

# Maxime Herda

Research Scientist in Applied Mathematics

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Last update 07/2022

## Current professional situation

Since 2018 **“Chargé de recherche” (Junior research scientist)**, *Inria Lille Nord-Europe*, France.  
Permanent member of the Inria research team RAPSODI (Reliable Approximation of Dissipative Systems).  
Also affiliated to the team ANEDP (Numerical Analysis and Partial Differential Equations) of the Laboratoire Paul Painlevé (University of Lille).

## Previous research positions

2017–2018 **FSMP postdoc**, *Jacques-Louis Lions Laboratory*, Sorbonne Université, Paris, France.  
2014–2017 **Research assistant (PhD)**, *Camille Jordan Institute*, University of Lyon, Villeurbanne.

## Teaching experience

Since 2019 **Part-time lecturer**, *University of Lille*, Villeneuve d'Ascq.

- Introduction to kinetic theory, research master's program (2022, 21h)
- Tutorials on calculus and topology for 2nd year math undergraduates (2021, 36h)
- Mathematical topics in signal processing, professional master's program (2019, 24h)

2020–2021 **Part-time lecturer**, *École Centrale de Lille*, Villeneuve d'Ascq.  
Undergraduate introductory course on scientific computing (16h/year)

2014–2017 **Teaching assistant**, *University of Lyon*, Villeurbanne.

- Oral assessments on measure theory and integration for 3rd year math students (14h)
- Oral assessments on algebra and analysis for 1st and 2nd year engineering students (77h)
- Tutorials on sequences and series of functions for undergraduate math students (36h)
- Tutorials on basic mathematical techniques for undergraduate physics, chemistry and engineering students (66h)

## Research interests

I am interested in the analysis of partial differential equations and the conception of structure preserving schemes for their numerical resolution.

**Keywords:** Numerical analysis, Analysis of partial differential equations, Finite volume methods, Kinetic equations, Parabolic equations and systems, Vlasov-(Fokker-Planck) equations, Long-time behavior, Entropy methods, Hypocoercivity, Asymptotic analysis, Hydrodynamic limits, Semi-Lagrangian schemes, Plasma physics, Positive polynomials.

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## Education

2014 – 2017 **PhD in applied mathematics**, *University of Lyon*, Villeurbanne, France.

Advisors : Francis Filbet and L. Miguel Rodrigues

Thesis title:

*"Asymptotic and numerical analysis of kinetic and fluid models for the transport of charged particles"*

Publicly defended on September 20, 2017 before the jury composed of:

Claire Chainais-Hillairet	Professor, Lille 1 University	President
Clément Mouhot	Professor, University of Cambridge	Reviewer
Sylvie Benzoni-Gavage	Professor, University of Lyon	Examiner
Daniel Han-Kwan	CNRS researcher, École Polytechnique	Examiner
Pauline Lafitte	Professor, Centrale Paris	Examiner
Francis Filbet	Professor, Toulouse 3 University	PhD advisor
L. Miguel Rodrigues	Professor, Rennes 1 University	PhD advisor

After reviews of the manuscript by:

Ansgar Jüngel Professor, Technische Universität Wien  
Clément Mouhot Professor, University of Cambridge

2013–2014 **MSc in mathematical engineering**, *University of Lyon*, Villeurbanne, France.

Master Thesis supervised by Francis Filbet and L. Miguel Rodrigues.

*Subject : "Modeling, analysis and numerical simulations in kinetic theory of magnetized plasmas"*

2010–2014 **Engineering degree from Centrale Lyon**, Centrale Lyon, Écully, France.

General engineering with speciality in applied mathematics (Num. analysis, PDE and stochastic modeling)

2012–2013 **Graduate Certificate in Mathematics**, University College Dublin, Dublin, Ireland.

Master-level course in pure mathematics (Algebra, Analysis)

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## Scientific publications

### Submitted

- [A14] M. Herda and A. Zurek. Study of a structure preserving finite volume scheme for a nonlocal cross-diffusion system. *Submitted (34p.)*, 2022.
- [A13] N. Ayi, H. Hivert, M. Herda, and I. Tristani. On a structure-preserving numerical method for fractional Fokker-Planck equations. *Submitted, preprint arXiv:2107.13416 (46p.)*, 2021.

