Grant Salton

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Quantum information scientist

Sr. Quantum Research Scientist Quantum Research Scientist Amazon Web Services (AWS)	*Dec. 2021 – present* *Feb. 2020 – Dec. 2021*
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 University**
Stanford, California, USA — *Sept. 2013 – Sept. 2018*

Supervisor: Prof. Patrick Hayden

Ph.D. Thesis: Quantum Error Correction and Spacetime

M.Sc. Physics — **Stanford University**
Stanford, California, USA — *Sept. 2013 – Sept. 2016*

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

M.Sc. Physics — **McGill University**
Montréal, Québec, Canada — *Sept. 2011 – Dec. 2013*

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

B.Sc. (Hons) Co-operative — **University of Waterloo**
Waterloo, Ontario, Canada — *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. M. Dalzell, B. D. Clader, G. Salton, M. Berta, C. Y. Lin, D. A. Bader, N. Stamatopoulos, M. J. A. Schuetz, F. G. S. L. Brandão, H. G. Katzgraber, W. J. Zeng. "End-to-end resource analysis for quantum interior point methods and portfolio optimization" (arXiv:2211.12489) *Submitted to PRXQuantum*

[2] B. D. Clader, A. M. Dalzell, N. Stamatopoulos, G. Salton, M. Berta, W. J. Zeng. ""Quantum Resources Required to Block-Encode a Matrix of Classical Data." (arXiv:2206.03505) *Accepted to IEEE Transactions on Quantum Engineering*

[3] S. Nezami, H. W. Lin, A. Brown, H. Gharibyan, S. Leichenauer, G. Salton, L. Susskind, B. Swingle, M. Walter. "Quantum Gravity in the Lab: Teleportation by Size and Traversable Wormholes, Part II." (arXiv:2102.01064) *Accepted to PRXQuantum*

[4] 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) *Accepted to PRXQuantum*

[5] 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.**

[6] C. Chen, G. Penington, G. Salton. "Entanglement Wedge Reconstruction using the Petz Map." *J. High Energ. Phys.* 2020, 168 (2020) (arXiv:1902.02844)

[7] P. Hayden, S. Nezami, S. Popescu, G. Salton, "Error Correction of Quantum Reference Frame Information." *Phys. Rev. X Quantum* 2, 010326 (2021) (arXiv:1709.04471) **Awarded "Best Poster" at QIP2017.**

[8] 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.**

[9] G. Salton, B. Swingle, M. Walter, "Entanglement from Topology in Chern-Simons Theory." *Phys. Rev. D* 95 (2017) 10, 105007 (arXiv:1611.01516)

[10] 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)

[11] 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.**

[12] G. Salton, R. B. Mann, N. C. Menicucci, "Acceleration-assisted entanglement harvesting and rangefinding." *New J. Phys.* 17 (2015) 3, 035001 (arXiv:1408.1395) **"Best talk" prize at INTRIQ conference.**

Invited Talks

2023 **Quantum Computing in the Cloud and Industrial Quantum Technology**
Silicon Valley Quantum Computing Group, Virtual, Feb. 2023

2022 **Analyzing Use Cases and Running Applications on Quantum Computers**
AWS re:Invent 2022, Las Vegas, NV, Nov. 2022

Quantum Computing in the Cloud and Industrial Quantum Technology
Physics Colloquium, Cal State Long Beach, Colloquium, Nov. 2022

2021 **Financial Portfolio Optimization with Quantum Computing**
AWS re:Invent 2021, Las Vegas, NV, Nov. 2021

How to Get Started with Quantum Computing on Amazon Braket
AWS re:Invent 2021, Las Vegas, NV, Nov. 2021

Repeat Session: How to Get Started with Quantum Computing on Amazon Braket
AWS re:Invent 2021, Las Vegas, NV, Nov. 2021

Quantum Computing in Practice
CDSE Days 2021, SUNY at Buffalo, virtual conference, Mar. 2021

2020 **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

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

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

Other Previous Positions

Scientific Advisor — **Area: Cloud Computing**

Earth Computing, Palo Alto, California — *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 — **Area: Quantum Information Science**

Stanford University, Stanford, California — *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 — **Area: Quantum Information in Cosmology**

McGill University, Montréal, Québec — *Sept. 2011 – Aug. 2013*

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

Research Affiliate — **Project: Relativistic Quantum Information**

Perimeter Institute for Theoretical Physics, Waterloo, Ontario — *Sept. 2010 – May 2011*

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

Summer Research Intern — **Project: Quantum Gambling**

Perimeter Institute for Theoretical Physics, Waterloo, Ontario — *May 2009 – Sept. 2009*

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

Astrophysics Research Student — **Project: Extremely Isolated Galaxies in the SDSS**

University of Waterloo, Waterloo, Ontario — *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 — **Project: Magnetospheric Kelvin-Helmholtz Instabilities**

Canadian Space Agency, St. Hubert, Quebec — *Sept. 2007 – May 2008*

- Studied space plasma physics phenomena and developed research simulations

Research Assistant — **Project: Chirped-Pulse Interferometry**

Institute for Quantum Computing, Waterloo, Ontario — *May 2007 – Sept. 2007*

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

Referee for Journals and Conferences

- Nature Quantum Information
- IEEE Transactions
- Physical Review X
- PRX Quantum
- Physical Review Letters
- Physical Review D
- Physical Review Research
- New Journal of Physics
- Quantum
- Quantum Information Processing
- Theory of Quantum Computation, Communication and Cryptography
- Quantum Science and Technology

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