

# Max Fathi

mfathi at lpsm.paris

Université Paris Cité  
LJLL & LPSM

Citizenship : France, USA  
Date of birth : March 4th 1989

## Education and Employment

2023-2028	Junior member of the Institut Universitaire de France
2023-26	Part-time member of the Département de Mathématiques et Applications, ENS-PSL
2020–	Full professor, Laboratoire Jacques-Louis Lions & Laboratoire de Probabilités, Statistique et Modélisation, Université de Paris
2017–20	CNRS researcher, Institut de Mathématiques de Toulouse
2019	Habilitation degree (HDR), Université Paul Sabatier
2015–16	FRG Visiting Assistant Researcher, University of California, Berkeley
2012–15	Teaching assistant, University Paris 6
2011–14	PhD in mathematics, University Paris 6 (defended Dec. 3rd 2014). Title : <i>Theoretical and numerical study of some stochastic models in statistical physics</i> . Advisor: Cédric Villani
2010–11	Research internship at the Courant Institute of Mathematical Sciences. Topic : Hydrodynamic limits. Advisor: S.R.S. Varadhan
2009-10	Master in Probability, University Paris 6. Thesis advisor: Cédric Villani
2008–12	Student at the École Normale Supérieure, Paris

## Funding

2023-25	• PI of the Emergence UPCité project MEMARN
2023-28	• PI of the ANR PRC project CONVIVIALITY, EUR 446,000
2018-21	• PI of the ANR JCJC project MESA, EUR 135,000
2018-19	• Co-PI (with M. Erbar) of the PHC Procope project ‘Entropic Ricci curvature’, EUR 6,000
2018-19	• PI of the project ‘Stability of Information-Theoretic Functional Inequalities’, funded by the Labex CIMI, EUR 13,100
2018-22	• Member of the ANR project EFI (PI Jean Dolbeault)
2017-18	• Co-PI (with T. Courtade) of the project ‘Geometric and Functional Inequalities in Information Theory’, funded by the France-Berkeley Fund, US \$ 11,400

## Student supervision

2018-21	Maxime Prod'homme, M2 internship, PhD (jointly supervised with F. Otto)
2019-22	Jordan Serres, M2 internship, PhD (both jointly supervised with F. Barthe)
2021	Martin Rakovsky, M1 internship
2021	Romain Gout, M1 internship
2022	Carlos Arias, M1 internship
2022-	Ons Rameh, M2 internship, PhD
2022-	Pablo López Rivera, M2 internship, PhD

I was a member of the jury for the PhD defenses of Mouad Ramil (2020), Dan Mikulincer (referee, 2021), Yannis Oudghiri (referee, 2022), Charles-Philippe Diez (2022) and Alex Delalande (referee, 2022).

