MANUELA GIROTTI

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Current position

Department of Mathematics and Computing Science 07/2021–now
Saint Mary's University, Halifax, NS
Assistant Professor

Professional Affiliations

Isaac Newton Institute for Mathematical Sciences 07/2022–12/2022
University of Cambridge, UK
Research Member

Mathematical Sciences Research Institute (MSRI) 08/2021–12/2021
University of California – Berkeley, CA
Research Member

Mila – Québec Artificial Intelligence Institute 08/2021–now
Université de Montréal, Montréal, QC
Associate Member / Collaborator

Department of Mathematics and Statistics 10/2017–now
Concordia University, Montréal, QC
Affiliate Assistant Professor

Past positions

Mila – Québec Artificial Intelligence Institute 08/2020–06/2021
Université de Montréal, Montréal, QC
Postdoctoral Fellow

Department of Mathematics 03/2019–01/2020
John Abbott College, Sainte-Anne-de-Bellevue, QC
Mathematics professor

Department of Mathematics 01/2017–12/2018
Colorado State University, Fort Collins, CO
Postdoctoral Fellow

Institut de Recherche en Mathématique et Physique 11/2014–10/2016
Université catholique de Louvain, Louvain-la-neuve, Belgium
Postdoctoral Fellow / Assistante de recherche

Education

Mila – Québec Artificial Intelligence Institute 2019–2020
Université de Montréal, Montréal, QC
M.Sc. in Machine Learning. *Suspended because of postdoc position (see above).*

Concordia University, Montréal, QC Canada 2010–2014
Ph.D. in Mathematics, supervisor Prof. Marco Bertola
Thesis title: *"Riemann-Hilbert approach to Gap Probabilities of Determinantal Point Processes"*.
External examiner: Prof. Alexander R. Its (IUPUI). Thesis ranking: excellent.

Università degli Studi di Milano, Milan, Italy 2008–2010

Laurea Magistrale (M.Sc.) in Mathematics, supervisor Prof. Elisabetta Rocca
Thesis title: *"Time relaxation of a phase-field model with entropy balance"*.
Thesis grade: 110/110 *cum laude*[*].

Università degli Studi di Milano, Milan, Italy 2005–2008
Laurea Triennale (B.Sc.) in Mathematics, supervisor Prof. Silke (Dietmar) Klemm
Thesis title: *"Dirac's magnetic monopole"*.
Thesis grade: 110/110 *cum laude*[*].

Certifications

Mental Health Commission of Canada 2021–now
Mental Health First Aider

ML Publications

- "Convergence Analysis and Implicit Regularization of Feedback Alignment for Deep Linear Networks", under review at COLT 2022 (with I. Mitliagkas, G. Gidel).

  Spotlight talk at the workshop Beyond First-Order Methods in ML Systems - ICML 2021.
- "A study of condition numbers for first-order optimization", *Proceedings of The 24th International Conference on Artificial Intelligence and Statistics*, PMLR 130:1261-1269, 2021 (with C. Guille-Escuret, B. Goujaud and I. Mitliagkas).

  Spotlight presentation and Student Paper Award at the Workshop on Optimization for Machine Learning OPT 2020 - NeurIPS.

Math Publications

- "Asymptotic Analysis of the Interaction Between a Soliton and a Regular Gas of Solitons", submitted (with T. Grava, R. Jenkins, K. McLaughlin and A. Minakov).
- "Rigorous asymptotics of a KdV soliton gas", *Comm. Math. Phys.*, 384, 2021 (with T. Grava, R. Jenkins and K. McLaughlin).
- "Fredholm determinant solutions of the Painlevé II hierarchy and gap probabilities of determinantal point processes", *Internat. Math. Res. Notices*, rnz168, 2019 (with T. Claeys and M. Cafasso).
- "Large gap asymptotics at the hard edge for product random matrices and Muttalib-Borodin ensembles", *Internat. Math. Res. Notices*, rnx202, 2017 (with T. Claeys and D. Stivigny).
- "Riemann-Hilbert approach to gap probabilities for the Bessel process", *Phys. D*, 295-296C, 103-121, 2015.
- "Asymptotics of the Tacnode process: a transition between the gap probabilities from the Tacnode to the Airy process", *Nonlinearity* **27**, 1937-1968, 2014.
- "Riemann-Hilbert approach to gap probabilities for the Generalized Bessel process", *Math. Phys. Anal. Geom.* **17** (1), 183-211, 2014.
- "Vanishing time-relaxation for a phase-field model with entropy balance", *Adv. Math. Sci. Appl.*, 22(**2**), 553-575, 2012.

