

# MANUELA GIROTTI

## Saint Mary's University

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<b>Current position</b>	<b>Saint Mary's University</b> Department of Mathematics and Computing Science, Halifax, NS Assistant Professor	07/2021–now
<b>Professional Affiliations</b>	<b>Isaac Newton Institute for Mathematical Sciences</b> University of Cambridge, UK Research Member, Simons Foundation Fellowship	07/2022–12/2022
	<b>Simons Laufer Mathematical Sciences Institute (SLMath)</b> (former Mathematical Sciences Research Institute - MSRI) University of California – Berkeley, CA Research Member	08/2021–12/2021
	<b>Mila – Québec Artificial Intelligence Institute</b> Université de Montréal, Montréal, QC Associate Member / Collaborator	08/2021–now
	<b>Concordia University</b> Department of Mathematics and Statistics, Montréal, QC Affiliate Assistant Professor	10/2017–now
<b>Past positions</b>	<b>Mila – Québec Artificial Intelligence Institute</b> Université de Montréal, Montréal, QC Postdoctoral Fellow	08/2020–06/2021
	<b>John Abbott College</b> Department of Mathematics, Sainte-Anne-de-Bellevue, QC Mathematics professor	03/2019–01/2020
	<b>Colorado State University</b> Department of Mathematics, Fort Collins, CO Postdoctoral Fellow	01/2017–12/2018
	<b>Institut de Recherche en Mathématique et Physique</b> Université catholique de Louvain, Louvain-la-neuve, Belgium Postdoctoral Fellow / Assistante de recherche	11/2014–10/2016
<b>Education</b>	<b>Concordia University</b> , Montréal, QC Canada Ph.D. in Mathematics, supervisor Prof. Marco Bertola Thesis title: <i>“Riemann-Hilbert approach to Gap Probabilities of Determinantal Point Processes”</i> . External examiner: Prof. Alexander R. Its (IUPUI). Thesis ranking: excellent.	2010–2014
	<b>Università degli Studi di Milano</b> , Milan, Italy Laurea Magistrale (M.Sc.) in Mathematics, supervisor Prof. Elisabetta Rocca Thesis title: <i>“Time relaxation of a phase-field model with entropy balance”</i> .	2008–2010

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*\*.

- Math Publications** - “Universality and Law of Large Numbers of a random  $N$ -soliton KdV potential”, in preparation (with K. McLaughlin).
- “Soliton versus the gas: Fredholm determinants, analysis, and the rapid oscillations behind the kinetic equation”, *arXiv:2205.02601*, 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.

- ML Publications**
- “Neural Networks Efficiently Learn Low-Dimensional Representations with SGD”, *arXiv:2209.14863*, submitted (with M. Erdogdu, I. Mitliagkas, A. Mousavi, S. Park). *Spotlight presentation* at the workshop on Optimization for Machine Learning OPT 2022 - NeurIPS.
  - “Convergence Analysis and Implicit Regularization of Feedback Alignment for Deep Linear Networks”, *arXiv:2110.10815*, submitted (with G. Gidel, I. Mitliagkas). *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.

- Research projects** - *American Institute of Mathematics*, SQuaREs program 2023–2024  
project: “Dispersive PDEs with randomness”.  
role: team leader.

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\*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.

## Grants

- *NSERC Discovery Grant – Early Career Researcher*, 2022–2027;  
project: “Integrable Probability and Universality in Mathematical Physics and Machine Learning”.  
role: Principal Investigator.
- *University Grant in Aid of Research* of Saint Mary’s University, 2021–2022;  
project: “Integrable Probability Models”.  
role: Principal Investigator.
- *CIFAR AI Catalyst Grant*  
with Ioannis Mitliagkas (Mila, Université de Montréal) and Murat Erdogdu (Vector Institute, University of Toronto), 2020–2022;  
project: “Rethinking generalization and model diagnostics in modern Machine Learning”.  
role: co-applicant.

## Student supervision

- supervisor of one NSERC USRA student, Saint Mary’s University, Summer 2022;  
project title: “The Aztec Diamond: enumeration, random tilings and integrable probability”;  
*contributed talk* at the Mathematics Science Atlantic Conference 2023.
- supervisor for a Honor project of the course MATH 345, Colorado State University, Spring 2018;  
project title: “The Van der Pol oscillator”.