## Publications

- A two-scale approach to the hydrodynamic limit, Part II: local Gibbs behavior, *ALEA*, Vol. 10, 625–651, 2013.
- Transport–Entropy inequalities and deviation estimates for stochastic approximation schemes, *Elect. Journal Probab.*, Vol. 18, 2013 (with N. Frikha).
- Modified logarithmic Sobolev inequalities for canonical ensembles, *ESAIM : Probab. & Stat.* Vol.19 (2015).
- Error analysis of the transport properties of Metropolized schemes, *ESAIM : Proceedings and Surveys*, Vol.48, 341–363, 2015, (with A.-A. Homman and G. Stoltz).
- The two-scale approach to hydrodynamic limits for non-reversible dynamics, *Markov Proc. Relat. Fields*, Vol.22, 1, 1-36, 2016. (with H. Duong).
- A gradient flow approach to large deviations for diffusion processes, *J. Math. Pures Appl.* (9) 106 (2016) , no. 5, 957-993.
- On the deficit in logarithmic Sobolev and transportation cost inequalities, *Discrete and Continuous Dynamical Systems* Volume 36, no. 12, December 2016 (with E. Indrei and M. Ledoux).
- Entropic Ricci curvature bounds for interacting systems, *Ann. Appl. Probab.*, Vol. 26 (3) (2016), 1774-1806. (with J. Maas).
- Improving dynamical properties of stabilized discretizations of overdamped Langevin dynamics, *Numerische Math.* 136 (2017), no. 2, 545-602. (with G. Stoltz).
- The gradient flow approach to hydrodynamic limits for the simple exclusion process, *Particle Systems and PDEs III*, ed. A. J. Soares and P. Gonçalves, *Springer Proceedings in Mathematics & Statistics*. (with M. Simon).
- Curvature and transport inequalities for Markov chains on discrete spaces, *Bernoulli* 24(1), 2018, 672-698 (with Y. Shu).
- Gradient flow structure for McKean-Vlasov equations on discrete spaces, *Discrete and Continuous Dynamical Systems - Series A* , Vol. 36, no. 12, December 2016 (with M. Erbar, V. Laschos and A. Schlichting).
- Free Stein kernels and an improvement of the free logarithmic Sobolev inequality, *Advances in Mathematics* 317 (2017) pp. 193-223 (with B. Nelson).
- Poincaré, modified logarithmic Sobolev and isoperimetric inequalities for Markov chains with non-negative Ricci curvature (with M. Erbar), *Journal of Functional Analysis*, Volume 274, Issue 11, 1 June 2018, Pages 3056-3089.
- Wasserstein stability of the entropy power inequality for log-concave densities (with T. Courtade and A. Pananjady), *IEEE Trans. Information Theory*, IEEE Transactions on Information Theory, vol. 64, no. 8, pp. 5691-5703, August 2018.
- A sharp symmetrized form of Talagrand’s transport-entropy inequality for the Gaussian measure, *Elect. Comm. Probab.*, Volume 23 (2018), paper no. 81, 9 pp.
- Existence of Stein Kernels under a Spectral Gap, and Discrepancy Bounds (with T. Courtade and A. Pananjady), *Annales de l’IHP : Probabilités et Statistiques*, Volume 55, Number 2, 2019.
- Stein kernels and moment maps, *Annals of Probability*, Vol. 47, No. 4, 2172-2185, 2019.
- A note on existence of free Stein kernels (with G. Cébron et T. Mai), *Proceedings of the AMS*, 148 (2020), no. 4, 1583-1594..
- Higher-order Stein kernels for Gaussian approximation, *Studia Mathematica*, 256 (2021), no. 3, 241-258.
- Stability of the Bakry-Emery theorem in  $\mathbb{R}^n$  (with T. Courtade), *Journal of Functional Analysis*, 279 (2020), no. 2.
- A proof of the Caffarelli contraction theorem via entropic regularization (with N. Gozlan and M. Prod’homme), *Calculus of Variations and PDE* 59 (2020), no. 3, Paper No. 96.

- Entropic curvature and convergence to equilibrium for mean-field dynamics on discrete spaces (with M. Erbar et A. Schlichting), *ALEA*, 17 (2020), no. 1, 445-471.
- Bounds on optimal transport maps onto log-concave measures (with M. Colombo), *J. Differential Equations* 271 (2021), 1007-1022.
- A short proof of quantitative stability for the Heisenberg-Pauli-Weyl inequality. *Nonlinear Anal.* 210 (2021).
- Hypocoercivity with Schur complements (with E. Bernard, A. Levitt and G. Stoltz), *Annales Henri Lebesgue*, 5 (2022), 523–557..
- Stability estimates for invariant measures of diffusion processes, with applications to stability of moment measures and Stein kernels (with D. Mikulincer), *Annali della SNS di Pisa, Classe di Scienze*, (5) 23 (2022), no. 3, 1417–1445.
- Self-improvement of the Bakry-Emery criterion for Poincaré inequalities and Wasserstein contraction using variable curvature bounds (with P. Cattiaux and A. Guillin), *J. Math. Pures Appl.*, (9) 166 (2022), 1–29.
- Relaxing the Gaussian assumption in Shrinkage and SURE in high dimension (with L. Goldstein, G. Reinert and A. Saumard), *Ann. Stat.*, 50 (2022), no. 5, 2737–2766..
- Stability of eigenvalues and observable diameter in  $RCD(1, \infty)$  spaces (with J. Bertrand), *J. Geom. Anal.* 32 (2022), no. 11, Paper No. 270.
- Bounds in  $L^1$  Wasserstein distance on the normal approximation of general M-estimators (with F. Bachoc), *Electron. J. Stat.* 17, No. 1, 1457-1491 (2023).
- Stability estimates for the sharp spectral gap bound under a curvature-dimension condition (with I. Gentil and J. Serres), *To appear in Annales de l'Institut Fourier*.
- Transportation onto log-Lipschitz perturbations, (with D. Mikulincer and Y. Shenfeld), *To appear in CVPDE*.

