

Nikita Kavokine

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Research statement

Liquids are usually described within classical physics, whereas solids require the tools of quantum mechanics. I study nanoscale systems where this distinction no longer holds. At these scales, liquid flows exhibit quantum effects as they interact with electrons in the solid walls. Using a broad range of tools comprising theory, experiments and numerical simulations, I aim at understanding these emerging quantum couplings, so as to achieve nanofluidic functionalities beyond classical limits.

Professional appointments

01/2023 – present: **Group Leader**, Department of Molecular Spectroscopy, Max Planck Institute for Polymer Research, Mainz

09/2022 – 12/2022: **Postdoctoral researcher**, Department of Molecular Spectroscopy, Max Planck Institute for Polymer Research, Mainz

09/2021 – 09/2022: **Flatiron Research Fellow**, Center for Computational Quantum Physics, Flatiron Institute, New York

09/2017 – 09/2021: **Graduate Research Assistant**, Ecole Normale Supérieure, Paris

Education

09/2017 – 06/30/2021 (*award date*): **PhD in Physics, Ecole Normale Supérieure, Paris**
Thesis : *Many-body effects in nanoscale fluid transport*, advised by Prof. Lydéric Bocquet.

09/2015 – 07/2017: **Master in Physics, Ecole Normale Supérieure, Paris**
Master of the *International Center for Fundamental Physics* (ICFP), Theoretical physics program.
Master thesis : *Oscillating focus microscopy*, Adam Cohen lab, Harvard University.

09/2014 – 07/2015: **Bachelor in Chemistry, Ecole Normale Supérieure, Paris**
With highest honors (*félicitations du jury*). Research internships: Baigl lab, Ecole Normale Supérieure and LSPN (Prof. Jieping Zhu), EPFL, Switzerland.

09/2012 – 07/2014: **Classes préparatoires aux grandes écoles, Lycée Louis le Grand, Paris**
First two years of undergraduate studies, preparing for the competitive entrance exams to the French *Grandes Ecoles*. Major: Physics and Chemistry (PCSI-PC*).

Awards and honors

- Alexander von Humboldt postdoctoral fellowship (2022)
- Nanomaterials for Energy Applications PhD thesis prize (Prix GDR NAME, 2022).
- C’Nano PhD thesis prize for fundamental research (2021).

- Young researcher prize in Micro- and Nanofluidics (Prix GDR MNF, 2021).
- PhD grant from Ecole Normale Supérieure (51 k€, 2018).
- 4-year undergraduate fellowship from Ecole Normale Supérieure (64 k€, 2014).
- Placed **first** at the entrance examinations of Ecole Normale Supérieure, Ecole Polytechnique, ENS Cachan and ESPCI (2014).
- *Médaille du Baccalauréat* (overall grade 20/20 at high school graduation exams), awarded by the French minister of education (2012).

Other professional activities

Reviewing activities

Reviewer for *Science*, *Nature Nanotechnology*, *Nature Communications*, *Nature Communications Physics*, *Nano Letters*, *PNAS*, *Science Advances*, *Journal of Physical Chemistry*, *Journal of Chemical Physics*, *Journal of Fluid Mechanics*, *Physics of Fluids*.

Industrial innovation

Co-founder of UPI systems, atomic force microscopy start-up company (2021).

Supervision and mentoring

Current supervisor of **two PhD students**: Baptiste Coquinot (since September 2021) and Hao Lu (since September 2022). Supervised the research internships of 2 Bachelor-level undergraduate students and 3 Master students between 2019 and 2021.

Teaching

- 2018 – 2021: Exercise classes in fluid mechanics for third-year students (CPES, PSL Research University)
- 2018 – 2021: Exercise classes in general physics for first-year students (CPES, PSL Research University)
- 2014 – 2016: Oral examination of first-year students in physics (PCSI, Lycée Louis le Grand).
- 2014: Training of high school students for the International Chemistry Olympiads.

Languages

- French, mother tongue.
- Russian, mother tongue.
- English, fluent. *Cambridge Certificate in Advanced English (grade A) and TOEFL (114/120)*.
- Spanish, fluent. *Spanish baccalaureate*.
- Italian, some knowledge.
- German, some knowledge.

