Contact Information

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- Pronouns: he/him

Education

Sept. 2008-	Ph.D. in physics, University of Southern California, Los Angeles CA.
Aug. 2013	Awarded: 13 August 2013 Viva: 27 April 2013 Supervised by Professor
	Stephan Haas, Thesis title: Quantum computation by transport: develop-
	ment and potential implementations

Sept. 2003-
May 2007Bachelors degree in engineering physics, Colorado School of Mines, Golden
CO, USA.

Employment

January 2024-	Lecturer in Newcastle School of Computing (50%) and independent con-
present	sultant (see: consulting)

October 2021- Teaching fellow at Durham University and independent consultant (see: December 2023 consulting)

June 2021- Sept. 2021	Senior postdoctoral researcher at Durham University funded through QCS hub
June 2018- June 2021	EPSRC UKRI Innovation fellowship based on hybrid quantum/classical computing (Durham grade 8 assistant professor)
Jan. 2016- June 2018	PDRA at Durham University on hybrid quantum-classical computing under direction of Prof. Viv Kendon, EPSRC grant reference EP/L022303/1
Sept. 2013- Dec. 2015	Postdoctoral researcher at London Centre for Nanotechnology performing experimental research on quantum annealing processors under direction of

Profs. Gabriel Aeppli and Andrew Green

Consulting

- Quantum Computing Inc. developing methods to improve quantum algorithms, contracted for up to 20 hours per week, from March. 2021, ongoing
- Defence Science and Technology Lab (UK) Quantum Pathfinder project developing quantum neural network techniques for image analysis, initial phase began October 2021 and concluded March 2022, second phase January 2023-March 2023

Invited Talks and Lectures

- Jülich Supercomputing Centre Spring School on Quantum Information Processing Lecture on hybrid quantum-Classical Computing 30 March 2023.
- UK-Swiss Quantum Computing Roadshow, Organized by the British Embassy in Berne, approximately 15 leading British Quantum Computing Researchers Invited to visit ETH Zurich, EPFL Lausanne and University of Geneva, to foster collaboration on quantum computing 6-8 March 2023.

- International Network in Quantum Annealing Conference 2022, held 9-11 November 2022 in London United Kingdom.
- AQC 2022, main conference in the field of quantum annealing, held 21 25 June 2022 at ICTP in Trieste Italy.
- Scientific Applications of Quantum Annealing, invite only conference to discuss latest advances in applying quantum annealing to scientific problems hosted by researchers at Los Alamos National Lab, held 11 15 June 2022 in Telluride Colorado USA.
- International Advanced Workshop on High Performance Computing workshop in Cetraro Italy held 26-30 June 2021 by experts in high performance computing.
- Quantum Simulation from Theory to Application, thematic program at the Erwin Schrödigner institute in Vienna, Austria attended 7-17 October 2019.
- Continuous-time quantum computing and simulation: perspectives and challenges, workshop organized by the Royal Society 2-3 October 2019.
- Top QC 2019, workshop in Cetraro Italy held 10-12 June 2019 by experts in high performance computing to discuss potential of quantum computing.
- DLR Workshop on Quantum Computing for Applications in Science and Industry, 1-2 October 2018 German Aerospace organization, interested in applied aspects of quantum computing.
- AQC 2018, main conference in the field of quantum annealing, held 25 28 June 2018 at NASA Ames research centre.

Research software and programming languages

- Python: Expert
- Matlab: Expert
- Mathematica: Intermediate
- Lisp: Beginner

Funding Principal investigator:

- Awarded a three year EPSRC UKRI Innovation fellowship'Hybrid Quantum Energy Landscape Computing', grant number: EP/S00114X/1 funded value: £465,703
- UKRI citizen science grant "First encounters with quantum computing: can games teach quantum reasoning?" in collaboration with Durham education department, grant number: BB/T018666/1 funded value: £19,836

Co-Investigator:

