

# Curriculum vitae

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## Clément Moreau

Born in Paris on June 15<sup>th</sup>, 1994

PhD in Applied mathematics

### Contact

Work address :                      Research Institute for Mathematical Sciences (RIMS)  
   Kyoto University  
   Kyoto 606-8502  
   Japan

Home address :                      Yoshida International House - Room 408  
   64 Yoshidanihonmatsu-cho, Sakyo-ku  
   Kyoto 606-8501  
   Japan

Phone:                                      (fr) +33 6 72 33 05 92  
   (jp) +81 70 1250 3646

Email:                                      cmoreau@kurims.kyoto-u.ac.jp

Webpage:                                <https://clementmoreau.github.io/>

### Current position

(from January 1st, 2024)

**CNRS researcher** at the Laboratoire des Sciences du Numérique de Nantes (LS2N)

(until December 31st, 2023)

**Postdoctoral Fellow** of the Japanese Society for the Promotion of Science (JSPS)

### Table of contents

|                                      |   |
|--------------------------------------|---|
| Academic career . . . . .            | 2 |
| Curriculum . . . . .                 | 2 |
| Research interests . . . . .         | 3 |
| Publications . . . . .               | 3 |
| Communications . . . . .             | 4 |
| Short-term research visits . . . . . | 6 |
| Teaching . . . . .                   | 7 |
| Administration . . . . .             | 7 |
| Outreach . . . . .                   | 8 |
| Miscellaneous skills . . . . .       | 8 |

## Academic career

- 2022–** **JSPS (Japan Society for the Promotion of Science) Postdoctoral Fellow**, RIMS, Kyoto University. Supervision: Kenta Ishimoto. Project title : “Mathematical control theory for microrobot and cell locomotion”.
- 2021–2022** **Invited researcher**, RIMS, Kyoto University.
- 2020–2021** **JSPS (Japan Society for the Promotion of Science) Postdoctoral Fellow**, RIMS, Kyoto University. Supervision: Kenta Ishimoto. Project title : “Applications of mathematical control theory to low-Reynolds number swimming”.

## Curriculum

- 2017–2020** **PhD in Applied mathematics** at Université Côte d’Azur  
SUPERVISION:  
Laetitia Giraldi, Inria Sophia-Antipolis  
Pierre Lissy, Université Paris-Dauphine  
Jean-Baptiste Pomet, Inria Sophia-Antipolis  
TITLE:  
*Controllability in finite and infinite dimension and applications to life-inspired nonlinear systems*  
DEFENSE:  
June 17<sup>th</sup>, 2020 (online).  
REVIEWERS:  
Eamonn Gaffney, Oxford University  
Emmanuel Trélat, Sorbonne Université  
EXAMINERS:  
Karine Beauchard, ENS Rennes  
Jean-Baptiste Caillaud, Université Côte d’Azur  
Antonio DeSimone, SISSA
- 2013–2017** **Student at the École Normale Supérieure de Cachan**. “Diplôme de l’ENS Cachan” (awarded for outstanding completion of ENS 4-year course) obtained in September 2017.
- 2016–2017** **“Pre-doctoral Research year abroad” program (*Année de Recherche Prédoctorale à l’Etranger*)**, University of York (United Kingdom)  
Project : “Numerical methods and simulations for elasto-hydrodynamics of microfilaments.” Supervision: Hermes Gadêlha.
- 2015–2016** **Master’s degree in Applied Mathematics, specialisation in “Mathematics for modelling”**, Université Pierre et Marie Curie (Paris 6), mention: bien (*magna cum laude*).  
Thesis: “Partial controllability of magnetic micro-swimmers.” Supervision: Laetitia Giraldi, Pierre Lissy and Jean-Baptiste Pomet.
- 2014–2015** **Master 1 (first year of graduate course) in “Pure Mathematics”**, ENS Cachan and Université Paris Diderot (Paris 7), mention: bien (*magna cum laude*).  
Thesis: “Real-time suboptimal control of hybrid vehicles.” Supervision: François Chaplais (CAS, Mines ParisTech).
- 2013–2014** **Bachelor’s degree in Mathematics**, ENS Cachan and Université Paris Diderot (Paris 7), mention: bien (*magna cum laude*).  
Thesis: “Numerical reconstruction of the Prokudin-Gorskii photographs.” Supervision: Enric Meinhardt-Llopis and Jean-Michel Morel (CMLA, ENS Cachan).

