Curriculum Vitae – Dr Charles Hill

Name	Charles David HILL
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Date of Birth	29th March, 1977
Place of Birth	Sydney, Australia
Nationality	Australia / UK

Professional History

2019 – 2021	Lecturer and Technical Lead, IBM Quantum Network Hub at the University of Melbourne
2011 - 2019	Postdoctoral researcher at University of Melbourne (Australia) as part of the Centre for Quantum Computation and Communication Technology
2008 - 2010	Postdoctoral researcher at University of Melbourne (Australia) as part of the Centre for Quantum Computer Technology (CQCT)
2006 - 2007	Postdoctoral researcher at University of Liverpool (UK)
2002 – 2006	PhD at University of Queensland (Brisbane, Australia).
	Thesis title: *"Gates, Algorithms, and Error Correction for the Kane Quantum Computer"* under Hsi-Sheng Goan and Gerard Milburn.
2000 – 2002	Computer programmer for Aspect Computing, primarily developing the Hansard Production System (HPS) at Australian Parliament House, Canberra.
1996 -- 1999	Bachelor of Science (First Class Honours in Physics) at Australian National University (Canberra, Australia)
1983 – 1995	Schooling in Australia and Austria (TER 99.45)

Research History

Dr. Charles Hill is a lecturer in quantum computing and quantum information at the University of Melbourne, Australia. He completed his PhD at the University of Queensland, supervised by Hsi-Sheng Goan and Gerard Milburn in 2006, modelling quantum gates and algorithms on the Kane architecture. He then worked on weak measurement and feedback with Jason Ralph at the University of Liverpool, looking at ways of relating feedback to physical quantum systems, before returning to Australia in 2008, to work with Professor Lloyd Hollenberg in the Centre for Quantum Computation and Communication Technology (CQC2T). He contributed to the scale up solid state quantum computation, in particular phosphorus in silicon based architectures, adiabatic quantum computation, quantum error correction, quantum control, tensor network techniques for the simulation of quantum algorithms, and the development and demonstration of non-Markovian tomography, the demonstration of large entangled quantum states and the development of quantum algorithms. Dr Hill now works in a critical technical role as part of the University of Melbourne's IBM Quantum Network Hub intiative. Dr Hill has an h-index of 24 (Google Scholar, 2021) with over 2,000 citations of his work.

Teaching and Lecturing

2018-2021, developing and teaching the masters level course *Introduction to Quantum Computing course*, PHYC90045/MULT90063.

2020-21, developing and teaching (with responsibility for mathematics and physics component - approximately 50%) the undergraduate course, *Elements of Quantum Computing,* PHYC20016.

2021, development of masters' course, *Quantum Software Fundamentals,* COMP90084

2017-2019, heavily involved in implementing the *Quantum User Interface* (QUI)

1996-2007, various tutoring and demonstrating; lecturing incl. 1st year thermodynamics (PHYC20002), 3rd year quantum mechanics (PHYC30018).

Leadership and Service

2018-2021, Establishment and Administering of IBM Quantum Hub at the University of Melbourne

2020-2021, Affiliate of Melbourne Centre for Data Science

2020-2021, Academic Disciplinary Committee for physics

2008-2021, Organisation of quantum paper reading group

2006-2021, Review for international journals and conferences in quantum information/computation

2019-2021, Organiser of IBM Quantum Seminars at the University of Melbourne

2019-2021, Founder and administrator Melbourne Quantum network

Supervision of Research Students

2020-2021, cosupervision/supervision of *21 research students* from physics, mathematics and CIS.

2006-2020, heavily involved in the supervision of over 20 successful masters and PhD students, including assisting in projects from external institutions (including UNSW, ANU, Delft)

Current Research Grants

2021, USAF-NRO Million-dollar quantum accelerator, *Modi, Hill - $100k*

2021-24, ARC Discovery Project, "Out-manoeuvring correlated noise in quantum computers", *Modi, Hill - $390k*

2020-23, Ford Alliance Project, NISQ algorithms for traffic/route optimization problems, *Hollenberg, Hill, Ghosh – $280k*

2021, Hybrid HPC-quantum computing for last-mile resupply optimisation AQTED,
Hollenberg, Hill, Usman, Myers, Smith-Miles – $50k

Internationally Recognised Patents

Hill, CD, Hollenberg, LCL, Fuechsle, M, Hile, SJ, House, MG, Peretz, E, Rogge, S & Simmons, MY 2016, 'Apparatus and method for quantum processing', US Patent App. 14/931,768

Hill, CD, Hollenberg, LCL, Simmons, MY, Peretz, E, Rogge, S, Fuechsle, M & Hile, SJ 2016, 'Apparatus and method for quantum processing', US Patent App. 14/931,738

Publications

1. Heredge, J., Hill, C., Hollenberg, L. & Sevior, M. Quantum Support Vector Machines for Continuum Suppression in B Meson Decays. *arXiv Prepr. arXiv2103.12257* (2021).

