneider, S Gradecak, M P Brenner, E Mazur J.
Appl. Phys. 117 125301(2015)

(1) Creating femtosecond-laser-hyperdoped silicon with a homogeneous doping profile
Y-T Lin, N Mangan, [S. Marbach](#), T Schneider, G Deng, S Zhou, M P Brenner, E Mazur *Appl. Phys. Lett.* 106
062105 (2015)

COMMUNICATION

75 events (37 international conferences (36 talks, 6 posters), 38 seminars). Selected list below.

International conferences with oral contribution:

- **Transport in Narrow Channels** - *Workshop* - Cargèse, France (2022) *invited talk*
- **Telluride** - *Nuclear Pore Complexes and Smart Polymers* - Telluride, USA (2022) *invited talk*
- **European Biophysics Conference** - Vienna, Austria (2021)
- **Liquid Matter** - Ljubljana, Slovenia (2017) - Prague, Czech Republic (2021)
- **APS March meeting** - Denver, USA (2020), Online, USA (2021)
- **Frontiers in ion channels and Nanopores** - Rome, Italy (2021)
- **APS Division of Fluid Dynamics** - Boston, USA (2015), Chicago, USA (2020)
- **Rising stars in Soft and Biological Soft Matter** - Chicago, USA (2020) *invited talk*
- **GRS-GRC - Chemistry and Physics of Liquids** - New Hampshire, USA (2019) - *best young scientist talk*
- **ICIAM 2019** - Applied mathematics - Valencia, Spain (2019) *invited talk*
- **Meco 44** - Key Challenges in Statistical Physics - Munich, Germany (2019) *invited talk*
- **JTMS** - Modeling and Simulation Days - Paris, France (2018)
- **MicroNanoFluidics** - Grenoble, France (2018)
- **IPoLS 2017** - Physics of living systems - Paris, France (2017)
- **Statphys 16** - Lyon, France (2016)
- **Physical Biology Circle Meeting** - Paris, France (2016)

Invited talks beyond my physics field

- (biophysics) *GDR Approche Quantitative du Vivant* - **Paris, France** (2022) *invited talk*
- (applied math) *SIAM Computational Science & Engineering* - **Texas, USA** (2017) *invited talk*
- (chemistry) *Interfacial molecular and electronic structure and dynamics* - **Telluride** (2020) *invited talk*
- (chemistry) *Water and Aqueous Electrolytes* - **Gordon Research Conference** (2018) *invited talk*
- (applied math) *Dispersive Hydrodynamics* - **les Houches** (2017) *invited talk*
- (biophysics) *Biophysics Community Day* - Paris (2016) *invited talk*

Examples of invited seminars:

- Fluid mechanics seminar - **University of Twente** (Netherlands, 2022)
- Soft Matter seminar - **Princeton University** (New York, USA, 2022)
- Discussion group - **Lennard-Jones Center** (Cambridge, UK, 2022)
- Chemical engineering lab - **Université Paul Sabatier** (Toulouse, France, 2022)
- Applied Math department - **Northwestern University** (Illinois, USA, 2021)
- Physics department - **Brown University** (Rhode Island, USA, 2021)
- Ladhys Lab seminar - **Ecole Polytechnique** (Paris, France, 2021)
- Physics general seminar - **Ecole Normale Supérieure** (Lyon, France, 2021)
- Fluid Mechanics seminar - **UC San Diego** (California, USA, 2021)
- Limmer Lab group meeting - **UC Berkley** (California, USA, 2021)
- PCSL group meeting - **EPFL** (Lausanne, Switzerland, 2021)
- Physical chemistry seminar - **Rutgers University** (New Jersey, USA, 2021)
- Bio-math seminar - **University of Iowa** (Iowa, USA, 2021)
- Keyser Lab group meeting - **Cambridge** (United Kingdom, 2021)
- Chemical engineering seminar - **U. T. Austin** (Texas, USA, 2021)
- Soft Matter Physics Lab - **Leiden University** (Netherlands, 2020)

- Interfacial water group meeting - **Princeton University** (New York, USA, 2020)
- Soft Matter Physics Lab - **Liphy, Grenoble University** (Grenoble, France, 2020)
- Bio math seminar - **New Jersey Institute of Technology** (New Jersey, USA, 2019)
- Applied math seminar - **City University of NY** (New York, USA, 2019)
- Soft Matter seminar - LOMA - **Bordeaux University** (Bordeaux, France, 2019)
- Thermal Physics seminar - IUSTI - **Aix Marseille University** (Marseille, France, 2019)
- Physics and Chemistry Lab - **Utrecht University** (Utrecht, Netherlands, 2018)
- Applied math small seminar, SEAS - **Harvard University** (Cambridge, USA, 2018)
- Physics and Chemistry Theory Lab - **ESPCI** (Paris, France, 2018)
- Physical Chemistry PHENIX Lab - **Sorbonne University** (Paris, France, 2018)

OUTREACH & CARBON FOOTPRINT



- Popularized publications

- 2 self-written (1 in *Reflets de la Physique*, 1 in the blog *Le Rayon*)
- 3 co-written (2 in *Le Monde*, 1 for the AIP publishing group)



- Regular contribution to general public conferences and events ranging from anybody to highschool students and undergraduates, including Science Fares every year



- YouTube Channel « Physics Sophie » (3 outreach videos on filtration and transport)

<https://www.youtube.com/channel/UCDMOBUicFKIA03foox4Q6LA>



- I created with a collaborator an **outreach blog on carbon footprints** (<http://sciriousgecko.com>) with Q&A on Twitter & a scientific publication; I regularly discuss with journalists on this topic. For example we helped elaborating some of the scientific content on a video about the carbon footprint of cheese (« we gotta talk about cheese... (sorry) » from the DW Planet A https://www.youtube.com/watch?v=_u_sLantkq4)