## Teaching activities

- MATH 2303 - Differential Equations I (*course coordinator*), Saint Mary’s University, Spring 2023;
- MATH 3441 - Real Analysis I, Saint Mary’s University, Fall 2022;
- 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;
- 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.

## Invited lectures

- lectures on Random Matrix Theory, Saint Mary’s University, Spring 2022;
- lectures on Determinantal Point Processes and Random Matrices, Tulane University, Fall 2019;
- lectures on Determinantal Point Processes and Random Matrices, Colorado State University, Fall 2017.

## Service activities

- secretary of the SIAM Activity Group “Nonlinear Waves and Coherent Structures”, 2023–2025.
- member of the scientific and organizing committee for the PIICQ Annual Meeting (Probabilités Intégrables, Intégrabilité Classique et Quantique), Angers, May 2023.
- member of the hiring committee (comité de sélection) at Université d’Angers (France), Spring 2022.
- co-organizer of the T-time seminar and social meetings, Saint Mary’s University, 2022–ongoing.
- member of the Students selection Committee, Mila Institute, 2020–2021.
- organizer of the Job Market Panel Series, Mila Institute, 2020–2021.
- Lab Representative, 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.

## Editorial activities

Referee to the following journals:

- SIAM Journal on Mathematical Analysis
- Annales Henri Poincaré
- Symmetry, Integrability and Geometry: Methods and Applications (SIGMA)
- Journal of Machine Learning Research
- European Physical Journal Plus
- Communications in Mathematical Physics

Referee to the following ML conferences:

- Conference on Neural Information Processing Systems 2021 (NeurIPS), workshop Optimization for Machine Learning
- International Conference on Learning Representations 2022 (ICLR), Blog Post Track

Area Chair to the following ML conferences:

- International Conference on Learning Representations 2023 (ICLR), Blog Post Track

## Academic outreach

- coordinator of the Halifax pod (local chapter) of the network “500 Women Scientists”, 2022–ongoing.
- organizer of the Math outreach event “Mathematics down to Earth”, during the Science Literacy Week, Saint Mary’s University, 2022.
- 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)<sup>2</sup> 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.

<b>Mentoring</b>	- mentor for the Association for Women in Mathematics (AMW).	
<b>Certifications</b>	<b>Mental Health Commission of Canada</b> Mental Health First Aider	2021–now
<b>Membership</b>	Member of the following associations: - Canadian Mathematical Society (CMS) - American Mathematical Society (AMS) - Society for Industrial and Applied Mathematics (SIAM)	
<b>Academic visits</b>	(for periods going from one to four weeks)  - May 2022, Université d’Angers (France), upon invitation of Prof. Mattia Cafasso. - 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 <i>Statistical Physics and Machine Learning</i> . - 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 Claey's. - 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 Claey's. - June 2012, <i>PIMS-Mprime Summer School in Probability</i> , University of British Columbia (Canada).	
<b>Scholarships and awards</b>	2000–2005 (high school)  - SKF Industrie S.p.A. scholarship, 2000–2005. - 2 <sup>nd</sup> qualified for Certamen Taurinense (Latin literature provincial competition), May 2005.  2005–2008 (undergraduate)  - Fondo per il sostegno dei giovani e per favorire la mobilità degli studenti (partial tuition waiver), Università degli Studi di Milano, 2005–2008.  2010–2014 (doctorate)  - Faculty of Arts&Science Graduate Fellowship, Concordia University, 2010–2013. - Concordia University Partial Tuition Graduate Scholarship for International Students, Concordia University, 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, Concordia University, 2012–2013. - Campaign for a New Millennium Graduate Scholarship - Faculty of Arts&Science, Concordia University, 2013–2014. - Concordia Accelerator Award, Concordia University, 2014.	

2017–2018 (postdoc)

- International Presidential Fellow program, Colorado State University, 2017–2018.
- SIAM OPSFA (Orthogonal Polynomials and Special Functions) bursary, 2017.

2019 (college professor)

- Professional Development funding, John Abbott College, 2019.

2021–... (assistant professor)

- Simons Foundation Fellowship, Isaac Newton Institute, Cambridge (UK), 2022.