Grants

- co-applicant and collaborator for the CIFAR AI Catalyst project "Rethinking generalization and model diagnostics in modern Machine Learning", with Ioannis Mitliagkas (Mila, Université de Montréal) and Murat Erdogdu (Vector Institute, University of Toronto), 2020–2022.
- recipient of the "University Grant in Aid of Research" with the project "Integrable Probability Models", Saint Mary's University, 2021–2022.

[*]Performance in the final examination is graded from 66 to 110. A *cum laude* can be added to the maximum grade as a special distinction.

- applicant to NSERC Discovery Grant – Early Career Researcher with the project "Integrable Probability and Universality in Mathematical Physics and Machine Learning", Fall 2021.

Student supervision

- supervisor of one (CS Major) student for a Honor project of the course MATH 345, Colorado State University, Spring 2018.

Academic visits

(for periods going from one to four weeks)

- February 2022, Colorado State University (CO), upon invitation of Prof. Ken McLaughlin;
- August 2020, visitor of École de Physique des Houches (France) during the workshop *Statistical Physics and Machine Learning*;
- June 2018, SISSA (Italy), upon invitation of Prof. Tamara Grava;
- October 2019, Tulane University (LA), upon invitation of Prof. Victor Moll;
- May 2018, Université catholique de Louvain (Belgium), upon invitation of Prof. Tom Claeys;
- June 2017, SISSA (Italy), upon invitation of Prof. Marco Bertola and Prof. Tamara Grava;
- May 2015 and February 2016, Université d'Angers (France), upon invitation of Prof. Mattia Cafasso;
- March 2014, Université catholique de Louvain (Belgium), upon invitation of Prof. Tom Claeys;
- June 2012, *PIMS-Mprime Summer School in Probability*, University of British Columbia (Canada).

Research projects

- co-applicant and collaborator for the CIFAR AI Catalyst project "Rethinking generalization and model diagnostics in modern Machine Learning", 2020–2022.
- international team member of the European Marie Skłodowska-Curie Research and Innovation Staff Exchange (RISE) project "Integrable Partial Differential Equations: Geometry, Asymptotics, and Numerics" (IPaDEGAN), 2018–2019.
- member of Interuniversity Attraction Poles - Dynamics, Geometry and Statistical Physics (DYGEST), Belgium, 2014–2016.
- team member of the European Research Council (ERC) project "Critical phenomena in random matrix theory and integrable systems" (CRaMIS), principal investigator Prof. Tom Claeys (UCLouvain), 2014–2016.

Teaching activities

- MATH 3406 - Differential Equations II, Saint Mary's University, Spring 2022;
- MATH 4442 - Real Analysis II, Saint Mary's University, Spring 2022;
- MATH 3441 - Real Analysis I, Saint Mary's University, Fall 2021;
- MATH-015 - Algebra&Trigonometry, John Abbott College, Winter 2019 and Fall 2019;
- MATH-NYB - Calculus II, John Abbott College, Winter 2019 and Fall 2019;
- MATH 530 - Mathematics for Scientists and Engineers, Colorado State University, Fall 2018;
- MATH 345 - Differential Equations (Honors option), Colorado State University, Spring 2018;
- lecture course on Determinantal Point Processes and Random Matrices (MATH 676 Topics in Mathematics), Colorado State University, Fall 2017;
- MATH 317 - Advanced Calculus of one variable, Colorado State University, Fall 2017;
- MATH 369 - Linear Algebra I, Colorado State University, Spring 2017;
- MATH 201 - Elementary Functions, Concordia University, Fall 2013;

- technical assistant of WeBWorK for the courses MATH 200, 201, 202, 203, 204, 205, Concordia University, Fall 2012 - Summer 2014;
- MATH 205 - Differential and Integral Calculus II, Concordia University, Winter 2011 and Fall 2011;

Service activities

- member of the hiring committee (comité de sélection) at Université d'Angers (France), Spring 2022.
- member of the Students selection Committee, Mila Insitute, 2020–2021.
- organizer of the Job Market Seminar Series, Mila Institute, 2020–2021.
- secretary general of the Lab Representatives, Mila Institute, 2020–2021.
- organizer of the Postdoc Seminar series, Colorado State University, 2017–2018.
- organizer of seminar series of the Mathematical Physics group, UC Louvain, 2015–2016.
- organizer of the Graduate Students Seminar series, Concordia University, 2012–2013.
- member of the Departmental Appraisal Committee, Concordia University, 2012–2013.
- president of the Mathematics&Statistics Graduate Students Association (MASGSA) and Graduate Students Representative, Concordia University, 2011–2013.

Scholarships and awards

High school

- Borsa di studio SKF (high school scholarship), SKF Industrie S.p.A., 2000–2005.
- 2nd qualified for Certamen Taurinense (Latin literature competition), May 2005.