2. Mooney, G. J., White, G. A. L., Hill, C. D. & Hollenberg, L. C. L. Whole-device entanglement in a 65-qubit superconducting quantum computer. *arXiv Prepr. arXiv2102.11521* (2021).

3. Mooney, G. J., White, G. A. L., Hill, C. D. & Hollenberg, L. C. L. Generation and verification of 27-qubit Greenberger-Horne-Zeilinger states in a superconducting quantum computer. *arXiv Prepr. arXiv2101.08946* (2021).

4. Laucht, A. *et al.* Roadmap on quantum nanotechnologies. *Nanotechnology* **32**, 162003 (2021).

5. Mooney, G. J., Hill, C. D. & Hollenberg, L. C. L. Cost-optimal single-qubit gate synthesis in the Clifford hierarchy. *Quantum* **5**, 396 (2021).

6. White, G. A. L., Hill, C. D. & Hollenberg, L. C. L. Performance Optimization for Drift-Robust Fidelity Improvement of Two-Qubit Gates. *Phys. Rev. Appl.* **15**, 14023 (2021).

7. White, G. A. L., Hill, C. D., Pollock, F. A., Hollenberg, L. C. L. & Modi, K. Demonstration of non-Markovian process characterisation and control on a quantum processor. *Nat. Commun.* **11**, 1–10 (2020).

8. Vallury, H. J., Jones, M. A., Hill, C. D. & Hollenberg, L. C. L. Quantum computed moments correction to variational estimates. *Quantum* **4**, 373 (2020).

9. White, G. A. L., Hill, C. D., Pollock, F. A., Hollenberg, L. C. L. & Modi, K. Experimental non-Markovian process characterisation and control on a quantum processor. *arXiv Prepr. arXiv2004.14018* (2020).

10. Usman, M., Wong, Y. Z., Hill, C. D. & Hollenberg, L. C. L. Framework for atomic-level characterisation of quantum computer arrays by machine learning. *npj Comput. Mater.* **6**, 1–8 (2020).

11. Mooney, G. J., Tonetto, S. U. Y., Hill, C. D. & Hollenberg, L. C. L. Mapping np-hard problems to restricted adiabatic quantum architectures. *arXiv Prepr. arXiv1911.00249* (2019).

12. Mooney, G. J., Hill, C. D. & Hollenberg, L. C. L. Entanglement in a 20-qubit superconducting quantum computer. *Sci. Rep.* **9**, 1–8 (2019).

13. Fuechsle, M. *et al.* Apparatus and method for quantum processing. (2019).

14. Dang, A., Hill, C. D. & Hollenberg, L. C. L. Optimising matrix product state simulations of Shor's algorithm. *Quantum* **3**, 116 (2019).

15. Usman, M. *et al.* Measurements and atomistic theory of electron g-factor anisotropy for phosphorus donors in strained silicon. *Phys. Rev. B* **98**, 35432 (2018).

16. Broome, M. A. *et al.* Two-electron spin correlations in precision placed donors in silicon. *Nat. Commun.* **9**, 1–7 (2018).

17. Usman, M., Hill, C., Hollenberg, L. & others. Design and control of phosphorous donor qubits in strained silicon environments. in *APS March Meeting Abstracts* **2017**, A28--007 (2017).

18. Wang, D. S., Hill, C. D. & Hollenberg, L. C. L. Simulations of Shor's algorithm using matrix product states. *Quantum Inf. Process.* **16**, 1–13 (2017).

19. Agundez, R. R., Hill, C. D., Hollenberg, L. C. L., Rogge, S. & Blaauboer, M. Superadiabatic quantum state transfer in spin chains. *Phys. Rev. A* **95**, 12317 (2017).

