

# Grant Salton

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## Quantum information scientist

### Quantum Research Scientist

Professional Services  
Amazon Web Services (AWS)

*Feb. 2020 – present*

### Visiting Researcher

Institute for Quantum Information and Matter  
Applied Physics and Materials Science  
California Institute of Technology (Caltech)

*Apr. 2020 – present*

### IQIM Postdoctoral Scholar in Theoretical Physics

Institute for Quantum Information and Matter  
California Institute of Technology (Caltech)

*Nov. 2018 – Feb. 2020*

### Visiting Postdoctoral Scholar

Department of Physics  
Stanford University

*Jan. 2019 – Jan. 2020*

## Education

### Ph.D. Physics

*Stanford, California, USA*

**Stanford University**

*Sept. 2013 – Sept. 2018*

**Supervisor:** Prof. Patrick Hayden

**Ph.D. Thesis:** Quantum Error Correction and Spacetime

### M.Sc. Physics

*Stanford, California, USA*

**Stanford University**

*Sept. 2013 – Sept. 2016*

**Supervisor:** Prof. Patrick Hayden

**M.Sc. Thesis:** Universal quantum computation by scattering in the Fermi-Hubbard model

### M.Sc. Physics

*Montréal, Québec, Canada*

**McGill University**

*Sept. 2011 – Dec. 2013*

**Co-supervisors:** Prof. Robert Brandenberger & Prof. Patrick Hayden

**M.Sc. Thesis:** Power spectrum of CMB polarization due to cosmic string wakes

### B.Sc. (Hons) Co-operative

*Waterloo, Ontario, Canada*

**University of Waterloo**

*Sept. 2005 – Apr. 2010*

**Major:** Mathematical Physics   **Minor:** Pure Mathematics   **Specialization:** Astrophysics

**Thesis:** Entanglement degradation from acceleration. Supervisors: Robert Mann & Nicolas Menicucci

## Selected Publications

- [1] A. Brown, H. Gharibyan, S. Leichenauer, H. W. Lin, S. Nezami, G. Salton, L. Susskind, B. Swingle, M. Walter. “Quantum Gravity in the Lab: Teleportation by Size and Traversable Wormholes.” (arXiv:1911.06314)
- [2] P. Faist, S. Nezami, V. Albert, G. Salton, F. Pastawski, P. Hayden, J. Preskill. “Continuous Symmetries and Approximate Quantum Error Correction.” *Phys. Rev. X* 10.4 (2020): 041018 (arXiv:1902.07714) **Selected for plenary talk at QIP2020.**
- [3] C. Chen, G. Penington, G. Salton. “Entanglement Wedge Reconstruction using the Petz Map.” *J. High Energ. Phys.* 2020, 168 (2020) (arXiv:1902.02844)
- [4] P. Hayden, S. Nezami, S. Popescu, G. Salton, “Error Correction of Quantum Reference Frame Information.” Accepted to *Phys. Rev. X Quantum* (arXiv:1709.04471) **Awarded “Best Poster” at QIP2017.**
- [5] J. Cotler, P. Hayden, G. Penington, G. Salton, B. Swingle, M. Walter, “Entanglement Wedge Reconstruction via Universal Recovery Channels.” *Phys. Rev. X* 9.3 (2019): 031011 (arXiv:1704.05839) **Accepted talk at QIP2018.**
- [6] G. Salton, B. Swingle, M. Walter, “Entanglement from Topology in Chern-Simons Theory.” *Phys. Rev. D* 95 (2017) 10, 105007 (arXiv:1611.01516)
- [7] P. Hayden, S. Nezami, G. Salton, B. Sanders, “Spacetime replication of continuous variable quantum information.” *New J. Phys.* 18 (2016) 8, 083043 (arXiv:1601.02544)
- [8] N. Bao, P. Hayden, G. Salton, N. Thomas, “Universal quantum computation by scattering in the Fermi-Hubbard model.” *New J. Phys.* 17 (2015) 9, 093028 (arXiv:1409.3585) **Included in IOPSelect.**
- [9] G. Salton, R. B. Mann, N. C. Menicucci, “Acceleration-assisted entanglement harvesting and ranging.” *New J. Phys.* 17 (2015) 3, 035001 (arXiv:1408.1395) **“Best talk” prize at INTRIQ conference.**