Publications

- [12] **N. Kavokine**, P. Robin and L. Bocquet. Interaction confinement and electronic screening in two-dimensional nanofluidic channels. *J. Chem. Phys.* **157**, 114703 (2022)
- [11] A. Marcotte, M. Lizee, B. Coquinot, **N. Kavokine**, K. Sobnath, C. Barraud, A. Bhardwaj, B. Radha, A. Niguès, L. Bocquet and A. Siria. Strong electronic winds blowing under liquid flows on carbon surfaces. ArXiv 2205.05037
- [10] B. Coquinot, L. Bocquet and **N. Kavokine**. Quantum feedback at the solid-liquid interface: flow induced current and negative friction. ArXiv 2205.03250
- [9] **N. Kavokine**, M.-L. Bocquet and L. Bocquet. Fluctuation-induced quantum friction in nanoscale water flows. *Nature* **602**, 84 – 90 (2022)
- [8] P. Robin, **N. Kavokine** and L. Bocquet. Modeling of emergent memory and voltage spiking in ionic transport through angstrom-scale slits. *Science* **373**, 687 – 691 (2021)
- [7] **N. Kavokine**, R. R. Netz and L. Bocquet. Fluids at the Nanoscale: from continuum to sub-continuum transport. *Annu. Rev. Fluid Mech.* **53**, 377 – 410 (2021)
- [6] S. Marbach, **N. Kavokine** and L. Bocquet. Resonant osmosis across active switchable membranes. *J. Chem. Phys.* **152**, 054704 (2020)
- [5] **N. Kavokine**, S. Zou, R. Liu, A. Niguès, B. Zou and L. Bocquet. Ultrafast photomechanical transduction through thermophoretic implosion. *Nat. Commun.* **11**, 50 (2020)
- [4] **N. Kavokine**, S. Marbach, A. Siria, L. Bocquet. Ionic Coulomb blockade as a fractional Wien effect. *Nat. Nanotech.* **14**, 573 – 578 (2019)
- [3] J. Vialetto, M. Hayakawa, **N. Kavokine**, M. Anyfantakis, S. Rudiuk, M. Morel, D. Baigl. Magnetic actuation of discrete liquid entities with a deformable paramagnetic liquid substrate. *Angew. Chem. Int. Ed.* **56**, 16565 – 16570 (2017)
- [2] S. Lou, Y. Adam, E. Weinstein, E. Williams, K. Williams, V. Parot, **N. Kavokine**, S. Liberles, L. Madisen, H. Zeng, and A. Cohen. Genetically targeted all-optical electrophysiology with a transgenic Cre-dependent Optopatch mouse. *J. Neurosci.* **43**, 11059 –11073, (2016)
- [1] **N. Kavokine**, S. Rudiuk, M. Morel, T. Bickel and D. Baigl. Light-Driven Transport of a Liquid Marble with and against Surface Flows. *Angew. Chem. Int. Ed.*, **55**, 11183 – 11187 (2016)

Invited talks and seminars

11/2022: **GDR Meso plenary conference**, Aussois, France. *Quantum plumbing: the mysteries of nanoscale flows.*

10/2022: **GDR Name plenary conference**, Lyon, France. *Many-body effects in nanoscale fluid transport.*

09/2022: **Seminar at the Köln Institute for Theoretical Physics**. *Quantum plumbing: the mysteries of nanoscale flows.*

09/2022: **SLAM talk at IST Austria**. *Quantum plumbing: the mysteries of nanoscale flows.*

06/2022: **Simons Foundation Staff Meeting**. *Quantum plumbing: the mysteries of nanoscale flows.*

05/2022: **Netz group seminar, Freie Universität Berlin**. *Quantum plumbing: the mysteries of nanoscale flows.*

04/2022: **Nanotechnology Seminar, Stevens Institute of Technology**. *Quantum plumbing: the mysteries of nanoscale flows.*

12/2021: **Seminar of the Center for Enhanced Nanofluidic Transport** (virtual, based at **MIT**, Cambridge, MA). *Nanofluidics: where liquids meet solids.*

12/2021: **Pro-QM Zeminar** (virtual, based at **Columbia University**, New York, NY). *Nanoscale flows: where fluid dynamics meet condensed matter.*

09/2021: **Micro- and Nanofluidics GDR meeting**, Toulouse, France. *Quantum friction in nanoscale water flows.*

09/2019: **Zhejiang University**, Hangzhou, China. *Ionic Coulomb blockade as a fractional Wien effect.*

09/2019: **Westlake Institute of Advanced Studies**, Hangzhou, China. *Ultrafast photomechanical transduction through thermophoretic implosion.*

