

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, Preskill Group
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

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

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

Select Publications

- [1] R. S. Andrist, M. J. A. Schuetz, P. Minssen, R. Yalovetzky, S. Chakrabarti, D. Herman, N. Kumar, G. Salton, R. Shaydulin, Y. Sun, M. Pistoia, H. G. Katzgraber. “Hardness of the Maximum Independent Set Problem on Unit-Disk Graphs and Prospects for Quantum Speedups”. (arXiv:2307.09442) *Submitted to PRX Quantum*
- [2] G. Rosenberg, J. K. Brubaker, M. J. A. Schuetz, G. Salton, Z. Zhu, E. Y. Zhu, S. Kadioğlu, S. E. Borujeni, H. G. Katzgraber. “Explainable AI using expressive Boolean formulas”. (arXiv:2306.03976) *Submitted to MAKE*
- [3] 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 PRX Quantum*
- [4] 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”. *IEEE Transactions on Quantum Engineering* 3 (2022): 1-23 (arXiv:2206.03505)
- [5] 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”. *PRX Quantum* 4.1 (2023): 010321 (arXiv:2102.01064)
- [6] 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”. *PRX Quantum*, 4.1 (2023): 010320 (arXiv:1911.06314)
- [7] 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.**
- [8] C. Chen, G. Penington, G. Salton. “Entanglement Wedge Reconstruction using the Petz Map”. *J. High Energ. Phys.* 2020, 168 (2020) (arXiv:1902.02844)
- [9] P. Hayden, S. Nezami, S. Popescu, G. Salton, “Error Correction of Quantum Reference Frame Information”. *PRX Quantum* 2.1 (2021): 010326 (arXiv:1709.04471) **Awarded “Best Poster” at QIP2017.**
- [10] 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.**
- [11] G. Salton, B. Swingle, M. Walter, “Entanglement from Topology in Chern-Simons Theory”. *Phys. Rev. D* 95 (2017) 10, 105007 (arXiv:1611.01516)
- [12] 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)
- [13] 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.**
- [14] 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.**
- [15] R. Brandenberger, N. Park, G. Salton “Angular Power Spectrum of B-mode Polarization from Cosmic String Wakes”. (arXiv:1308.5693)

Invited Talks

- 2023 Panel Discussion: Novel Quantum Applications and Use Cases**
Stanford Responsible Quantum Technology Conference, Stanford University, Stanford, CA, May. 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
- PRX Quantum
- 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