**Status** **Italy** - citizen, **Canada** - permanent resident.

**Computer skills** Languages: Python, Java, C++, HTML, Perl.  
Software: WebWork, MatLab, L<sup>A</sup>T<sub>E</sub>X, Maple.  
Python libraries: PyTorch, SciKitLearn, Numpy, Matplotlib, Pandas.

**Languages**

- Italian (native)
- English (full professional proficiency, C2)
- French (full professional proficiency, C2)

**Conferences talks (Math)**

- *Random matrices, random solitons, and random rational functions, and soliton gasses*, special session “Orthogonal Polynomials and Applications” during the Joint Mathematics Meeting, Boston (MA), 2023.
- *Random matrices, random solitons, and soliton gasses*, XVIII Brunel–Bielefeld Workshop on Random Matrix Theory, Brunel (UK), 2022.
- *The dynamics soliton gasses: Fredholm determinants, asymptotics, and kinetic equations*, special session “Recent advances on nonlinear evolution equations” during the Canadian Mathematical Society winter meeting, Toronto (ON), 2022.
- *Soliton versus the gas: Fredholm determinants, asymptotics, and kinetic equations*, “Analysis of dispersive systems” workshop, Isaac Newton Institute, Cambridge (UK), 2022.
- *Soliton versus the gas: Fredholm determinants, asymptotics, and kinetic equations*, 2022 SIAM Conference on Nonlinear Waves and Coherent Structures, session on “Recent Advances on Integrable Nonlinear Wave Equations”, Bremen (Germany), 2022.
- *Soliton v. the gas: Fredholm determinants, analysis, and finer details*, “Women in Dispersive Hydrodynamics” workshop, Isaac Newton Institute, Cambridge (UK), 2022.
- *Soliton v. the gas: Fredholm determinants, analysis, and the rapid oscillations behind the kinetic equation*, workshop “Excursions in Integrability”, SISSA, Trieste (Italy), 2022.
- *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.
- *A KdV soliton gas: asymptotic analysis via Riemann–Hilbert problem*, workshop New horizons in dispersive hydrodynamics -virtual-, Isaac Newton Institute, Cambridge (UK), 2021.
- *A KdV soliton gas: asymptotic analysis via Riemann–Hilbert problem*, workshop Integrable Systems in Newcastle -virtual-, Newcastle (UK), 2021.

- *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.
- *Rigorous asymptotics of a KdV soliton gas*, 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*, SIAM annual meeting, Toronto (ON), 2020 (cancelled due to COVID-19).
- *A KdV soliton gas: asymptotic analysis via Riemann–Hilbert problems*, Midwestern Workshop on Asymptotic Analysis, Indiana University, Bloomington (IN), 2018.
- *Rigorous asymptotics of a KdV soliton gas*, International Conference in Mathematical Physics, Montréal (QC), 2018.
- *Rigorous asymptotics of a KdV soliton gas*, workshop “Hamiltonian systems & applications”, Università degli Studi Milano-Bicocca, Milano (Italy), 2018.
- *Rigorous asymptotics of the soliton gas*, special session “Probabilistic Models in Mathematical Physics” at the AMS Spring Meeting, Vanderbilt University, Nashville (TN), 2018.
- *Asymptotics of gap probabilities via Riemann-Hilbert approach*, AMS Joint Mathematics Meeting, San Diego (CA), 2018.
- *Integrable gap probabilities for the Generalized Bessel process*, workshop “Painlevé Equations and Applications: A Workshop in Memory of A. A. Kapaev”, Michigan Center for Applied and Interdisciplinary Mathematics (MCAIM), Ann Arbor (MI), 2017.
- *Smallest singular value distribution and large gap asymptotics for products of random matrices*, 14th International Symposium on Orthogonal Polynomials, Special Functions and Applications (OPSFA14), University of Kent (UK), 2017.
- *“Integrable” gap probabilities for the Generalized Bessel process*, workshop “Painlevé Equations and Discrete Dynamics”, Banff International Research Station (BIRS), 2016.
- *Smallest singular value distribution and large gap asymptotics for products of random matrices*, workshop “Six-vertex model, dimers, shapes, and all that”, Simons Center for Geometry and Physics, Stony Brook University (NY), 2016.