07/2019: **Freie Universität Berlin**, Berlin, Germany. *Ionic Coulomb blockade as a fractional Wien effect.*

04/2019: **University of Montpellier**, Montpellier, France. *Ionic Coulomb blockade as a fractional Wien effect.*

Contributed talks

03/2022: **APS March Meeting**, Chicago, US. *Nanoscale flows: interaction confinement and quantum effects.*

03/2021: **APS March Meeting** (virtual). *Quantum friction in nanoscale fluid transport.*

03/2020 : **Meeting of the Mediterranean Institute for Fundamental Physics**, Rome, Italy. *Ultrafast photomechanical transduction through thermophoretic implosion.*

10/2019 : **CECAM workshop** “Applications of Diffusiophoresis in Drying, Freezing and Flowing Colloidal Suspensions”, Lausanne, Switzerland. *Ultrafast photomechanical transduction through thermophoretic implosion.*

07/2019 : **Stat Phys 27**, Buenos Aires, Argentina. *Ionic Coulomb blockade as a fractional Wien effect.*

06/2019 : **International Soft Matter Conference**, Edinburgh, UK. *Ionic Coulomb blockade as a fractional Wien effect.*

04/2019 : **PhD and Postdoc seminar**, Ecole Normale Supérieure, Paris, France. *Ionic Coulomb blockade as a fractional Wien effect.*

11/2018 : **Lorentz Center workshop on micro- and nanofluidics**, Leiden, Netherlands. *Ionic Coulomb blockade as a fractional Wien effect.*

07/2018 : **NTQMP conference**, Armenia. *Ionic Coulomb blockade as a fractional Wien effect.*

04/2018 : **CECAM workshop** “Phoretic effects at the nanoscale”, Lausanne, Switzerland. *Ionic Coulomb blockade and fractional Wien effect in ion transport across nanopores.*

07/2017: **Flow17 conference**, Paris, France. *Light-driven transport of liquid marbles with and against surface flows.*

Posters

06/2020 : **International Soft Matter Conference**, Edinburgh, UK. *Ultrafast photomechanical transduction through thermophoretic implosion.*

02/2019 : **Dead Sea Water, Nanomaterials at the Water-Energy Nexus**, Ein-Gedi, Israel. *Ionic Coulomb blockade as a fractional Wien effect.*

10/2018 : **Liquids At Interfaces conference**, Bordeaux, France. *Ionic Coulomb blockade as a fractional Wien effect.*

Outreach and press

03/2022: [Newspaper article](#). *Du quantique dans l'écoulement de l'eau.* David Larousserie, **Le Monde**.

03/2022: [Online article](#). *'Quantum brakes' slow water flow through carbon nanotubes.* Isabelle Dumé, **Physics World**.

02/2022: [Magazine article](#). *Quantum friction explains water's freaky flow.* Karmela Padavic-Kallaghan, **Scientific American**.

02/2022: [Magazine article](#). *Quantum friction explains strange way water flows through nanotubes.* Chen Ly, **New Scientist**.

02/2022: [Newspaper article](#). *Hoe nauwer het nanobuisje is, hoe sneller water erdoorheen stroomt*. Dorine Schenck, **NRC**.

02/2022: [Online article](#). *New phenomenon 'quantum friction' explains water's bizarre properties*. Tim Wogan, **Chemistry World**.

02/2022: [Podcast](#). *Weirdly flowing water finally has an explanation: 'quantum friction'*. **Nature**.

02/2022: [Press release](#). *"Quantum friction" slows water flow through carbon nanotubes, resolving long-standing fluid dynamics mystery*. Highlighted on [Phys.org](#), [SciTechDaily](#), [ScienMag](#), [Nanowerk](#) and [Bioengineering.org](#).

09/2021: [Magazine article](#). *Nanofluidique : un neurone ionique artificiel, c'est possible ?* Romain Fouchard, **Science&Vie**.

09/2021: [Online article](#). *These Super-Efficient, Artificial Neurons Do Not Use Electrons*. Payal Dhar, **IEEE Spectrum**.

08/2021: [Online article](#). *IA: un neurone ionique artificiel ouvre un champ d'application considérable*. Sébastien Gavois, **Nextinact.com**.

08/2021: [Press release](#). *Un neurone ionique artificiel pour les mémoires électroniques de demain*.