

Mark William Girard

PhD in Applied Mathematics

Institute for Quantum Computing
University of Waterloo
200 University Avenue West
Waterloo, ON N2L 3G1 Canada

E-mail: mark.w.girard@gmail.com
Phone: 587-229-9536
Web: <https://markwgirard.github.io/>

EMPLOYMENT

- 2017 – 2020 **Postdoctoral Fellow.** Institute for Quantum Computing, University of Waterloo.
- 2018 – 2020 **Sessional instructor.** Faculty of Mathematics, University of Waterloo.
- 2016 **Sessional instructor.** Department of Mathematics and Statistics, University of Calgary.

EDUCATION

- 2012 – 2017 **University of Calgary**, Calgary, Alberta, Canada
Degree: PhD in Mathematics
Adviser: Gilad Gour
Thesis title: *Convex Analysis for Quantum Information Theory*
- 2010 – 2012 **Albert-Ludwigs-Universität Freiburg**, Freiburg im Breisgau, Germany
Degree: Diplom Physics
Thesis: *Optimal Control of Many-Body Entanglement with Measures Optimized on the Fly*
- 2006 – 2010 **Trinity University**, San Antonio, Texas, USA
Degree: B.Sc. with majors in Mathematics, Physics, and German

AWARDS AND ACHIEVEMENTS

- 2018 University of Calgary's Chancellor's Graduate Medal – Doctoral Level.
- 2016 – 2017 Izaak Walton Killam Pre-Doctoral Scholarship. Killam Trusts, University of Calgary.
- 2016 Eric Milner Prize for Excellence in Mathematics Communication. Department of Mathematics and Statistics, University of Calgary.
- 2015 Graduate Assistant Teaching Excellence Award. Department of Mathematics and Statistics, University of Calgary. (Awarded for both Winter and Fall terms of 2015.)
- 2014 – 2016 Alberta Innovates – Technology Futures, Graduate Student Scholarship.
- Winter 2014 Faculty of Science Recruitment Award. University of Calgary.
- 2012 – 2013 Queen Elizabeth II Award. Department of Physics & Astronomy, University of Calgary.
- 2010 – 2012 German Academic Exchange Service – Graduate Study Scholarship.
- Summer 2010 Summer Undergraduate Research Fund, National Institute for Standards and Technology (NIST), Boulder, Colorado.
- 2010 Outstanding Graduating Senior. Department of Physics & Astronomy, Trinity University.
- 2010 Meritorious Award winner in COMAP (math modeling competition).
 – Honorable Mention in 2008 competition
- Summer 2008 Summer Undergraduate Research Fund, NIST, Boulder, Colorado.
- 2006 – 2010 Murchison Scholar. Trinity University.

TEACHING EXPERIENCE

Instructor

- ◇ Faculty of Mathematics at University of Waterloo
 - MATH 137 – Honours Calculus I (Fall 2020)
 - MATH 117 – Calculus I for Engineers (Spring 2019)
 - MATH 212 – Advanced Calculus for Electrical Engineers 2 (Spring 2018, Fall 2019)
- ◇ Department of Mathematics and Statistics at University of Calgary
 - MATH 271 – Discrete Mathematics (Summer 2016)
 - (Developed course materials and lecture notes, wrote homework and exam problems.)

Teaching Assistant

- ◇ Department of Mathematics and Statistics at University of Calgary
 - MATH 271 – Discrete Mathematics (Winter 2015, Fall 2015)
 - MATH 311 – Linear Methods II (Winter 2015)
 - AMAT 307 – Differential Equation for Engineers (Fall 2014)
 - MATH 273 – Honours Mathematics: Numbers and Proofs (Fall 2014)
 - MATH 211 – Linear Methods I (Winter 2014).
 - MATH 283 – Honors Calculus II (Winter 2014).
- ◇ Department of Physics and Astronomy at University of Calgary:
 - PHYS 323 – Optics and Electronics (Fall 2012, Fall 2013).
 - PHYS 259 – Electromagnetic Theory for Engineers (Winter 2013).

Teaching awards

- ◇ Eric Milner Prize for Excellence in Mathematics Communication (2016).
Department of Mathematics and Statistics, University of Calgary.
- ◇ Graduate Assistant Teaching Excellence Award (Winter and Fall terms of 2015).
Department of Mathematics and Statistics, University of Calgary.

Instructor training programs

- ◇ Graduate Student Instruction Training Program (Department of Mathematics and Statistics, University of Calgary), under the mentorship of Dr. Thi Dinh.
 - Completed Step 1 Winter 2015.
 - Completed Step 2 Winter 2016.
- ◇ Instructional Skills Workshop (Taylor Institute for Teaching and Learning, University of Calgary), February 2015.