2011–2013 “Classe préparatoire” MPSI/MP, (intensive two-year undergraduate course to prepare for the competitive entrance examination to French “Grandes Écoles”), Lycée Clemenceau, Nantes.

## Research interests

- **Control theory and optimisation:** control-affine systems with and without drift, conditions of local controllability, geometric control, state-constrained control, control of parabolic PDEs and reaction-diffusion systems, shape optimisation.
- **Fluid mechanics:** Stokes equations, low-Reynolds number hydrodynamics, fluid-structure interactions, computational aspects, boundary integral method.
- **Control and modelling for microswimming:** hydrodynamics, modelling, elasticity and elastic filaments, controllability and optimal control and design of microrobots.

## Publications

NB: symbols \* et † indicate, respectively, alphabetical author order and contribution-based author order.

### Publications in peer-reviewed journals

[16]† M. P. Dalwadi, C. Moreau, E. A. Gaffney, B. Walker, K. Ishimoto, “Generalised Jeffery’s equations for rapidly spinning particles. Part II: Helicoidal objects with chirality”, to appear in *Journal of Fluid Mechanics*. [arXiv:2301.11032](https://arxiv.org/abs/2301.11032)

[15]† M. P. Dalwadi, C. Moreau, E. A. Gaffney, K. Ishimoto, B. Walker, “Generalised Jeffery’s equations for rapidly spinning particles. Part I: Spheroids”, to appear in *Journal of Fluid Mechanics*. [arXiv:2301.11311](https://arxiv.org/abs/2301.11311)

[14]\* L. Giraldi, P. Lissy, C. Moreau, J.-B. Pomet, “A necessary condition for local controllability of systems with two scalar controls”, to appear in ESAIM:COCV. [hal:02178973v4](https://hal.archives-ouvertes.fr/hal-02178973v4)

[13]\* K. Ishimoto, C. Moreau, K. Yasuda, “Odd elastohydrodynamics: non-reciprocal living material in a viscous fluid”, *Physical Review X Life* 1, no.2, Oct 2023. [DOI:10.1103/PRXLife.1.023002](https://doi.org/10.1103/PRXLife.1.023002)

Attention score on Altmetric (Dec. 2023): 270 (top 1%)

[12] C. Moreau, “Controllability and optimal control of microswimmers: theory and applications”, *Journal of the Physical Society of Japan* 92, no 121005, Oct 2023. (contribution to the Special Topics issue “Advances in the physics of biofluids locomotion”). [DOI:10.7566/JPSJ.92.121005](https://doi.org/10.7566/JPSJ.92.121005)

[11]† B. J. Walker, K. Ishimoto, C. Moreau, E. A. Gaffney, Emergent rheotaxis of shape-changing swimmers in Poiseuille flow, *Journal of Fluid Mechanics* 944, no. R2. [DOI:10.1017/jfm.2022.474](https://doi.org/10.1017/jfm.2022.474)

[10]\* K. Ishimoto, C. Moreau, K. Yasuda, “Self-organised swimming with odd elasticity”, *Physical Review E* vol. 105, no. 060403, Jun 2022. [DOI:10.1103/PhysRevE.105.064603](https://doi.org/10.1103/PhysRevE.105.064603)

[9]† B. J. Walker, K. Ishimoto, E. A. Gaffney, C. Moreau, “The control of particles in the Stokes limit”, *Journal of Fluid Mechanics* vol. 942, no. A1, May 2022. [DOI:10.1017/jfm.2022.253](https://doi.org/10.1017/jfm.2022.253)

[8]† E. A. Gaffney, M. P. Dalwadi, C. Moreau, K. Ishimoto, B. J. Walker, “Canonical orbits for planar microswimmers in shear flow”, *Physical Review Fluids* vol. 7, no. L022101, Feb 2022. [DOI:10.1103/PhysRevFluids.7.L022101](https://doi.org/10.1103/PhysRevFluids.7.L022101)