## Preprints

- HWI inequalities via couplings (with T. Courtade), *Arxiv preprint*.
- Some obstructions to contraction theorems on the half-sphere (with M. Fradelizi, N. Gozlan and S. Zugmeyer), *Arxiv preprint*.
- Stability of the Poincaré-Korn inequality (with T. Courtade), *Arxiv preprint*.
- Stability of Klartag's improved Lichnerowicz inequality, (with T. Courtade) *Arxiv preprint*.

## Unpublished works

- Hydrodynamic limit for conservative spin systems with super-quadratic, partially inhomogeneous single-site potential (with G. Menz).

## Teaching activities

2023-24	• Teacher for a course on Functional analysis at the Ecole Normale Supérieure.
2022-23	• Teacher for two 4th year course on probability (Stochastic Processes and Limit Theorems, 24h each), one 4th year course on information theory (24h), one 5th year course on optimal transport (20h), teaching assistant for 3rd year courses on statistics (42h) and probability (36h), supervisor for student projects in numerical analysis (20h)
2021-22	• Teacher for two 4th year course on probability (Stochastic Processes and Limit Theorems, 24h each), one 4th year course on information theory (24h), one 5th year course on optimal transport (20h), teaching assistant for 3rd year courses on statistics (42h) and probability (36h)
2020-21	• Teacher for two 4th year course on probability (Stochastic Processes and Limit Theorems, 24h each), teaching assistant for 3rd year courses on statistics (84h) and integration (36h)
2019-20	• Teacher for a 5th year reading seminar on Stein's method, 12 hours, Université Paul Sabatier
2019	• Teacher for a course on optimal transport, for a summer school <i>Geometry and Data Science</i> , 10 hours, Université Paul Sabatier
2018-19	• Teacher for a 4th year Course on Probability and Statistics, 22 hours, Université Paul Sabatier
2017-18	• Teacher for a 4th year Course on Probability and Statistics, 22 hours, Université Paul Sabatier
2014-15	• Teaching assistant for the 2nd year course <i>Advanced study of series and integrals</i> , 72 hours, Université Paris 6
2013-14	• Teaching assistant for the 1st year course <i>Linear algebra and integrals</i> , 54 hours, Université Paris 6 • Oral examinations for the 2nd year course <i>Algebra and geometry</i> , 10 hours, Université Paris 6
2012-13	• Teacher for the course <i>Quantitative and mathematical methods</i> for 1st year social sciences students, $3 \times 24$ hours, Sciences Po Reims, Euro-American campus • Teaching assistant for the 2nd year course <i>Algebra and geometry</i> , 71 hours, Université Paris 6
2011-12	• Teacher for a Debating course, 18 hours, ENS Ulm
2009-10	• Oral examinations for 1st and 2nd year math and physics students in classes préparatoires aux grandes écoles, 85 hours, Lycée Chaptal and Lycée Saint Louis