Università degli Studi di Milano

- Fondo per il sostegno dei giovani e per favorire la mobilità degli studenti (partial tuition waiver), 2005–2008.

Concordia University

- Faculty of Arts&Science Graduate Fellowship, 2010–2013.
- Concordia University Partial Tuition Graduate Scholarship for International Students, 2010–2011.
- ISM Scholarship, Institut des Sciences Mathématiques (ISM, Montréal), 2011–2012.
- ISM Travel Scholarship, Institut des Sciences Mathématiques (ISM, Montréal), June 2011;
- Exemption des frais de scolarité supplémentaires (MEQ), Ministère de l'Éducation, du Loisir et du Sport du Québec, 2011–2013.
- Concordia Merit Scholarship, 2012–2013.
- Campaign for a New Millennium Graduate Scholarship - Faculty of Arts&Science, 2013-2014.
- Concordia Accelerator Award, 2014.

Colorado State University

- International Presidential Fellow program, 2017–2018.

John Abbott College

- Professional Development funding, 2019.

Status

Italy - citizen, **Canada** - permanent resident (since 2017).

Computer Skills

Languages: Python, Java, C++, HTML, Perl.
Software: WebWork, MatLab, LaTeX, Maple.
Python libraries: PyTorch, SciKitLearn, Numpy, Matplotlib, Pandas.

Languages

- Italian (native)
- English (full professional proficiency, C2)
- French (full professional proficiency, C2)
- Dutch (elementary proficiency, A1)
- Persian (elementary proficiency, A1).

Organizational activities

- organizer of the Graduate Students Seminar series, Concordia University, 2012–2013.
- organizer of seminar series of the Mathematical Physics group, UC Louvain, 2015–2016.
- co-organizer of the Postdoc Seminar series, Colorado State University, 2017–2018.

Academic outreach

- invited panelist to the event "Work/life balance in academia", within the Connection and Introductory Workshop: Universality and Integrability in Random Matrix Theory and Interacting Particle Systems, MSRI, Berkeley (CA), 2021.
- invited talk *"Solitons 101"* at $(MD)^2$ Math Day, John Abbott College, 2019.
- invited talk *"A Peek into the Math world: randomness and matrices"* for the International Presidential Fellow program, 2018.
- volunteer for Math Day 2017 and Math Day 2018, Colorado State University, 2017–2018.
- co-organizer of the Mathematics installations at Exposcience - Stewart Hall Science&Technology Exhibition (Concordia University), Pointe-Claire (QC), 2012–2013.
- invited talk *"A Peek into the Math world: from abstraction to applications"* at the Institut Italien de Culture de Montréal, 2012.

Invited ML talks

- *A note on condition numbers of first-order optimization*, at the workshop "Statistical Physics and Machine Learning", École de Physique des Houches (France), 2020.
- *Condition numbers for first-order optimization*, East Coast Optimization Meeting -virtual-, Fairfax (VA), 2021.
- *Convergence Analysis and Implicit Regularization of Feedback Alignment for Deep Linear Networks*, Beyond First-Order Methods in ML Systems workshop -virtual-, International Conference on Machine Learning, 2021.
- *Convergence Analysis and Implicit Regularization of Feedback Alignment for Deep Linear Networks*, LightOn AI Meetup -virtual-, Paris, 2021.

Invited Math talks

- *Time relaxation of a phase-field model with entropy balance*, Concordia University, 2011.
- *Gap probabilities for the Generalized Bessel process: a Riemann-Hilbert approach*, Concordia University, 2013.
- *Gap probabilities and Isomonodromic τ-function: from integrable systems to non-intersecting Brownian motion*, Università degli Studi Milano-Bicocca, Milan (Italy).
- *Gap Probabilities of the Tacnode process*, Centre de Recherche Mathématiques (CRM), Montréal, 2014.
- *Riemann-Hilbert approach to Gap Probabilities of Determinantal Point Processes*, KU Leuven (Belgium), 2015.
- *Smallest singular value distribution and large gap asymptotics for products of random matrices*, at the conference "Six-vertex model, dimers, shapes, and all that", Simons Center for Geometry and Physics, Stony Brook University (NY), 2016.