[7]† B. J. Walker, K. Ishimoto, E. A. Gaffney, C. Moreau, M. P. Dalwadi, “Effects of rapid yawing on simple swimmer models and planar Jeffery’s orbits”, *Physical Review Fluids* vol. 7, no. 023101, Jan 2022. [DOI:10.1103/PhysRevFluids.7.023101](https://doi.org/10.1103/PhysRevFluids.7.023101)

[6]<sup>†</sup> C. Moreau, K. Ishimoto, “Driving a microswimmer with wall-induced flow”, *Micromachines* vol. 12, no. 9:1025, Aug 2021. DOI:10.3390/mi12091025

[5]<sup>†</sup> C. Moreau, K. Ishimoto, E. A. Gaffney, B. J. Walker, “Control and controllability of microswimmers by a shearing flow”, *Royal Society Open Science* 8: 211141, Aug 2021. DOI:10.1098/rsos.211141

[4]<sup>\*</sup> P. Lissy, C. Moreau, “State-constrained controllability of linear reaction-diffusion systems”, *ESAIM:COCV*, vol. 27, no. 70, Jul 2021. DOI:10.1051/cocv/2021057

[3] C. Moreau, “Local controllability of a magnetized Purcell’s swimmer”, *IEEE Control Systems Letters*, vol.3, no.3, pp. 637-642, May 2019. DOI:10.1109/LCSYS.2019.2915004

[2]<sup>†</sup> C. Moreau, L. Giraldi, H. Gadêlha, “The asymptotic coarse-graining formulation of slender-rods, bio-filaments and flagella”, *Journal of the Royal Society Interface*, vol. 15, no. 144, Jul 2018. DOI:10.1098/rsif.2018.0235

[1]<sup>\*</sup> L. Giraldi, P. Lissy, C. Moreau, J.-B. Pomet, “Addendum to “Local Controllability of the Two-Link Magneto-Elastic Micro-Swimmer” ”, *IEEE Transactions on Automatic Control*, vol. 63, pp. 2303-2305, Jul 2018. DOI:10.1109/TAC.2017.2764422

## Preprints

[P1] C. Moreau, K. Ishimoto, Y. Privat, “Shapes optimising grand resistance tensor entries for a rigid body in a Stokes flow”, submitted. arXiv:2207.06023

## Conference proceedings

[C2] C. Moreau, “Local Controllability of Magnetized Purcell’s Swimmers”, 21st IFAC World Congress (online), IFAC-PapersOnLine, vol. 53, no. 2, 2020.

[C1] (Joint publication CDC and L-CSS [3]) C. Moreau, “Local controllability of a magnetized Purcell’s swimmer”, 58th Conference on Decision and Control (CDC), 2019.

## Communications

### Oral presentations at national and international conferences

|                  |  |
|------------------|--|
| <b>Aug 2023</b>  | International Congress on Industrial and Applied Mathematics (ICIAM) 2023, Tokyo, Japon      |
| <b>Jun 2023</b>  | Colloquium Euromech, Nice, France  |
| <b>Jan 2023</b>  | Workshop “New Perspectives on Active Matter”, Warwick, Royaume-Uni                           |
| <b>Sept 2022</b> | JSIAM Annual Meeting, Sapporo, Japon   |
| <b>Jul 2022</b>  | World Congress of Biomechanics, Taipei, Taiwan (online participation)                        |
| <b>Jun 2022</b>  | CANUM 2020+2, Evian-les-Bains, France  |
| <b>Jun 2022</b>  | ECCOMAS Congress 2022, Oslo, Norway  |
| <b>Mar 2022</b>  | Odd viscoelasticity workshop, Dutch Institute for Emergent Phenomena, Amsterdam, Netherlands |
| <b>Jan 2022</b>  | Active Matter Workshop 2022, Meiji University, Japan   |
| <b>Jun 2021</b>  | Biofluids Symposium, Kyoto University (online)   |
| <b>Jan 2021</b>  | Active Matter Workshop 2021, Meiji University (online)                                       |
| <b>Dec 2020</b>  | Congrès d’Analyse Numérique (online)   |