## Selected talks

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|------|--|
| 2023 | <ul style="list-style-type: none"> <li>• Colloquium, Avignon</li> <li>• Probability seminar, Grenoble</li> <li>• Workshop Stability of Functional Inequalities, Madrid</li> <li>• Probability seminar, IHES</li> <li>• Analysis-probability seminar, Leipzig</li> <li>• Summer school on Concentration Inequalities and Localization Techniques in high dimension (12h course, MSRI)</li> <li>• Foundations of Computational Mathematics 2023 (session talk)</li> <li>• Analysis seminar, Lyon</li> <li>• Probability seminar, Muenster</li> </ul>   |
| 2022 | <ul style="list-style-type: none"> <li>• Mathematics colloquium, Bielefeld</li> <li>• Heat Kernels, Stochastic Processes and Functional Inequalities, Oberwolfach</li> <li>• Analysis seminar, Peking University (online)</li> <li>• Workshop on Optimal Transport and Applications, Pisa</li> <li>• From Dirichlet Forms to Wasserstein Geometry, HCM Bonn</li> <li>• Stein's Method: the Golden Anniversary, IMS Singapore</li> <li>• SPA 2022, contributed session on functional inequalities (online)</li> <li>• Advances in Stein's method and its applications in Machine Learning, BIRS Workshop (online)</li> <li>• Asymptotic Geometric Analysis Online Seminar</li> <li>• Groupe de Travail Transport Optimal-EDP-Machine Learning, Orsay</li> </ul> |
| 2021 | <ul style="list-style-type: none"> <li>• Kantorovitch initiative seminar (online)</li> <li>• Séminaire croisé MAP5-LPSM, Paris</li> <li>• Groupe de Travail CTOP, IHP, Paris</li> <li>• Séminaire CALVA, Paris</li> <li>• Workshop on Schrödinger Problem and Mean-field PDE Systems, CIRM, Marseille</li> <li>• Workshop ANR Quamprocs, Orleans</li> <li>• Journées du GDR AFHP, Besançon</li> <li>• Université Gustave Eiffel (analysis seminar, online)</li> <li>• University of Vienna (probability seminar, online)</li> <li>• University of Lisbon (PDE seminar, online)</li> <li>• Columbia University (applied probability seminar, online)</li> <li>• Ecole Polytechnique (probability seminar, online)</li> </ul>                                    |
| 2020 | <ul style="list-style-type: none"> <li>• Concentration of Measure Phenomena Workshop, Simons Center, Berkeley (online)</li> <li>• Séminaire SPOT, Toulouse</li> <li>• Université de Lille (probability seminar)</li> <li>• Université de Nancy (probability and statistics seminar)</li> <li>• Université de Clermont-Ferrand (probability seminar)</li> <li>• Ecole des Ponts (CERMICS seminar)</li> </ul>  |
| 2019 | <ul style="list-style-type: none"> <li>• Weizmann Institute (Geometric functional analysis and probability seminar)</li> <li>• Georgia Tech (high dimensional seminar)</li> <li>• INRIA Paris (Mokaplan seminar)</li> <li>• Workshop on Geometry and Probability, Osaka (mini-course and invited talk)</li> <li>• Symposium in memory of Charles Stein, IMS Singapore (invited talk)</li> <li>• TU Dortmund (RTG seminar)</li> <li>• Optimal Transport in Analysis and Probability, ESI Vienna (invited talk)</li> <li>• Geometric and Functional inequalities in Convexity and Probability, Florence (invited talk)</li> <li>• Université Paris 5 (Probability seminar)</li> </ul>  |