## Research Awards and Funding

Level	Description	Place of Tenure	Competition	Dates Held
Graduate	NSERC Post Graduate Scholarship	Stanford University	National	09/2013 – 08/2016
Graduate	McGill Research Assistantship	McGill University	Institutional	09/2012 – 08/2013
Graduate	NSERC Canada Graduate Scholarship	McGill University	National	09/2011 – 08/2012
Graduate	McGill Research Assistantship	McGill University	Institutional	09/2011 – 08/2012
Undergrad	Summer Undergraduate Research Internship	Perimeter Institute for Theoretical Physics	International	05/2009 – 09/2009
Undergrad	NSERC Undergrad Student Research Award	University of Waterloo	National	09/2008 – 12/2008
Undergrad	NSERC Undergrad Student Research Award	University of Waterloo	National	05/2006 – 09/2006

## Fellowships and Other Awards

Level	Description	Place of Tenure	Basis	Dates Awarded
Graduate	Chalk-Rowles Fellowship	McGill University	Academic	09/2012
Graduate	Lorne Trottier Science Accelerator	McGill University	Academic	09/2011
Graduate	Graduate Excellence Fellowship	McGill University	Academic	09/2011
Graduate	Graduate Travel Award	McGill University	Academic	01/2012
Undergraduate	Dean’s Honours	University of Waterloo	Academic	All terms
Undergraduate	Helen Sawyer Hogg Scholarship in Astronomy	University of Waterloo	Academic	01/2010
Undergraduate	I. R. Dagg Memorial Scholarship	University of Waterloo	Leadership	09/2009
Undergraduate	University of Waterloo President’s Scholarship	University of Waterloo	Academic	09/2005

## Invited Talks

- 2020 AWS re:Invent: Is Now the Right Time to Explore Quantum Computing?**  
*AWS re:Invent 2020*, virtual conference, Dec. 2020
- Entanglement Wedge Reconstruction and the Petz Map**,  
*Caltech High Energy Seminar*, Caltech, Pasadena, CA, Jan. 2020
- 2019 Symmetries and Quantum Error Correction**,  
*IBMQ Seminar*, IBM Watson Research Center, Yorktown Heights, NY, Nov. 2019
- Covariant Quantum Error Correction: Symmetries, Reference Frames, and AdS/CFT**,  
*Last Frontiers in Quantum Information Science*, Talkeetna, AK, July 2019
- Covariant Quantum Error Correction**  
*Quantum Information Seminar*, Perimeter Institute, Waterloo ONT, April 2019
- 2018 Resource Theory of Non-Gaussian Operators**  
*Stanford Quantum Information Seminar*, Stanford University, Stanford CA, May 2018
- Entanglement Wedge Reconstruction via Approximate Operator Algebra QEC**  
*String Seminar*, University of Amsterdam, Amsterdam, the Netherlands, Jan. 2018
- 2017 Approximate Operator Algebra QEC and Entanglement Wedge Reconstruction**  
*Perimeter Institute Quantum Information Seminar*, Waterloo, ONT, Nov. 2017
- Replicating Quantum Information in Spacetime using Continuous Variables**  
*Canadian Institute for Advanced Research Meeting*, Niagara Falls, ONT, Oct. 2017
- Entanglement Wedge Reconstruction from a Quantum Bayes' Rule**  
*Stanford Quantum Information / Quantum Gravity Seminar*, Stanford, CA, June 2017
- Entanglement Wedge Reconstruction from a Quantum Bayes' Rule**  
*Caltech High Energy Theory Seminar*, California Institute of Technology, Pasadena, CA, May 2017
- ★ **Public Lecture: Spacetime Replication of Continuous Variable Quantum Info**  
*IEEE Information Theory and IEEE Photonics Societies*, Stanford University, Stanford, CA, April 2017
- Entanglement Wedge Reconstruction from a Quantum Bayes' Rule**  
*High Energy Theory Seminar*, University of British Columbia, Vancouver, BC, March 2017
- 2015 Spacetime Replication of Continuous Variable Quantum Information**  
*Institute for Quantum Science and Technology Seminar*, University of Calgary, Calgary, AB, Aug. 2015