- *"Integrable" gap probabilities for the Generalized Bessel process*, at the conference "Painlevé Equations and Discrete Dynamics", Banff International Research Station (BIRS), 2016.
- *Smallest singular value distribution and large gap asymptotics for products of random matrices*, University of Michigan (MI), 2017.
- *Smallest singular value distribution and large gap asymptotics for products of random matrices*, at the 14th International Symposium on Orthogonal Polynomials, Special Functions and Applications (OPSFA14), University of Kent (UK), 2017.
- *Integrable gap probabilities for the Generalized Bessel process*, at the conference "Painlevé Equations and Applications: A Workshop in Memory of A. A. Kapaev", Michigan Center for Applied and Interdisciplinary Mathematics (MCAIM), Ann Arbor (MI), 2017.
- *Asymptotics of gap probabilities via Riemann-Hilbert approach*, at the AMS Joint Mathematics Meeting, San Diego (CA), 2018.
- *Rigorous asymptotics of the soliton gas*, at the AMS Spring Meeting, Vanderbilt University, Nashville (TN), 2018.
- *Rigorous asymptotics of a KdV soliton gas*, at the International Conference in Mathematical Physics, Montréal (QC), 2018.
- *A KdV soliton gas: asymptotic analysis via Riemann–Hilbert problems*, at the Midwestern Workshop on Asymptotic Analysis, Indiana University, Bloomington (IN), 2018.
- *Waves and solitons: the case of a Korteweg-de Vries solitonic gas*, Departmental Colloquium at Tulane University, New Orleans (LA), 2019.
- *Fredholm Determinant Solutions of the Painlevé II Hierarchy and Gap Probabilities of Determinantal Point Processes*, at the SIAM annual meeting, Toronto (ON), 2020 *(cancelled due to COVID-19)*.
- *Fredholm Determinant Solutions of the Painlevé II Hierarchy and Gap Probabilities of Determinantal Point Processes*, Orthogonal Polynomials, Special Functions, Operator Theory and Applications (OPSFOTA) virtual seminar series, 2020.
- *Rigorous asymptotics of a KdV soliton gas*, at the workshop "Analysis of dispersive systems", Isaac Newton Institute for Mathematical Sciences, Cambridge (UK), 2020 *(cancelled due to COVID-19)*.
- *Fredholm Determinant Solutions of the Painlevé II Hierarchy and Gap Probabilities of Determinantal Point Processes*, CRM Mathematical Physics Lab virtual seminar series, Montréal (QC), 2020.
- *A KdV soliton gas: asymptotic analysis via Riemann–Hilbert problem*, Integrable Systems in Newcastle -virtual-, Newcastle (UK), 2021.
- *A KdV soliton gas: asymptotic analysis via Riemann–Hilbert problem*, New horizons in dispersive hydrodynamics -virtual-, Isaac Newton Institute, Cambridge (UK), 2021.
- *Fredholm Determinant Solutions of the Painlevé II Hierarchy and Gap Probabilities of Determinantal Point Processes*, Connections Workshop: Universality and Integrability in Random Matrix Theory and Interacting Particle Systems, MSRI (UC Berkeley), 2021.
- *Asymptotic Analysis of the Interaction Between a Soliton and a Regular Gas of Solitons (a.k.a. Gulliver and the Lilliputians)*, Integrable Systems and Random Matrix Theory seminar series -virtual-, University of Michigan, Ann Arbor (MI), 2021.
- *Asymptotic Analysis of the Interaction Between a Soliton and a Regular Gas of Solitons (a.k.a. Gulliver and the Lilliputians)*, Dalhousie-AARMS Analysis-Applied Math-Physics Seminar -virtual-, Dalhousie University, Halifax (NS), 2022.
- *Asymptotic Analysis of the Interaction Between a Soliton and a Regular Gas of Solitons (a.k.a. Gulliver and the Lilliputians)*, special session on "Soliton gases for integrable systems and related topics: recent progress and developments" at

12th IMACS Conference on Nonlinear Evolution Equations and wave Phenomena, University of Georgia, Athens (GA), 2022.

Other outreach

- journalist for the high-school magazine "Il Salice", Torino, 2000–2005.
- volunteer at the event amfAR Milano 2009, amfAR - The Foundation for AIDS research, Milano, 2009.
- volunteer for the project "Test di usabilità sulla Biblioteca Digitale dell'Università degli Studi di Milano" (test of usability of the university Digital Library), Milano, 2010.
- volunteer at the events Café Scientique 2012 and Café Scientique 2013 (sponsored by CIHR – McGill University Health Center; organized by Comunità Scientifica Italiana in Canada), Montréal, 2012–2013.
- volunteer at the nonprofit restaurant FoCo Cafe, Fort Collins (CO), 2017–2018.

Extra curricular interests

- sailing (Passeport Voile - Niveau 3 Croisière, Fédération Française de Voile, 2019);
- singing (part of the following choirs: Schola Gregoriana Mediolanensis, Stella Matutina, Concordia University Choir);
- skiing (nordic and downhill);
- cooking.