- 2018
  - Weizmann Institute (Geometric functional analysis and probability seminar)
  - Université de Strasbourg (Probability seminar)
  - Conference on Asymptotic expansion and Malliavin calculus, IHP
  - MPI Leipzig (Analysis-probability seminar)
  - Université de Rennes (Probability seminar)
  - An analyst, a geometer and a probabilist walk into a bar, conference in Cardiff (contributed talk)
  - Thematic day on convergence to equilibrium in statistical physics, Paris
  - Modern Mathematical Methods for Data Analysis workshop, Liège (invited talk)
  - Université Paris 6 (Functional analysis seminar)
  - University of Münster (Probability seminar)
  - Workshop on Entropies, the Geometry of Nonlinear Flows, and their Applications, Banff (invited talk)
  - Journées de lancement du projet EFI, Paris
- 2017
  - University of Kansas (Mathematics colloquium)
  - New York University (Probability seminar)
  - Université Paris-Sud (ANEDP seminar)
  - Intense activity period on Metric Measure Spaces, University of Bonn (participant talk)
  - GeoProb 2017, Université du Luxembourg (invited talk)
  - IHP trimester program on statistical physics (young researchers seminar)
  - UCLA (Probability seminar)
- 2017
  - Workshop on Problems in Transport and related topics in Graphs, Georgia Tech (invited talk)
  - Université du Luxembourg (Probability seminar)
  - PDE/Probability Interactions: Kinetic Equations, Large time and Propagation of Chaos conference, CIRM Marseilles (invited talk)
  - ETH Zurich (Analysis seminar and Probability seminar)
  - Université Paris Dauphine (Analysis-probability seminar)
- 2016
  - Workshop Optimal Transportation and Applications, Pisa (invited talk)
  - Workshop on Optimal Transport, University of Bonn (invited talk)
  - 11th AIMS Conference on Dynamical Systems, Differential Equations and Applications, Orlando (invited session talk)
  - Calculus of Variations and Nonlinear PDEs conference, Columbia University (invited talk)
  - Carnegie Mellon University (Analysis seminar)
  - UCLA (Probability seminar)
  - Northwestern University (Probability seminar)
  - Université Aix-Marseilles (Probability seminar)
  - Young European Probabilists XIII workshop, TU Eindhoven (invited talk)
  - Georgia Tech (seminar)
- 2015
  - Davis-Warwick Probability workshop (invited talk)
  - UC Berkeley (Differential geometry seminar)
  - WIAS Berlin (PDE seminar)
  - UC Berkeley (Probability seminar)
  - Oberwolfach (workshop Interplay of Analysis and Probability in Applied Mathematics)
  - Statistical mechanics and computation of large deviations rate functions workshop, ENS Lyon (invited talk)
  - University of Bath (Analysis seminar)
  - Journées de Probabilités, Toulouse (participant talk)
  - University of Rome ‘La Sapienza’ (Analysis seminar)
  - University of Bonn (Probability seminar)
  - Université de Nice (Probability seminar)
  - Université de Toulouse (Probability seminar)
  - Ecole des Ponts (CERMICS seminar)

2014	<ul style="list-style-type: none"> <li>• Oberwolfach (workshop Variational Methods for Evolution)</li> <li>• Institut Henri Poincaré (Optimal transport seminar)</li> <li>• Université de Lyon (Analysis seminar)</li> <li>• Université de Clermont-Ferrand (Applied mathematics seminar)</li> <li>• Saint Flour Summer School (participant talk)</li> <li>• University of Bonn (Stochastic analysis seminar)</li> <li>• Université Paris Est-Créteil (PhD student seminar)</li> <li>• Young European Probabilists XI workshop, TU Eindhoven (invited talk)</li> <li>• Université Paris 6 (PhD student probability seminar)</li> </ul>
2013	<ul style="list-style-type: none"> <li>• Max Planck Institute, Leipzig (Applied Analysis seminar)</li> <li>• TU Eindhoven (Stochastics seminar)</li> <li>• Journées de Probabilités, Orléans (participant talk)</li> <li>• ENS Lyon (Probability seminar)</li> </ul>
2011	<ul style="list-style-type: none"> <li>• Max Planck Institute, Leipzig (Applied Analysis seminar)</li> <li>• Université Paris 6 (PhD student probability seminar)</li> <li>• Courant Institute, New York (student probability seminar)</li> </ul>