### Accepted or published in journals

- [A12] C. Chainais-Hillairet, M. Herda, S. Lemaire and J. Moatti. Long-time behaviour of hybrid finite volume schemes for advection-diffusion equations: linear and nonlinear approaches. *Numerische Mathematik*, doi.org/10.1007/s00211-022-01289-w, 2022.
- [A11] P. Degond, M. Herda, and S. Mirrahimi. A Fokker-Planck approach to the study of robustness in gene expression. *Mathematical Biosciences and Engineering*, 17 (6):6459-6486, 2020.
- [A10] C. Cancès, C. Chainais-Hillairet, M. Herda, and S. Krell. Large time behavior of nonlinear finite volume schemes for convection-diffusion equations. *SIAM Journal on Numerical Analysis*, 58 (5), pp.2544-2571, 2020.
- [A9] N. Ayi, H. Hivert, M. Herda, and I. Tristani. A note on hypocoercivity for kinetic equations with heavy-tailed equilibrium. *Comptes Rendus. Mathématique*, 358 (3):333-340, 2020.
- [A8] B. Després and M. Herda. Computation of sum of squares polynomials from data points. *SIAM Journal on Numerical Analysis*, 58 (3):1719-1743, 2020.

- [A7] M. Campos Pinto, F. Charles, B. Després, and M. Herda. A projection algorithm on the set of polynomials with two bounds. *Numerical Algorithms*, 85:1475-1498, 2020.
- [A6] M. Bessemoulin-Chatard, M. Herda, and T. Rey. Hypocoercivity and diffusion limit of a finite volume scheme for linear kinetic equations. *Mathematics of Computation*, 89:1093-1133, 2020.
- [A5] C. Chainais-Hillairet and M. Herda. Large-time behavior of a family of finite volume schemes for boundary-driven convection-diffusion equations. *IMA Journal of Numerical Analysis*, 40 (4):2473-2505, 2020.
- [A4] M. Herda and L. M. Rodrigues. Anisotropic Boltzmann-Gibbs dynamics of strongly magnetized Vlasov-Fokker-Planck equations. *Kinetic and Related Models*, 12(3):593-636, 2019.
- [A3] M. Herda and L. M. Rodrigues. Large-time behavior of solutions to Vlasov-Poisson-Fokker-Planck equations: From evanescent collisions to diffusive limit. *Journal of Statistical Physics*, 170(5):895-931, 2018.
- [A2] F. Filbet and M. Herda. A finite volume scheme for boundary-driven convection-diffusion equations with relative entropy structure. *Numerische Mathematik*, 137(3):535-577, 2017.
- [A1] M. Herda. On massless electron limit for a multispecies kinetic system with external magnetic field. *Journal of Differential Equations*, 260(11):7861-7891, 2016.

#### Accepted or published in conference proceedings

- [P2] C. Chainais-Hillairet and M. Herda.  $L^\infty$  bounds for numerical solutions of noncoercive convection-diffusion equations. *Finite Volumes for Complex Applications IX - Methods, Theoretical Aspects, Examples. FVCA 2020. Springer Proceedings in Mathematics & Statistics, vol 323.*, 2020.
- [P1] M. Badsı and M. Herda. Modelling and simulating a multispecies plasma. In CEMRACS 2014-numerical modeling of plasmas, volume 53 of *ESAIM Proceedings and Surveys*, pages 22-37. EDP Sci., Les Ulis, 2016.

#### Other publications

- [E1] B. Després, M. Herda. Correction to: Polynomials with bounds and numerical approximation – Numerical Algorithms, 2018, vol. 77, no 1, p. 309-311. (Original paper by B. Després: Numerical Algorithms, 2017, vol. 76, no 3, p. 309-311.)

#### Memoirs

- [T1] M. Herda. Analyse asymptotique et numérique de quelques modèles pour le transport de particules chargées – *PhD thesis*. Link : <http://chercheurs.lille.inria.fr/herda/pdf/these.pdf>, 2017.