- Feasibility Study on Quantum Optimization of Aircraft Container Loading, Innovate UK grant between Newcastle and Unisys £271,462 Sept. 2023 Aug. 2024 grant number: 10073838 .
- Quantum Algorithms for Nonlinear Differential Equations QuANDiE £265,018 June 2023-Mar. 2025 grant number: EP/Y004515/1

- Remote quantum computing experiments
- Use of HPC clusters

- Named participant in International Network on Quantum Annealing (INQA), led by Professor Paul Warburton £321,863, Feb. 2022-Feb. 2025 grant number: EP/W027003/1
- National Quantum Computing Centre standardization tender led by the National Physics Laboratory for evaluation of quantum annealers, Durham share \pounds 14,714, awarded November 2021.
- Named Co-Investigator on Quantum Enhanced and Verified Exascale Computing QEVEC, £1,015,931 Aug. 2021 - Aug. 2024 grant number: EP/W00772X/1.
- Named Co-Investigator on EPSRC collaborative computational project in quantum computing CCP-QC, £163,420 network runs March 2020 Feb. 2025 grant number: EP/T026715/1.
- Named as a Co-Investigator in UKRI EPSRC Hub in Quantum Computing and Simulation (grant number: EP/T001062/1), original Durham grant share £125,580.
- Funding through NQIT (EPSRC networked quantum information technology hub) project to experimentally test reverse annealing on D-Wave devices $\pounds 18,730$
- D-Wave device time funded by BP (formerly British Petroleum) to work on a project with Simon Benjamin from Oxford and Michael Gutmann from Edinburgh machine time sold at commercial rate for value of approximately \$10,000 (US)

Teaching and supervision experience

- I employed a postdoc as part of my fellowship project (recruited February 2019 contract ended December 2021 due to no-cost extension)
- Primary supervisor of two PhD students (one started October 2018, one started October 2021), cosupervised two students who has now attained a PhD
- Have taught level 3 computer projects in Durham physics autumn 2016-spring 2020, students develop small scale numerical research project
- Developed a new computer project on 'quantum optimization and algorithms' one section taught by me in the 2019-2020 academic year
- Have supervised numerous level 4 undergraduate research projects at Durham
- Acted as an external examiner for a masters by research (MRes) project at Durham in Autumn 2021
- Developed and gave guest lecture course on quantum annealing as part of the UCL Quantum Engineering CDT graduate course March 2021 and 2022 (lecture notes available on my personal webpage); 3 lectures, plus developing a homework assignment and a test questions; Course was well received by students
- Lectured level 4 quantum optics at Durham, autumn term 2021 and 2022
- External examiner for a Doctoral thesis at University of Saarbrucken (Germany)

Administrative Activities/Citizenship

- AQC 2024 programme committee chair
- Topic editor for Frontiers in: Computer Science; Experience with Quantum Annealing Computation
- Served on the program committee for IEEE International Conference on Quantum Computing & Engineering in 2023

- Invited reviewer for annealing time applications to the Jülich supercomputing centre JUNIQ program
- Provided (by request) letter supporting continued funding for quantum annealer upgrades at Jülich supercomputing centre JUNIQ program
- Served on organizing committee of QuAMP 2021 held in September 2021
- Member of Physical Review A editorial board from January 2021
- Served on the program committee for the Quantum Computing Thematic Track of the International Workshop on Computational Science since 2020
- Served on the program committee for QTOP 2019, the First International Workshop on Quantum Technology and Optimization Problems, held in Munich
- Editorial board member of PLOS ONE specializing in Physical Science and Quantum Computation from 2018 to 2022
- Numerous peer review activities, leading to being awarded IoP trusted reviewer status
- Organized a career day for early career researchers in Durham Quantum Light and Matter section (15 March 2019)
- Ordinary member of the Institute of Physics Computational Physics Group committee 2017-2022