|                 |   |
|-----------------|---|
| <b>Jul 2020</b> | 21 <sup>st</sup> IFAC World Congress (online)   |
| <b>Dec 2019</b> | 58 <sup>th</sup> Conference on Decision and Control (CDC), Nice, France   |
| <b>Jul 2019</b> | Equadiff Conference, Leiden, Netherlands  |
| <b>May 2019</b> | Colloque Inter'Actions, Bordeaux, France  |
| <b>May 2019</b> | SMAI Congress, Guidel, France   |
| <b>Dec 2018</b> | 13 <sup>th</sup> International Young Researchers Workshop on Geometry, Mechanics and Control, Coimbra, Portugal |
| <b>Jan 2018</b> | 12 <sup>th</sup> International Young Researchers Workshop on Geometry, Mechanics and Control, Padoue, Italie    |
| <b>Nov 2017</b> | PGMO Days, EDF Lab, Saclay, France  |

#### Presentations at lab seminars and workshops

|                 |  |
|-----------------|--|
| <b>Nov 2023</b> | Shape Seminar, Tohoku University, Sendai, Japan  |
| <b>Nov 2023</b> | Takeuchi Lab Seminar, The University of Tokyo, Tokyo, Japan  |
| <b>Nov 2023</b> | Seminar of the department of physics of Kyushu University, Fukuoka, Japan  |
| <b>Oct 2023</b> | ASHBi Seirin's Laboratory Seminar, Kyoto, Japan  |
| <b>Jun 2023</b> | ANR COSSEROOTS workshop, La Londe-les-Maures, France   |
| <b>May 2023</b> | Kobayashi Group Seminar, Tokyo, Japan  |
| <b>Jan 2023</b> | Physics Theory Group Seminar, Warwick, United Kingdom  |
| <b>Nov 2022</b> | Seminar of the Mathematics department, Turin, Italy  |
| <b>Nov 2022</b> | Seminar of the CODEX team in LS2N, Nantes, France  |
| <b>Nov 2022</b> | ASHBI Seirin's Laboratory Seminar, Kyoto, Japan  |
| <b>Aug 2022</b> | Yamamoto Groups Seminar, Kyoto, Japan  |
| <b>Jun 2022</b> | Groupe de travail contrôle de l'IECL, Nancy, France  |
| <b>Mar 2022</b> | RIMS Fluid Dynamics Group seminar, Kyoto, Japan  |
| <b>Feb 2022</b> | RIMS Fluid Dynamics Group seminar, Kyoto, Japan  |
| <b>Dec 2021</b> | Applied Maths Seminar, Kyoto University, Japan   |
| <b>Dec 2021</b> | CRAN Seminar, Nancy, France (en ligne)   |
| <b>Nov 2021</b> | RIMS Fluid Dynamics Group seminar, Kyoto, Japan  |
| <b>Sep 2021</b> | IRMA PDE Seminar, Strasbourg, France.  |
| <b>Mar 2021</b> | Yamamoto Group (Theoretical Modeling of Soft Matter and Living Systems) Seminar, Transport Phenomena Laboratory, Kyoto University (online) |
| <b>Feb 2021</b> | Seminar of the LMBA "Analyse, Phénomènes Stochastiques et Applications" team, Brest, France (online)                                       |
| <b>Feb 2021</b> | Seminar of the I2M "Analyse Appliquée" team, Marseille, France (online)  |
| <b>May 2020</b> | PhD seminar of the LJLL, Paris, France (online)  |
| <b>Apr 2018</b> | PhD seminar of the PDE and Numerical Analysis team of the LJAD, Nice, France   |

#### Poster presentations

- Jul. 2023**      XXe Jacques-Louis-Lions Spanish-French School on Numerical Simulations in Physics & Engineering, Barcelone, Spain
- Feb 2020**      Research Workshop of the Israel Science Foundation on Micro-Swimmers and Soft Robotics, Haifa, Israel
- Jun 2018**      Congrès National d'Analyse Numérique (CANUM), Cap d'Agde, France