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### Grants

- 2021-2022 **Principal Investigator of a PHC Amadeus**, French-Austrian bilateral partnership with TU Wien. Funding of  $\sim 2\text{k€}$ /year for research visits.
- May-Jul 2019 **Fellowship**, *Hausdorff research Institute for Mathematics*, Bonn, Germany. Acceptation of a research project (theoretical and numerical study of the fractional kinetic Fokker-Planck equation) for the Junior Trimester Program in kinetic theory. Seven weeks research stay financed by HIM.
- 2017-2018 **Laureate of the FSMP postdoc program**, *FSMP*, Paris, France. One-year postdoctoral fellowship funded by the "Fondation Sciences Mathématiques de Paris".
- 2014-2017 **PhD Scholarship**, *University of Lyon*, France. Funded by the French ministry of higher education and research.

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### Research Visits

- May-Jul 2019 **Hausdorff research Institute for Mathematics**, 7 weeks, Bonn, Germany. Junior trimester program in kinetic theory

Feb 2019 **Imperial College London**, 1 week, UK.

Invited by Pierre Degond thanks to the CNRS-Imperial "Abraham de Moivre" UMI

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## Reviewing activities

I reviewed for Journal of Computational Physics, Foundations of Computational Mathematics, IMA Journal of Numerical Analysis, Nonlinearity, Journal of Scientific Computing, Mathematics of Computation, Communications in Pure and Applied Analysis, Kinetic and Related Models, SIAM Journal on Numerical Analysis, ESAIM Proceedings and Surveys...

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## Supervisions / mentoring

### PhD students

Oct 2020– **Julien Moatti**.

Subject: Development and numerical analysis of high order schemes for convection-diffusion models and study of the large-time behavior

Co-supervision with C. Chainais-Hillairet and S. Lemaire.

### Postdoc

Jan–Aug 2020 **Igor Honoré**, *Now assistant professor (maître de conférence) in University of Lyon.*

Subject: Large-time behavior of numerical schemes for kinetic equations via probabilistic methods

Funded by Inria Lille - Nord Europe and Hauts-de-France region

### Master students

Jun–Jul 2021 **Léonie Cleenewerck**.

Subject: Implementation of numerical schemes for simulations in population dynamics

Apr–Jul 2020 **Julien Moatti**.

Subject: Large-time behavior and entropy methods for hybrid finite volume schemes

Co-supervision with C. Chainais-Hillairet and S. Lemaire.

### Undergraduate students

Apr–May 2019 **Guillaume Helebecque**.

Subject: Simulation of charged particles in a strong magnetic field

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## Organisation of Scientific events

### Seminars

Oct 2019 – July 2022 **Co-organiser of the Numerical Analysis and PDE seminar**, *Laboratoire Paul Painlevé*, Lille.

Weekly seminar of the ANEDP (numerical analysis and partial differential equations) team in the Laboratoire Paul Painlevé (Univ. Lille).

### Conferences

October 2021 **Co-organiser of the 4th edition of "Asymptotic Behavior of systems of PDE arising in physics and biology: theoretical and numerical points of view" (ABPDE 4)**, *Lille*.

### Mini-conferences

November 2022 **Co-organiser of the "Applied Analysis day in Hauts-de-France"**, *Lille*.

One-day conference co-organized by all the math laboratories of the Hauts-de-France region.

Oct 2019 **Co-organiser of the "Journée de la Fédération de Recherche Mathématique du Nord-Pas-de-Calais"**, *Lille*.

One-day conference co-organized by all the math laboratories of the Nord-Pas-de-Calais region.

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## Administrative duties

- Since 2021 **Substitute member to the Lille Inria center committee.**
- Since 2021 **Nominated member of the Lille Inria work group on the use of IT resources.**
- Since 2020 **Elected member of the Paul Painlevé laboratory council and “commission mixte”.**