20. Nguyen, T., Hill, C. D., Hollenberg, L. C. L. & James, M. R. Fan-out estimation in spin-based quantum computer scale-up. *Sci. Rep.* **7**, 1–11 (2017).

21. Woolfe, K. J., Hill, C. D. & Hollenberg, L. C. L. Scaling and efficient classical simulation of the quantum Fourier transform. *Quantum Inf. & Comput.* **17**, 1–14 (2017).

22. Perunicic, V. S., Hill, C. D., Hall, L. T. & Hollenberg, L. C. L. A quantum spin-probe molecular microscope. *Nat. Commun.* **7**, 1–10 (2016).

23. Nguyen, T., Hill, C. D., Hollenberg, L. C. L. & James, M. R. Surface code continuous quantum error correction using feedback. in *2015 54th IEEE Conference on Decision and Control (CDC)* 7101–7106 (2015).

24. Usman, M. *et al.* Strain and electric field control of hyperfine interactions for donor spin qubits in silicon. *Phys. Rev. B* **91**, 245209 (2015).

25. Hill, C. D. *et al.* A surface code quantum computer in silicon. *Sci. Adv.* **1**, e1500707 (2015).

26. Kalra, R., Laucht, A., Hill, C. D. & Morello, A. Robust two-qubit gates for donors in silicon controlled by hyperfine interactions. *Phys. Rev. X* **4**, 21044 (2014).

27. Perunicic, V. S., Hall, L. T., Simpson, D. A., Hill, C. D. & Hollenberg, L. C. L. Towards single-molecule NMR detection and spectroscopy using single spins in diamond. *Phys. Rev. B* **89**, 54432 (2014).

28. Hill, C. D., Fowler, A. G., Wang, D. S. & Hollenberg, L. C. L. Fault-tolerant quantum error correction code conversion. *Quantum Inf. & Comput.* **13**, 439–451 (2013).

29. Perunicic, V. S., Hall, L. T., Simpson, D. A., Hill, C. D. & Hollenberg, L. C. L. Single molecule NMR detection and spectroscopy using single spins in diamond. *arXiv Prepr. arXiv1307.8220* (2013).

30. McGuinness, L. P. *et al.* Ambient nanoscale sensing with single spins using quantum decoherence. *New J. Phys.* **15**, 73042 (2013).

31. Makin, M. I., Cole, J. H., Hill, C. D. & Greentree, A. D. Spin guides and spin splitters: Waveguide analogies in one-dimensional spin chains. *Phys. Rev. Lett.* **108**, 17207 (2012).

32. Hill, C. D., Greentree, A. D. & Hollenberg, L. C. L. Parallel interaction-free measurement using spatial adiabatic passage. *New J. Phys.* **13**, 125002 (2011).

33. Ralph, J. F., Jacobs, K. & Hill, C. D. Frequency tracking and parameter estimation for robust quantum state estimation. *Phys. Rev. A* **84**, 52119 (2011).

34. Hill, C. D., Fowler, A. G., Wang, D. S. & Hollenberg, L. C. L. Fault-tolerant quantum error correction code conversion. *arXiv Prepr. arXiv1112.2417* (2011).

35. Fowler, A. G. *et al.* Surface code quantum communication. *Phys. Rev. Lett.* **104**, 180503 (2010).

36. Hill, C. D., Flitney, A. P. & Menicucci, N. C. A competitive game whose maximal Nash-equilibrium payoff requires quantum resources for its achievement. *Phys. Lett. A* **374**, 3619–3624 (2010).

37. Hall, L. T., Hill, C. D., Cole, J. H. & Hollenberg, L. C. L. Ultrasensitive diamond magnetometry using optimal dynamic decoupling. *Phys. Rev. B* **82**, 45208 (2010).

38. Hall, L. T. *et al.* Monitoring ion-channel function in real time through quantum decoherence. *Proc. Natl. Acad. Sci.* **107**, 18777–18782 (2010).

39. Makin, M. I. *et al.* Time evolution of Gaussian pulses in the one-dimensional Jaynes-Cummings-Hubbard Hamiltonian. in *ACOLS ACOFT 09 Conference: Proceedings of the Australasian Conference on Optics, Lasers and Spectroscopy, and Australian Conference on Optical Fibre Technology in association with the International Workshop on Dissipative Solitons 2009* 302 (2009).