Leadership training

• Participated in Durham University's Research Project Leadership programme

Industrial engagement and public outreach

- Invited member of the technical advisory board of Quantum Computing Inc., a startup built around quantum software, traded as NASDAQ: QUBT
- Member of the Quantum Computing Inc. team for the BMW/AWS quantum computing challenge, which was named as a finalist
- Supervise PhD project on quantum computing applications funded by dunnhumby
- Attended (by invitation) BCI summit in May 2019, summit attended by scientists and venture capitalists to discuss opportunities in emerging technologies, including quantum computing
- Numerous interactions with D-Wave Systems Inc., the top producer of quantum annealers including being involved in an NQIT partnership project where I am the researcher and they are the partner. My paper Modernizing Quantum Annealing (see publications), helped to pioneer the new reverse annealing feature now available to users of their devices.
- Methodology for development of quantum used cases co-written with Applied Qubit
- Invited remote talks given to Zaiku Group on the subject of rapid quenches for quantum optimisation and domain-wall encoding in quantum annealing
- Interviewed for a Gizomodo article about technology behind D-Wave Systems
- I played a key role in designing game content for Quantum Odyssey, a video game about quantum computing produced by Quarks Interactive, a company which one of my postgraduate students runs
- I played a key role in adapting the Quantum Odyssey to the "save Schrödinger's cat" card game for APS physics quest 2021, distributed in approximately 20,000 kits

Publications^{1 2}

- Cycle discrete-time quantum walks on a noisy quantum computer
 V. Wadhia, N. Chancellor, V. Kendon Eur. Phys. J. D 78, 29 (2024).
- [2] A Thermodynamic Approach to Pptimization in Complex Quantum Systems
 A. Imparato, N. Chancellor, G. De Chiara Quantum Sci. Technol. 9 025011 (2024).
- [3] Graphical Structures for Design and Verification of Quantum Error Correction
 N. Chancellor, A. Kissinger, S. Zohren, J. Roffe, D. HorsmanQuantum Science and Technology 8, 045028 (2023).
- [4] Using copies to improve precision in continuous-time quantum computing
 J. Bennett, A. Callison, T. O'Leary, M. West, N. Chancellor, V. Kendon Quantum Science and Technology 8, 035031 (2023).
- [5] Comparing the hardness of MAX 2-SAT problem instances for quantum and classical algorithms
 P. Mirkarimi, A. Callison, L. Light, N. Chancellor, V. Kendon Phys. Rev. Research 5, 023151 (2023).
- [6] NP-hard but no longer hard to solve? Using quantum computing to tackle optimization problems R. Au-Yeung, N. Chancellor, P. Halffmann Frontiers in Quantum Science and Technology, vol. 2 ISSN 2813-2181 (2023).
- [7] Understanding domain-wall encoding theoretically and experimentally J. Berwald, N. Chancellor, R. Dridi Philosophical Transactions of the Royal Society A.381: 20210410 (2022).
- [8] Controller-based Energy-Aware Wireless Sensor Network Routing using Quantum Algorithms J. Chen, P. Date, N. Chancellor, M. Atiquzzaman, C. Sreenan IEEE Transactions on Quantum Engineering, vol. 3, pp. 1-12, Art no. 3102912 (2022).
- [9] Modernizing quantum annealing II: genetic algorithms with the inference primitive formalism N. Chancellor Natural Computing doi: 10.1007/s11047-022-09905-2 (2022).
- [10] *Hybrid quantum-classical algorithms in the noisy intermediate-scale quantum era and beyond* A. Callison and N. Chancellor Phys. Rev. A **106**, 010101 (2022). **invited perspective**
- [11] Error measurements for a quantum annealer using the one-dimensional Ising model with twisted boundaries

N. Chancellor, P. J. D. Crowley, T. Đurić, W. Vinci, M. H. Amin, A. G. Green, P. A. Warburton, G. Aeppli npj Quantum Information **8**, 73 (2022).