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## Communications

### Talks in conferences, workshops and summer schools

- 03/2022 - SIAM Conference on Analysis and PDEs, mini-symposium "Challenges in the Kinetic Modelling of Complex Systems" - Berlin, Germany (online).
- 03/2022 - ANR Mohycon workshop: Numerical methods for multiscale problem - Pornichet, France
- 07/2021 - Multi-scale modeling for pattern formation in biological systems - Mittag-Leffler Institute, Sweden (online).
- 04/2021 - Workshop MOME ("Modélisation Mathématique en Ecologie"), Amiens, France (online).
- 07/2019 - 9th International Congress on Industrial and Applied Mathematics (ICIAM 2019) - Valencia, Spain.
- 06/2019 - Analytical and Computational Problems for Mixtures and Plasma Dynamics Workshop - Hausdorff Research Institute For Mathematics, Bonn, Germany
- 10/2018 - Applied Mathematics and Simulation for Semiconductors (AMaSiS 2018) - Berlin, Germany.
- 06/2018 - French numerical analysis congress (CANUM) - Cap d'Agde, France.
- 03/2018 - Young researcher PDE days 2018 - Nancy, France.
- 02/2018 - Conference "Young Researchers Workshop: Kinetic models in biology and social sciences" - School of Math. and Statistical Sciences - Arizona State University, USA.
- 11/2017 - Workshop "Kinetic Theory and Fluid Mechanics" - IMT - Toulouse 3 University, France.
- 09/2017 - Workshop "Dynamics in multi-component systems" - Paul Painlevé Laboratory - Lille 1 University, France.
- 06/2017 - Mini-symposium "MULTIKIN" - SMAI congress 2017 - La Tremblade, France.
- 04/2017 - "KiNeMa" Summer School - IESC - Cargèse, France.
- 07/2015 - "Nonlinear evolutions" Summer school - Hausdorff Center for Mathematics - Universität Bonn, Germany.
- 06/2015 - Mini-symposium "Kinetic equations" - SMAI congress 2015 - Les Karelis, France.
- 08/2014 - CEMRACS 2014 - CIRM - Luminy, France.

### Talks in seminars

- 05/2022 - Applied Analysis seminar, Université de Picardie Jules Verne, France.
- 05/2022 - EMA team seminar, Université Littoral Côte d'Opale, France.
- 06/2020 - Kinetic Coffee - Cambridge University, UK (online seminar).
- 02/2019 - Applied mathematics seminar - Imperial College London - UK.
- 10/2018 - Day of the Nord Pas de Calais Mathematics Research Federation, Lille, France.
- 12/2017 - PDE seminar - J.A. Dieudonné Laboratory - Nice Sophia Antipolis University, France.
- 11/2017 - PDE seminar - Jean Kuntzmann Laboratory - Grenoble Alpes University, France.
- 03/2017 - PDE seminar - Paul Painlevé Laboratory - Lille 1 University, France.
- 03/2017 - Applied mathematics seminar - Jean Leray Laboratory - Nantes University, France.
- 11/2016 - PDE seminar - IRMA - Strasbourg University, France.
- 10/2015 - PDE seminar - IRMAR - Rennes 1 University, France
- 10/2015 - MMCS days- Camille Jordan Institute - University of Lyon, France.
- 09/2015 - ITER seminar - Jacques-Louis Lions Laboratory - Paris 6 University, France.
- 09/2015 - C.A.K.E. seminar - Center for Mathematical Sciences - University of Cambridge, UK.

### Talks for scientific diffusion

- 01/2019 - 30 minutes of science - Inria Lille - Nord Europe.

## Poster presentations in congresses and conferences

- 06/2020 (online conference) - FVCAIX - Bergen, Norway
- 10/2018 - Symposium EDP-Normandie 2017 - Nicolas Oresme Laboratory - Caen-Normandie University, France.
- 06/2016 - ABPDE conference - Paul Painlevé Laboratory - Lille 1 University, France.
- 05/2016 - MATKIT conference - Center for Mathematical Sciences - University of Cambridge, UK.
- 11/2013 - Second International Workshop on Reduced Basis, POD and PGD model - Blois, France.

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## Languages

French **Mother tongue**

English **Fluent**

Italian **Basic knowledge**

*TOEFL iBT: 102/120*

*CELI 3*

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## Computer skills

Programming: Python, C++

Web: HTML5, CSS

Office:  $\LaTeX$ , MS Office

Scientific: Matlab / Scilab / Octave, Numpy / Scipy, Pytorch, SAGE, R, VisIt, Gnu-plot, COMSOL

OS: GNU/Linux, MS Windows, Mac