Supervision of undergraduate research projects

- ◇ Undergraduate senior thesis project supervision
 - Winter 2016 – supervised one undergraduate senior thesis project
 - Fall 2016 – assisted in supervising two undergraduate senior thesis projects
- ◇ Summer undergraduate researcher supervision
 - Summer 2016 – supervised two summer undergraduate student researchers

Teaching service

- ◇ Teaching and Learning Committee in Department of Mathematics and Statistics at U. Calgary.
 - Provided input regarding restructuring of undergraduate calculus curriculum and generation of problem banks for calculus homeworks and exams (2016-2017).
 - Organized TA training workshop for new graduate student TAs in Department of Mathematics and Statistics at University of Calgary (2015, 2016).

PUBLICATIONS

REFEREED JOURNALS

11. M Girard, M Plávala, and J Sikora. Jordan products of quantum channels and their compatibility. To appear in *Nature Communications*. arXiv:2009.03279
10. M. Girard and J. Levick. Twirling channels have minimal mixed-unitary rank. *Linear Algebra and its Applications* **615** 217-227 (2021). arXiv:2005.07056
9. M. Girard, SH Kye, and E. Størmer. Convex cones in mapping spaces between matrix algebras. *Linear Algebra and its Applications* **608** 248-269 (2021). arXiv:2002.09614
8. E. Chitambar, J. de Vicente, M. Girard and G. Gour. Entanglement manipulation and distillability beyond LOCC. *Journal of Mathematical Physics* **61** (4) 042201 (2020). arXiv:1711.03835
7. M. Girard. On directional derivatives of trace functionals of the form $A \mapsto \text{Tr}(Pf(A))$. *Linear Algebra and its Applications* **569** pp 62-77 (2019).
6. M. Girard, G. Gour. Entanglement monotones and transformations of symmetric bipartite states. *Physical Review A* **95** 012308 (2017). arXiv:1609.08016.
5. M. Girard and G. Gour. Computable entanglement conversion witness that is better than the negativity. *New Journal of Physics* **14** 093013 (2015). arXiv:1410.7094.
4. M. Girard, Y. Zinchenko, S. Friedland and G. Gour. Numerical estimation of the relative entropy of entanglement. *Physical Review A* **91** 029901 (2015).
3. M. Girard, G. Gour and S. Friedland. On convex optimization problems in quantum information theory. *Journal of Physics A: Mathematical and Theoretical* **47** 505302 (2014). arXiv:1402.0034.
– Selected by editors for *Highlights of 2014*.
2. S. Glancy, M. Girard, E. Knill. Gradient-based stopping rules for maximum-likelihood quantum state tomography algorithms. *New Journal of Physics* **14** 095017 (2012).
1. D. Ugolini, M. Girard, G.M. Harry, V.P. Mitrofanov. Discharging Fused Silica Test Masses with Ultraviolet Light. *Physics Letters A* **327** 5741 (2008).

PREPRINTS

3. M. Girard, D. Leung, C.K. Li, J. Levick, V. Paulsen, Y.T. Poon and J. Watrous. On the mixed-unitary rank of quantum channels (2020). arXiv:2003.14405
2. B. Coutts, M. Girard, J. Watrous. Certifying optimality for convex quantum channel optimization problems (2018). arXiv:1810.13295
1. M.W. Girard, G. Gour. The binegativity of two-qubit states (2017). arXiv:1701.02724

THESES

- PhD thesis: *Convex Analysis for Quantum Information Theory*. June 2017. Department of Mathematics and Statistics, University of Calgary. Adviser: Gilad Gour.
- Diplom thesis: *Optimal Control of Many-body Entanglement with Measures Optimized on the Fly*. Aug 2012. Physikalisches Institut, Albert-Ludwigs-Universität Freiburg. Adviser: Florian Mintert.

PRESENTATIONS

INVITED CONFERENCE AND WORKSHOP TALKS

Convex programming for quantum resource theories. Canadian Mathematical Society Summer Meeting – Mathematical Methods in Quantum Information. Fredericton, New Brunswick, Canada, June 2-5, 2018.

Entanglement manipulation and distillability beyond LOCC. Canadian Mathematical Society Winter Meeting – Mathematical Methods in Quantum Information. Waterloo, Ontario, Canada, December 8-11, 2017.

Conversion witnesses for transforming quantum states under PPT-operations. Canadian Mathematical Society Winter Meeting – Optimization Techniques in Quantum Information. Niagara Falls, Ontario, Canada, December 2-5, 2016.

Symmetric bipartite quantum entanglement. Workshop on Representation Theory in Quantum Information, University of Guelph. August 22-25, 2016.

Quantum information theory and conversion witnesses. The Sixth Northwest Functional Analysis Seminar, Banff International Research Station, Banff, Alberta, Canada. April 11-13, 2015.

Improving bounds on distillable entanglement. Canadian Mathematical Society Winter Meeting – Matrix Theory in Quantum Information. Ottawa, Ontario, Canada, December 6-9, 2013.