- [12] AKLT-states as ZX-diagrams: diagrammatic reasoning for quantum states
 R. D. P. East, J. van de Wetering, N. Chancellor, A. G. Grushin Physical Review X Quantum 3, 010302 (2021).
- [13] Performance of Domain-Wall Encoding for Quantum Annealing
 J. Chen, T. Stollenwerk, N. Chancellor IEEE Transactions on Quantum Engineering, 2, pp. 1-14, Art no. 3102714, (2021).
- [14] Search range in experimental quantum annealingN. Chancellor, V. Kendon Phys. Rev. A 104, 012604 (2021).
- The challenge and opportunities of quantum literacy for future education and transdisciplinary problemsolving
 L. Nita, L. Mazzoli Smith, N. Chancellor, H. Cramman Research in Science & Technological Education, doi:10.1080/02635143.2021.1920905 (2021).

¹Information current as of April 9, 2024, see my webpage, nicholas-chancellor.me for updates

 $^{^{2}}$ Most of these papers follow an author order convention where the first author made the largest contribution in terms of work performed, and the last author supervised the work.

- [16] Energetic perspective on rapid quenches in quantum annealing
 A. Callison, M. Festenstein, J. Chen, L. Nita, V. Kendon, N. Chancellor Physical Review X Quantum
 2, 010338 (2021).
- [17] Quantum Computing for Quantum Tunnelling
 S. Abel, N. Chancellor, M. Spannowsky Physical Review D 103, 016008 (2021).
- [18] Fluctuation guided search in quantum annealingN. Chancellor Phys. Rev. A **102**, 062606 (2020). editor's suggestion
- [19] Quantum codes from classical graphical models
 J. Roffe, S. Zohren, D. Horsman, N. Chancellor IEEE Transactions on Information Theory 66 1, 130-146 (2020).
- [20] Finding spin-glass ground states using quantum walks
 A. Callison, N. Chancellor, F. Mintert, V. Kendon New Journal of Physics 21 123022 (2019).
- [21] Practical designs for permutation symmetric problem Hamiltonians on hypercubes
 A. Ben Dodds, V. Kendon, C. S. Adams, N. Chancellor Phys. Rev. A 100 032320 (2019).
- [22] Domain wall encoding of integer variables for quantum annealing and QAOA N. Chancellor Quantum Sci. Technol. 4 045004 (2019).
- [23] Quantum search with hybrid adiabatic-quantum walk algorithms and realistic noise
 J. G. Morley, N. Chancellor, S. Bose, V. Kendon Physical Review A 99 022339 (2019).
- [24] Protecting quantum memories using coherent parity check codes
 J. Roffe, D. Headley, N. Chancellor, D. Horsman, V. Kendon Quantum Sci. Technol. 3 035010 (2018).
- [25] Circuit design for multi-body interactions in superconducting quantum annealing system with applications to a scalable architecture
 N. Chancellor, S. Zohren, P. A. Warburton npj Quantum Information 3, 21 (2017).
- [26] Modernizing Quantum Annealing using Local SearchesN. Chancellor New Journal of Physics 19, 023024 (2017).
- [27] Quantum walk transport properties on graphene structures
 H. Bougroura, H. Aissaoui, N. Chancellor, V. Kendon Phys. Rev. A 94, 062331 (2016).
- [28] A Direct Mapping of Max k-SAT and High Order Parity Checks to a Chimera Graph
 N. Chancellor, S. Zohren, P. A. Warburton, S. C. Benjamin, S. Roberts Sci. Rep. 6, 37107 (2016).
- [29] An Overview of Approaches to Modernize Quantum Annealing Using Local Searches N. Chancellor, ETPCS Proceedings of the 7th International Workshop on Physics and Computation 214, pp. 16-21 (2016).
- [30] Maximum-Entropy Inference with a Programmable Annealer
 N. Chancellor, S. Szoke, W. Vinci, G. Aeppli, P. A. Warburton, Sci. Rep. 6, 22318 (2016).
- [31] Pfaffian-like ground states for bosonic atoms and molecules in 1D optical lattices
 T. Duric, N. Chancellor, P. J. D. Crowley, P. Di Cintio, A. G. Green, Physical Review B 93, 085143 (2016).
- [32] Interaction-induced anomalous quantum Hall state on the honeycomb lattice T. Duric, N. Chancellor, I. F. Herbut, Phys. Rev. B 89, 165123 (2014).
- [33] Quantification and Control of non-Markovian Evolution in Finite Quantum Systems via Feedback
 N. Chancellor, C. Petri, L. Campos Venuti, A. F. J. Levi, S. Haas. Phys. Rev. A 89, 052119 (2014).
- [34] Non-Markovian Equilibration Described by Symmetry Breaking
 N. Chancellor, C. Petri, S. Haas. Phys. Rev. B 87, 184302 (2013).
- [35] Scalable Universal Holonomic Quantum Computing Realized with the Adiabatic Quantum Data Bus