## Other professional activities

2023-2022	<ul style="list-style-type: none"> <li>• Faculty advisor for M1 programs in Data Science and in Cryptography at UPC</li> <li>• Co-organizer of a workshop Interactions PDE/Probability at the CIRM</li> <li>• Member of the Scientific committee for the month-long program Stein's Method: The Golden Anniversary, IMS Singapore</li> <li>• Organizer of a reading seminar on neural networks at the LPSM</li> </ul>
2021-2019	<ul style="list-style-type: none"> <li>• Member of the scientific committee for the MIR Library, U. Paris</li> <li>• Co-organizer of a workshop Interactions PDE/Probability at the CIRM</li> </ul>
2019	<ul style="list-style-type: none"> <li>• Co-organizer of a semester program on Calculus of Variations, IMT Toulouse.</li> </ul>
	Co-organizer of a winter school, and of a workshop on optimal transport
2018	<ul style="list-style-type: none"> <li>• Organizer of a workshop 'Stability of Functional Inequalities and Applications', Toulouse</li> </ul>
2018	<ul style="list-style-type: none"> <li>• Co-organizer of a work group on correlation and concentration inequalities in probability at the IMT</li> </ul>
2017-19	<ul style="list-style-type: none"> <li>• Co-organizer of the probability seminar at the IMT</li> </ul>
2015	<ul style="list-style-type: none"> <li>• Co-organizer of a workshop 'Analytic approaches to scaling limits for random systems', during the Optimal Transport semester at the Hausdorff Institute of Mathematics.</li> </ul>
2012-13	<ul style="list-style-type: none"> <li>• Organizer of a work group on the article <i>Solving the KPZ equation</i> by Martin Hairer, at the Laboratoire de Probabilités et Modèles Aléatoires.</li> </ul>
2011-12	<ul style="list-style-type: none"> <li>• Co-organizer of a student seminar in probability at the ENS Ulm.</li> </ul>

I have participated in the following hiring committees : Marne la Vallée (MCF Analysis 2019), Université de Paris (PR Probability 2021, PR Statistics 2024), Orsay (MCF Statistics and Probability, 2021), Université Paris 10 Nanterre (MCF Probability, 2022 & 2024).

Associate editor for Discrete and Continuous Dynamical Systems since 2020.

Associate editor for Annales de l'IHP : Probabilités et Statistiques since 2024.

I have been a referee for the following journals : AIMS Mathematics, Annales de la Faculté Scientifique de Toulouse, Annals of Probability, Annals of Applied Probability, Annales Henri Lebesgue, Annales de l'IHP: Analyse Non-Linéaire, Annales de l'IHP: Probabilités et Statistiques, Astérisque, Bernoulli, Calculus of Variations and PDEs, Communications in Mathematical Physics, Comptes Rendus de l'Académie des Sciences, Discrete and Continuous Dynamical Systems, Electronic Communications in Probability, Electronic Journal in Probability, ESAIM: Probability and Statistics, IEEE Transactions on Information Theory, Information Geometry, International Mathematics Research No-



tices, *Inventiones Mathematicae*, *Journal de Mathématiques Pures et Appliquées*, *Journal of Functional Analysis*, *Journal of Nonlinear Analysis*, *Journal of Statistical Physics*, *Journal of Statistical Planning and Inference*, *Journal of Theoretical Probability*, *Mathematische Annalen*, *Nonlinearity*, *Probability Theory and Related Fields*, *Random Matrices: Theory and Applications*, *SIAM Journal on Mathematical Analysis*, *SIAM Journal on Applied Algebra and Geometry*, *Statistics and Probability Letters*, *Stochastic Processes and Applications*.

Reviewer for *Mathscinet* (2016–2020) and *Zentralblatt* (2016–2017).

Member of the GDR AFHP and CALVA.