### Short-term research visits

- Jun 2023**      Sorbonne Université (France), with M. Bonnivard (1 week)
- May 2023**      The University of Tokyo (Japan), with S. Schnyder (1 week)
- Jan 2023**      Warwick University (United Kingdom), with M. Turner (1 week)
- Jan 2023**      Oxford University (United Kingdom), with E. A. Gaffney (1 week)
- Jan 2023**      Sorbonne Université (France), with M. Bonnivard (1 week)
- Nov 2022**      Politecnico di Torino (Italy), with M. Zoppello (1 week)
- Nov 2022**      Université de Nantes (France), with S. Marx (1 week)
- Sep 2021**      Université de Lorraine (France), with J. Lohéac (1 week)
- May 2021**      Sorbonne Université (France), with M. Bonnivard (1 week)
- May 2022**      Université de Strasbourg (France), with Y. Privat (2 weeks)
- Sep 2021**      Université de Strasbourg (France), with Y. Privat (2 weeks)
- Jan 2020**      Bristol University (United Kingdom), with H. Gadêlha (2 weeks)
- Jun 2018**      York University (United Kingdom), with H. Gadêlha (1 week)

## Teaching

### Université Paris-Dauphine (2019-2020)

| Subject  | Level                       | Type      | Students | Hours |
|----------|-----------------------------|-----------|----------|-------|
| Analysis | Undergrad in Math/Economics | Tutorials | 30       | 64    |

### Université Côte d'Azur (2017-2019)

| Subject    | Level                           | Type               | Students | Hours |
|------------|---------------------------------|--------------------|----------|-------|
| Analysis   | Undergrad in Economics          | Tutorials          | 25-30    | 64    |
| Statistics | Undergrad in Economics          | Tutorials          | 25-30    | 36    |
| Statistics | Undergrad in Math/Comp. Science | Tutorials/Practice | 25-30    | 28    |

### Miscellaneous

- 2022–2024** **Lecture in the Master 2 program “Cell Physics”** at Strasbourg University, France : “Mathematical approaches to microscopic swimming”. – 4h
- 2020 (Jan)** **Mini-course** “An easy-to-use fluid-structure simulator for active/passive rods/filaments” dispensed to graduate and postgraduate students of the Engineering Mathematics department at Bristol University (UK). – 10h
- 2015–2016** **“Colles” in mathematics** (individual oral examinations, part of the French “Classe préparatoires” intensive training for competitive engineering school entrance examinations), Lycée Janson-de-Sailly, Paris – 60h

### Supervision

- 2023** Supervision of E. Thys, graduate student at ENS Rennes.
- 2021** Co-supervision, with V. De Bortoli and A. Doucet, of B. Archer, graduate student at Oxford University. Dissertation title: “The application of genetic reinforcement learning techniques for the control of microscopic robots”

### Administration

- 2019–2020** **Elected representative of the PhD students** at the CEREMADE (Univ. Paris- Dauphine) lab council
- 2019–2020** **member of the CEREMADE’s committee for gender equality.**

## Outreach

### Contributor for the Images des Mathématiques website

From 2018 to 2023, I have been a writer for the monthly press review of the “[Images des mathématiques](#)” website. This review offers an exhaustive summary of the articles that deal with topics related to mathematics, in French-speaking, general-public media. The press review is read by around 2,500 people each month.

### Scientific activities in school sector

- Presentation in front of Japanese high-school students (in Feb 2021, Jan 2023, and Nov 2023), within the JSPS Science Dialogue program.
- Organisation of a workshop on randomness with French junior high school students in October 2019.

### Scientific activities for the general public

- Organisation of a workshop “Maths and Games” at the French festival “Belle Epine” in August 2020.
- “Open Days” at Inria Sophia-Antipolis (2018): research presentation to the public.
- Participation to the French “My PhD in 180 seconds” contest in 2018.
- Short live presentation for “La méthode scientifique” program on national French radio.

### Media coverage

- Mention of [13] in *New Scientist* magazine and numerous other media outlets (see [Altmetric](#))
- Mention of [10] in articles on [Phys.org](#) and [EurekAlert](#)

## Miscellaneous skills

### Computer science

*Computational and programming software*    Matlab/Scilab  
Maple, Mathematica  
Notions of Python, Fortran, FreeFEM++

*Miscellaneous*                                    L<sup>A</sup>T<sub>E</sub>X, html, Adobe Illustrator

### Languages



*French:* mothertongue

*English:* fluent (C2)

*German:* intermediate (B2)

*Japanese:* elementary (A2)