## Contributed Talks

- 2019 Covariant Quantum Error Correction**, *QIST 2019*, Kyoto, Japan
- 2018 Quantum Error Correction and Spacetime** *Ph.D. defense*, Stanford University
- Approximate Operator Algebra Quantum Error Correction**, *SQuInT 2018*, Santa Fe, NM
- ★ **Approximate Operator Algebra Quantum Error Correction**, *QIP2018*, Delft, the Netherlands
- 2017 Covariant Quantum Error Correction in Holography**, *It from Qubit School*, Bariloche, Argentina
- Entanglement Wedge Reconstruction via Universal Recovery Channels** (poster), *qinfo17*, Santa Barbara, CA
- Entanglement from Topology in Chern-Simons Theory** (poster), *qinfo17*, Santa Barbara, CA
- Entanglement Wedge Reconstruction via Universal Recovery Channels** (poster), *QEC17*, Univ. of Maryland

- Entanglement from Topology in Chern-Simons Theory (poster), *SQuInT 2017*, Baton Rouge, LA
- Entanglement from Topology in Chern-Simons Theory (poster), *QIP2017*, Seattle, WA
- 2016 Characterizing States in Chern-Simons Theory, *It from Qubit Workshop*, Waterloo, ONT
- Spacetime Replication of Continuous Variable Quantum Information, *RQI North*, Waterloo, ONT
- 2016 Spacetime Replication of Continuous Variable Quantum Information, *SQuInT 2016*, Albuquerque, NM
- Spacetime Replication of Continuous Variable Quantum Information (poster), *QIP2016*, Banff, AB
- 2015 Spacetime Replication of Continuous Variable Quantum Information, *QIQG*, Waterloo, ONT
- Algebraic Quantum Error Correction: a Unified Theory (poster), *SQuInT 2015*, Berkeley, CA
- Universal Quantum Computation by Scattering in the Fermi-Hubbard Model (poster), *QIP2015*, Sydney
- 2014 Spacetime Replication of Continuous Variable Quantum Information, *QEC14*, ETH Zurich, Switzerland
- 2013 Acceleration-Assisted Entanglement Harvesting, *CONFETI 2013*, Orford, QC. (Award for best talk)
- 2012 Cosmic String Signals in CMB Polarization, *Cosmic Strings in New Windows*, Montréal, QC
- Measuring Distance by Harvesting Entanglement, *Quantum Information Seminar*, Montréal, QC
- Black Holes, Information, Complementarity, and Firewalls, *Graduate Student Seminar*, Montréal, QC
- Measuring Distance with Acceleration-assisted Entanglement Harvesting, *RQI North*, Waterloo, ONT
- Measuring Distance by Harvesting Entanglement, *Canadian Student Conf on Quantum Info*, Waterloo, ONT

## Teaching Experience

### Substitute Lecturer

*California Institute of Technology, Pasadena, CA*

*Oct 2019 – Jan 2020*

- Substituted for Prof. John Preskill. Course: Ph219a/CS219a – Quantum Computation
- Substituted for Prof. Fernando G.S.L. Brandão. Course: Ph219b/CS219b – Quantum Error Correction

### Teaching Assistant

*Stanford University, Stanford, CA*

*April 2014 – June 2018*

- TA for PHYS 25 (Modern Physics), Spring 2018
- TA for PHYS 43 (Electricity and Magnetism), Spring 2017
- TA for PHYS 134/234 (Advanced Topics in Quantum Mechanics), Autumn 2014 and Autumn 2015
- TA for PHYS 25 (Modern Physics), Spring 2014