CONTRIBUTED CONFERENCE AND WORKSHOP TALKS

Entanglement conversion witnesses better than negativity. Theory Canada 10. University of Calgary. June 13, 2015.

Quantum entanglement and completely positive maps. 11th PIMS Young Researchers Conference in Mathematics and Statistics. University of British Columbia, Vancouver, Canada. June 2-4, 2014.

Improving bounds on distillable entanglement. Canadian Quantum Information Students' Conference. Institute for Quantum Information Science, University of Calgary, Calgary, Alberta, Canada. June 26, 2013.

Entanglement Control with Measures Optimized on the Fly. German Physical Society (DPG) Spring Meeting. Dresden, March 2011.

Using UV Illumination to Mitigate Excess Charge on Optics in Vacuum. American Physical Society March Meeting. New Orleans, March 10, 2008.

Using UV Illumination to Mitigate Excess Charge on Optics in Vacuum. Texas Section of the APS. October 19, 2007.

POSTER PRESENTATIONS

Entanglement manipulation and distillability beyond LOC. 21st Conference on Quantum Information Processing. TU Delft, The Netherlands. January 15-19, 2018.

Symmetric bipartite entanglement. 20th Conference on Quantum Information Processing. Seattle, WA, USA. January 15-20, 2017.

All convex-roof entanglement monotones under symmetry. Workshop on Multipartite Entanglement. Centro de Ciencias de Benasque, Spain. May 23-27, 2016.

Entanglement conversion witnesses in quantum information. 19th Conference on Quantum Information Processing. The Banff Center, Banff, AB, Canada. January 11-15, 2016.

Improving bounds on distillable entanglement. Quantum Information and Foundations of Quantum Mechanics. University of British Columbia, Vancouver, Canada. July 2-5, 2013.

SEMINAR AND COLLOQUIUM TALKS

Mathematics of Quantum Entanglement (invited). Eric Milner Colloquium, Department of Mathematics and Statistics, University of Calgary. December 9, 2016.

Transformation witnesses in quantum resource theories — entanglement, PPT, and beyond. Quantum Information and Geometric Statistics seminar. University of Guelph, Ontario, Canada, December 6, 2016.

What is information? (invited). Mathematics Education and Enrichment Association seminar, University of Calgary. October 15, 2016.

What is Entropy? Graduate Student Research Seminar, Department of Mathematics and Statistics, University of Calgary. November 6, 2015.

Quantum entanglement and positive maps (invited). Department of Mathematics and Statistics Graduate Seminar, University of Calgary. October 5, 2015.

Quantum entanglement and completely positive maps. Department of Mathematics and Statistics Graduate Student Seminar. University of Calgary. October 7, 2014.

Maximum Likelihood Quantum State Estimation for Optical Cat State Generation. Quantum Optics and Statistics Seminar. Physikalisches Institut of the Albert-Ludwigs-Universität Freiburg. October 18, 2010.

Maximum Likelihood Quantum State Estimation for Optical Cat State Generation. Student SURF Colloquium. NIST Boulder, August 5 2010.

GEANT Modeling of Optical Charging from Cosmic Rays. Departmental seminar. Trinity University, Department of Physics and Astronomy. April 27, 2010.

Exploring the Geometry and Topology of Quantum States. Departmental seminar. Trinity University, Department of Mathematics. April 18, 2010.

ACADEMIC SERVICE AND CONTRIBUTIONS

Academic governance

- ◇ President of the Graduate University of Calgary Mathematics Society (GUMS), 2014-2016.
- ◇ Mathematics and Statistics student representative to Graduate Student Association (University of Calgary), 2014-2016.
- ◇ President of Society of Physics Students chapter. Trinity University, 2007-2010.

Conference and seminar organization

- ◇ Organizer of weekly Quantum Information Theory seminars at Institute for Quantum Computing (2017 – 2020)
- ◇ 19th Conference on Quantum Information Processing – Tutorial Programme. University of Calgary, January 9-10, 2016. (assisted with registration, organization and logistics)
- ◇ 12th PIMS Young Researchers Conference in Mathematics and Statistics, University of Calgary, May 27-29, 2015. (Primary organizer)
- ◇ Theory Canada 10, University of Calgary, June 11-13, 2015. (Made abstract booklet, assisted with organization and logistics.)

Refereed papers for the following journals

- ◇ Electronic Journal of Linear Algebra
- ◇ European Physical Journal D
- ◇ IEEE Transactions on Information Theory
- ◇ Journal of Physics A: Mathematical and Theoretical
- ◇ Linear Algebra and its Applications
- ◇ Physical Review A
- ◇ Physical Review Letters

- ◇ Quantum Information Processing

TECHNICAL SKILLS

Matlab, Python, \LaTeX , Mathematica, Unix operating systems

February 2021