#### Colloquium and seminars (Math)

- *The dynamics of random KdV solitons and soliton gasses*, Applied Mathematics Colloquium, Fields Institute, Toronto (ON), 2022.
- *Asymptotic Analysis of the Interaction Between a Soliton and a Regular Gas of Solitons (a.k.a. Gulliver and the Lilliputians)*, AARMS Analysis-Applied Math-Physics seminar, 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)*, Integrable Systems and Random Matrix Theory seminar series -virtual-, University of Michigan, Ann Arbor (MI), 2021.
- *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.
- *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.
- *Waves and solitons: the case of a Korteweg-de Vries solitonic gas*, Departmental Colloquium at Tulane University, New Orleans (LA), 2019.

- *Smallest singular value distribution and large gap asymptotics for products of random matrices*, Integrable Systems and Random Matrix Theory seminar series, University of Michigan (MI), 2017.
- *Riemann-Hilbert approach to Gap Probabilities of Determinantal Point Processes*, Classical Analysis seminar, KU Leuven (Belgium), 2015.
- *Gap Probabilities of the Tacnode process*, Mathematical Physics seminar, Centre de Recherche Mathématiques (CRM), Montréal, 2014.
- *Gap probabilities and Isomonodromic  $\tau$ -function: from integrable systems to non-intersecting Brownian motion*, Mathematical Physics seminar, Università degli Studi Milano-Bicocca, Milan (Italy).

#### Conference talks (ML)

- *Neural Networks Efficiently Learn Low-Dimensional Representations with SGD*, special session “Mathematics of Machine Learning” during the Canadian Mathematical Society winter meeting, Toronto (ON), 2022.
- *Convergence Analysis and Implicit Regularization of Feedback Alignment for Deep Linear Networks*, special session “Scientific Machine Learning” during the Canadian Mathematical Society summer meeting, Memorial University of Newfoundland, St. John’s (NL), 2022.
- *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.
- *Condition numbers for first-order optimization*, East Coast Optimization Meeting -virtual-, Fairfax (VA), 2021.
- *A note on condition numbers of first-order optimization*, at the workshop “Statistical Physics and Machine Learning”, École de Physique des Houches (France), 2020.

#### Colloquium and seminars (ML)

- *Physics Informed Neural Networks and Dispersive PDEs*, Early Career Researchers meetings, Isaac Newton Institute, Cambridge (UK), 2022.
- *Convergence Analysis and Implicit Regularization of Feedback Alignment for Deep Linear Networks*, LightOn AI Meetup -virtual-, Paris, 2021.
- *Random Matrix Theory for uninitiated (and ML applications)*, Montréal Machine Learning and Optimization (MTL MLOpt), Montréal, 2020.

#### Other outreach

- volunteer at the nonprofit restaurant FoCo Cafe, Fort Collins (CO), 2017–2018.
- volunteer at the events Café Scientifique 2012 and Café Scientifique 2013 (sponsored by CIHR – McGill University Health Center; organized by Comunità Scientifica Italiana in Canada), Montréal, 2012–2013.
- 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 event amfAR Milano 2009, amfAR - The Foundation for AIDS research, Milano, 2009.
- journalist for the high-school magazine “Il Salice”, Torino, 2000–2005.

#### Other interests

- sailing:
  - Passeport Voile, Niveau 3 Croisière, Fédération Française de Voile, 2019,
  - Pleasure Craft Operator Card, Transport Canada, 2021;
- singing: part of the following choirs as alto singer
  - Schola Gregoriana Mediolanensis (gregorian; 2009–2010),
  - Stella Matutina (gregorian; 2014–2016),
  - *Vêpres de Saint Waudru* concert, Mons – European Capital of Culture 2015,



- Concordia University Choir (classic and contemporary; 2010–2014 and 2019–2020),
- Dalhousie Collegium Cantorum (classic and contemporary; 2022–now);
- skiing (nordic and downhill):
  - SKF Ski competition, category “Junior Women”, Sestriere (Italy), 2000;
  - Valsalice Ski competition, category “Women”, Sestriere (Italy), 2001;
  - Canadian Ski Marathon, category “Randonneur/Tourer”, 2021.