and Potential Implementation Using Superconducting Flux Qubits N. Chancellor and S. Haas. Phys. Rev. A **87**, 042321 (2013).

- [36] Experimental Signature of Programmable Quantum Annealing
 S. Boixo, T. Albash, F. Spedalieri, N. Chancellor, D. A. Lidar. Nature Comm. 4, 3067 (2013).
- [37] Using the J1-J2 Heisenberg Spin Chain as an Adiabatic Quantum Data Bus N. Chancellor and S. Haas. New Journal of Physics. 14, 095025 (2012).
- [38] Propagation of Disturbances in Degenerate Quantum Systems N. Chancellor and S. Haas. Phys. Rev. B **84**, 035130 (2011).
- [39] Local Quenches in Frustrated Quantum Spin Chains: Global Versus Subsystem Equilibration
 M. Diez, N. Chancellor, S. Haas, L. Campos Venuti, P. Zanardi. Phys. Rev. A 82, 032113 (2010).
 Preprints
- [40] Experimental demonstration of improved quantum optimization with linear Ising penalties P. Mirkarimi, D. C. Hoyle, R. Williams, N. Chancellor ar χ iv:2404.05476(2024).
- [41] Quantum optimization with linear Ising penalty functions for customer data science
 P. Mirkarimi, I. Shukla, D. C. Hoyle, R. Williams, N. Chancellor arχiv:2404.05467(2024).
- [42] Load Balancing For High Performance Computing Using Quantum Annealing
 O. Rathore, A. Basden, N. Chancellor, H. Kusumaatmaja arχiv:2403.05278 (2024). submitted to Scientific Reports
- [43] Zeno-effect Computation: Opportunities and ChallengesJ. Berwald, N. Chancellor, R. Dridi arχiv:2311.08432 (2023).
- [44] Grover Speedup from Many Forms of the Zeno Effect
 J. Berwald, N. Chancellor, R. Dridi arχiv:2305.11146 (2023). submitted to Quantum
- [45] Suppressing unwanted fluctuations in QAOA and approximate quantum annealing
 T. Anwar Atif, C. Potts, D. Haycraft, R. Dridi, N. Chancellor arχiv:2212.00515 (2022).
- [46] Inclusive learning for quantum computing: supporting the aims of quantum literacy using the puzzle game Quantum Odyssey
 L. Nita, N. Chancellor, L. Mazzoli Smith, H. Cramman, G. Dost arχiv:2106.07077 (2021). submitted to Journal of Research in Science Teaching
- [47] Toward a standardized methodology for constructing quantum computing use cases N. Chancellor, R. Cumming, T. Thomas $ar\chi iv: 2006.05846$ (2020).
- [48] Decoding quantum error correction with Ising model hardware
 J. Roffe, S. Zohren, D. Horsman, and N. Chancellor arχiv:1903.10254 (2019).
- [49] Embedding quadratization gadgets on Chimera and Pegasus graphs N. Dattani, N. Chancellor ar χ iv:1901.07676 (2019).
- [50] Pegasus: The second connectivity graph for large-scale quantum annealing hardware N. Dattani, S. Szalay, N. Chancellor ar χ iv:1901.07636 (2019).
- [51] Experimental Freezing of mid-Evolution Fluctuations with a Programmable Annealer N. Chancellor, G. Aeppli, P. A. Warburton, arχiv:1605.07549 (2016).