40. Hall, L. T., Cole, J. H., Hill, C. D. & Hollenberg, L. C. L. Sensing of fluctuating nanoscale magnetic fields using nitrogen-vacancy centers in diamond. *Phys. Rev. Lett.* **103**, 220802 (2009).

41. Makin, M. I., Cole, J. H., Hill, C. D., Greentree, A. D. & Hollenberg, L. C. L. Time evolution of the one-dimensional Jaynes-Cummings-Hubbard Hamiltonian. *Phys. Rev. A* **80**, 43842 (2009).

42. Wang, D. S., Fowler, A. G., Hill, C. D. & Hollenberg, L. C. L. Graphical algorithms and threshold error rates for the 2d colour code. *arXiv Prepr. arXiv0907.1708* (2009).

43. Hill, C. & Ralph, J. Weak measurement and control of entanglement generation. *Phys. Rev. A* **77**, 14305 (2008).

44. Hill, C., Goodwin, D. & Ralph, J. Control of two qubit systems with Hamiltonian feedback. in *Quantum Information and Computation VI* **6976**, 69760C (2008).

45. Hill, C. & Ralph, J. Deterministic purity evolution via weak measurement for bipartite quantum systems in *PROCEEDINGS-SPIE THE INTERNATIONAL SOCIETY FOR OPTICAL ENGINEERING* **6603**, 6603 (2007).

46. Hill, C. D. Robust controlled-NOT gates from almost any interaction. *Phys. Rev. Lett.* **98**, 180501 (2007).

47. Testolin, M. J., Hill, C. D., Wellard, C. J. & Hollenberg, L. C. L. Robust controlled-NOT gate in the presence of large fabrication-induced variations of the exchange interaction strength. *Phys. Rev. A* **76**, 12302 (2007).

48. Griffith, E. J., Hill, C. D., Ralph, J. F., Wiseman, H. M. & Jacobs, K. Rapid state purification in a superconducting charge qubit. *Phys. Rev. B* **75**, 14511 (2007).

49. Hill, C. & Ralph, J. Weak measurement and rapid state reduction in entangled bipartite quantum systems. *New J. Phys.* **9**, 151 (2007).

50. Griffith, E. J., Hill, C. D., Ralph, J. F., Wiseman, H. M. & Jacobs, K. Rapid-state purification protocols for a Cooper pair box. *Phys. Rev. B* **75**, 14511 (2007).

51. Hill, C. & Ralph, J. Deterministic purity evolution via weak measurement for bipartite quantum systems. in *Noise and Fluctuations in Photonics, Quantum Optics, and Communications* **6603**, 66030S (2007).

52. Hill, C. D. Algorithms, gates and error correction for the Kane quantum computer. (2006).

53. Ralph, J. F., Griffith, E. J., Hill, C. D. & Clark, T. D. Rapid purification of a solid state charge qubit. in *Quantum Information and Computation IV* **6244**, 624403 (2006).

54. Hill, C. D. *et al.* Fast donor-based electron spin quantum computing. in *Micro-and Nanotechnology: Materials, Processes, Packaging, and Systems II* **5650**, 44–54 (2005).

55. Hill, C. D. *et al.* Fast solid-state donor electron spin quantum computing. UQ PhD Thesis, (2005).

56. Hill, C. D. *et al.* Global control and fast solid-state donor electron spin quantum computing. *Phys. Rev. B* **72**, 45350 (2005).

57. Hill, C. Remarks by Charles Hill. in *Proceedings of the ASIL Annual Meeting* **98**, 329–331 (2004).

58. Fowler, A. G., Hill, C. D. & Hollenberg, L. C. L. Quantum-error correction on linear-nearest-neighbor qubit arrays. *Phys. Rev. A* **69**, 42314 (2004).

59. Goan, H.-S. & Hill, C. Fast non-adiabatic gates for the Kane quantum computer in the presence of dephasing. in *APS March Meeting Abstracts* **2004**, R1--260 (2004).

60. Hill, C. D. & Goan, H.-S. Comment on "Grover search with pairs of trapped ions". *Phys. Rev. A* **69**, 56301 (2004).

61. Hill, C. D. & Goan, H.-S. Fast Non-Adiabatic Gates and Quantum Algorithms on the Kane Quantum Computer in the Presence of Dephasing. in *AIP Conference Proceedings* **734**, 167–170 (2004).

62. Hill, C. D. & Goan, H.-S. Gates for the Kane quantum computer in the presence of dephasing. *Phys. Rev. A* **70**, 22310 (2004).