### Physics Teaching Mentor

*Stanford University, Stanford, CA*

*April 2015 – June 2018*

- Facilitate interactions between physics TAs and the department of physics
- Mediate conflicts and provide support for TAs
- Run evaluation sessions with students to provide feedback for first-time TAs

### Teaching Assistant

*McGill University, Montréal, Québec*

*Sept. 2011 – Aug. 2013*

- Taught introductory lessons for physics labs
- Volunteered to proctor exams and labs

### Private Tutor

*Waterloo, Ontario*

*May 2010 – July 2013*

- Tutored math and physics privately at high school and university levels

## Teaching Assistant (First Year Physics)

*University of Waterloo, Waterloo, Ontario*

*Sept. 2009 – Dec. 2009*

- Ran a help center for a first year physics course and taught tutorials

## Summer Schools and Long Term Programs

- It from Qubit Summer School, June 16-28, 2019. Yukawa Institute for Theoretical Physics. Kyoto, Japan
- It from Qubit Summer School, January 8-13, 2018. Centro Atómico Bariloche. Bariloche, Argentina
- It from Qubit Summer School, July 18-29, 2016. Perimeter Institute for Theoretical Physics. Waterloo, Ontario
- Princeton Summer School on Condensed Matter Physics, July 28-31, 2014. Princeton University
- Quantum Hamiltonian Complexity Boot Camp, Jan 15-18, 2014. Simons Inst. for the Theory of Computing, Berkeley, CA
- 13th Canadian Summer School on Quantum Info., June 17-21, 2013. University of Calgary, Calgary, Alberta
- 12th Canadian Summer School on Quantum Info., June 11-16, 2012. Institute for Quantum Computing, Waterloo, Ontario
- Summer School on Cosmology, July 15-Aug. 3, 2012. International Centre for Theoretical Physics, Trieste, Italy

## Referee for Journals and Conferences

- Nature Quantum Information
- IEEE Transactions
- New Journal of Physics
- Quantum Information Processing
- Theory of Quantum Computation, Communication and Cryptography
- Quantum Science and Technology

## Previous Positions

### Scientific Advisor

*Earth Computing, Palo Alto, California*

**Area: Cloud Computing**

*Dec. 2018 – Oct. 2019*

- Served on the board of advisors for a distributed computing startup, providing guidance on the company's core protocols

### Graduate Research Student

*Stanford University, Stanford, California*

**Area: Quantum Information Science**

*Sept. 2013 – Aug. 2018*

- Research at the interface of quantum information theory and other areas of physics
- Emphasis on quantum error correction, quantum computation, and quantum gravity

### Graduate Research Student

*McGill University, Montréal, Québec*

**Area: Quantum Information in Cosmology**

*Sept. 2011 – Aug. 2013*

- Researched cosmological models of the early universe with an emphasis on quantum information

### Research Affiliate

*Perimeter Institute for Theoretical Physics, Waterloo, Ontario*

**Project: Relativistic Quantum Information**

*Sept. 2010 – May 2011*

- Studied the effects of non-inertial motion on entanglement harvested from quantum fields

### Summer Research Intern

*Perimeter Institute for Theoretical Physics, Waterloo, Ontario*

**Project: Quantum Gambling**

*May 2009 – Sept. 2009*

- Developed a theory of decision making in the face of quantum uncertainty (“quantum gambling”)

### Astrophysics Research Student

*University of Waterloo, Waterloo, Ontario*

**Project: Extremely Isolated Galaxies in the SDSS**

*May 2006 – Sept. 2006 and Sept. 2008 – Feb. 2009*

- Studied the formation and evolution of extremely isolated galaxies
- Used data science methodology to analyze large astrophysical datasets

### Space Plasma Physics Researcher

*Canadian Space Agency, St. Hubert, Quebec*

**Project: Magnetospheric Kelvin-Helmholtz Instabilities**

*Sept. 2007 – May 2008*

- Studied space plasma physics phenomena and developed research simulations

- Performed numerical analysis of a new chirped-pulse laser interferometry technique