63. Hill, C. D. & Goan, H.-S. Fast nonadiabatic two-qubit gates for the Kane quantum computer. *Phys. Rev. A* **68**, 12321 (2003).

Recent Conference Presentations

Dr Hill regularly presents research at national and international conferences on quantum information and computation, including some notable presentations in the previous few years: "Architecture for a 2D surface code quantum computer based on exchange-coupled donor qubits in silicon", Silicon Quantum Electronics Workshop, Sydney, Australia. "Matrix Product State simulations of quantum circuits", at ThinkQ Conference, IBM, New York, USA, "Simulating Quantum Algorithms with Matrix Product States", Australian Institute of Physics Annual Conference, Sydney, Australia. "Matrix Product State Simulations of Quantum Circuits", 13th Conference on the Theory of Quantum Computation, Communication and Cryptography. "A Phosphorus in Silicon Adiabatic Quantum Computer", 3rd Conference and Workshop on Spin-Based Quantum Information Processing, Sydney, "Architectures and quantum control for silicon-based quantum computing", Quantum Science Symposium, Cambridge, UK. "Quantum Information Processing", an invited presentation, to COMMAD, Sydney, Australia, "Quantum control and technology based on spins in semiconductors", 4th China-Australia Quantum-Control Workshop, Hefei, China, and "Scaling Phosphorus in Silicon Quantum Computing", Silicon Quantum Electronics Workshop, Delft, Netherlands. In addition, Dr. Hill regularly represents the theory group at the annual US Army Quantum Computing review conference, and has invited presentations at universities, such as Cambridge, Monash and Liverpool Universities.

Recent Industry Engagement

2017-21 Technical lead in the establishment and staff of the IBM Quantum Network Hub at the University of Melbourne.

2018 consulted for the University of Melbourne on Quantum Error Correction Code software IP negotiations with Google.

2019-21 on-going industry engagement as part of the Quantum Hub

2020- Ford Alliance project looking at quantum algorithms relevant to Ford Motor company.

2021- Army research project looking at quantum algorithms for last-mile resupply.

2021- Consultancy for Archer Materials

Student Feedback

2018

PHYC90045, Introduction to Quantum Computing, 2018	Mean
1. Overall, the experience gained through this subject has been intellectually stimulating	**4.92**
2. Overall, this subject has been well co-ordinated	**4.50**
3. Overall, this subject has been supported by useful learning resources	**4.58**
4. Overall, this subject has been well-taught	**4.75**
5. Focusing on my own learning in this subject, I have been required to work at a high standard	**4.58**
6. Focusing on my own learning in this subject, I found the assessment tasks useful in guiding my study	**4.64**
7. Focusing on my own learning in this subject, I received valuable feedback on my progress	**4.17**
8. Focusing on my own learning in this subject, I learnt new ideas, approaches and/or skills	**4.75**
9. Focusing on my own learning in this subject, I learnt to apply knowledge to practice	**4.58**
10. Focusing on my own learning in this subject, I have been part of a group committed to learning	**4.17**

2019

PHYC90045, Introduction to Quantum Computing, 2019		Mean
1. Overall, the experience gained through this subject has been intellectually stimulating	12	4.58
2. Overall, this subject has been well co-ordinated	12	4.25
3. Overall, this subject has been supported by useful learning resources	12	4.25
4. Overall, this subject has been well-taught	12	4.50
5. Focusing on my own learning in this subject, I have been required to work at a high standard	12	4.75
6. Focusing on my own learning in this subject, I found the assessment tasks useful in guiding my study	12	4.58

7. Focusing on my own learning in this subject, I received valuable feedback on my progress	12	3.83
8. Focusing on my own learning in this subject, I learnt new ideas, approaches and/or skills	12	4.58
9. Focusing on my own learning in this subject, I learnt to apply knowledge to practice	12	4.33
10. Focusing on my own learning in this subject, I have been part of a group committed to learning	12	4.00

2020

PHYC90045, Introduction to Quantum Computing, 2020	
The study materials and resources provided were helpful in my learning.	3.67
The teaching activities provided me with good opportunities for interaction and collaboration with other students.	3.92
I interacted with the teaching staff in ways that helped me to learn.	4.42
The assessment requirements were clear to me.	3.75
Overall, my study workload was manageable.	3.92
Overall, I was satisfied with my learning experience in Semester One.	3.58