Mile Gu, Nanyang Assistant Professor

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RESEARCH HIGHLIGHTS:

High impact research, including 5 in various Nature/Science suite journals, 9 in Physical Review Letters and Physical Review X, and various highlights in Nature, Science (6 separate occasions).

- Proved that quantum mechanics can build simpler model of reality. Published in ***Nature Comm. 3, 762, 1133–1135***. Invited guest article in ***New Scientist, Issue 2995***. Experimentally demonstrated in ***Science Advances Vol. 3, no. 2, e160130***.

- Demonstration of quantum discord is a physical resource. Published in ***Nature Physics 8, 671–675***, highlighted in ***Nature Photonics 6, 724–725,*** *and awarded* ***Research Highlight of the Month,*** *January 2013 at the National University of Singapore.*

- Demonstration of emergent laws – macroscopic laws that cannot be derived from microscopic principles. Published in *Physica D. 238, 835-839* and highlighted in ***Nature 459, 332-334*** and ***New Scientist 2676.***

- Jointly proposed continuous variable cluster state computation – a new model of quantum computation that has ***400+ combined citations***, starting a new research direction. See ***Phys. Rev. A 79, 062318*** *and* ***Phys. Rev. Lett., 97(11):11050.***

- Jointly proved that methods of General Relativity can be applied to find optimal quantum algorithms. Published in ***Science, 311(5764):1133–1135*** and highlighted in ***Science Perspectives*** *on the same issue.*

Overall output of 52 publications, 2109 cites with H-index of 19 (as measured by Google Scholar on 24/6/2018).

PROFESSIONAL HISTORY:

02/2016 - Present	**Nanyang Assistant Professor,** Complexity Institute and the School of Physical and Mathematical Sciences, Nanyang Technological University, Singapore.
02/2016 - Present	**Research Assistant Professor,** Centre for Quantum Technologies, National University of Singapore
11/2013 - 01/2016	**Assistant Professor,** Center for Quantum Information, Institute for Interdisciplinary Information Sciences, Tsinghua University, China.
10/2009 - 11/2013	**Research Fellow,** Centre for Quantum Technologies, National University of Singapore

EDUCATION:

02/2005 - 11/2009	**PhD** (Quantum Complexity, Emergence and Measurement by Computation), University of Queensland, Brisbane, Australia. *Supervisors: Michael Nielsen, Tim Ralph, Andrew Doherty*

02/2003 - 02/2005 **Masters in Physics** (Quantum Optics) *1st Class Honors*, Auckland University, New Zealand, *Supervisors: Scott Parkins, Howard Carmichael*

02/2001 - 12/2002 **Bachelor of Science** (*Triple Major*, in Physics, Computer Science and Applied Mathematics) Auckland University, Auckland, New Zealand.

SELECTED AWARDS:

2016 ***National Research Foundation Fellow –*** *National Research Foundation, Singapore*
2013 ***China Young 1000 Talent -*** *Central Organizing Committee of China*
2013 ***Research Highlight of the Month (January)*** *– National University of Singapore*
2006-2009 ***Australian Postgraduate Award*** *- University of Queensland*
2005 ***Distinguished Scholar Award****, University of Queensland*

SELECTED GRANTS:

2018-2021 ***Thermodynamics of Computational Structure in Complex Information Processing –*** *The John*
330,000 USD *Templeton Foundation,* ***Role:*** *Director*

2018-2021 ***Designing practical quantum memories for tracking time with absolute precision***
150,000 SGD *(Ministry of Education, Singapore)* ***Role:*** *Principal -Investigator*

2017-2018 ***Observer-dependent complexity: The quantum-classical divergence over 'what is complex?'***
50,600 USD *(Foundational Questions Institute, United States)* ***Role:*** *Principal Investigator (jointly with Andrew Garner)*

2016-2021 ***Enhancing the Efficiency of Modelling and Simulating Complex Systems via Quantum Mechanics***
2,606,400 SGD *(National Research Foundation, Singapore)* ***Role:*** *Principal Investigator*

2016-2018 ***Quantum Physics and Complexity*** *(Australian Research Council, Australia)* ***Role:*** Co-Investigator
540,800 AUD

2015-2017 ***Occam's Quantum Mechanical Razor: Can Quantum theory admit the Simplest Understanding of***
246,100 USD ***Reality?*** *(The John Templeton Foundation)* ***Role:*** *Principal Investigator*

2014 ***Using Discord to Preserve the Benefits of Entanglement-Breaking Noise***
200,000 CNY *(National Natural Science Foundation of China)* ***Role:*** *Principal Investigator*

2014-2015 ***1000 Talent Award Research Funds*** *(Organization Department of the CPC Central Committee)*
2,000,000 CNY ***Role:*** *Principal Investigator*

SELECTED MEDIA AND PRESS:

- "Zen and the art of quantum complexity." ***New Scientist,*** *2995, (2014)*
- "Quantum optics: Discord in the Ranks." ***Nature Photonics: News and Views*** 6.11 (2012):
- "Why nature is not the sum of its parts." ***New Scientist*** 200.2676 (2008)
- "Computation: The edge of reductionism." ***Nature: News and Views*** 459.7245 332-334 (2009)
- "Implementing a Quantum Computation by Free Fall." ***Science Perspectives,*** 311.5764 (2006)

Scientific Presentations and Outreach:

- **50+ Invited Talks and Lectures** at various conferences, workshops and academic institutions (e.g. the Australian Institute of Physics Congress; Para Limes conference on Causality-Reality, CQIC Colloquium University of Toronto; Clarendon Laboratories Seminar Series Oxford)
- I wrote several ***Invited articles*** for popular media, including *New Scientist, the Foundational Questions Institute (FQXi)*, University of Queensland Infinity Magazine, *and Book Reviews* for Physics Today

Professional Services:

- **Organizers of multiple workshops,** e.g. the Workshop on interdisciplinary frontiers of quantum and complexity science 2017 (qcomplexity.quantumlah.org), Nanyang Quantum 2017 (quantumcomplexity.org/nyquantum2017).
- **PhD Enrolment Panelist** for the Institute for Information Sciences, Tsinghua University 2013 – 2015 and School of Physical and Mathematical Sciences 2018 -
- **Referee** for many international journals (Physics Rev Lett, Nature Photonics, Phys. Rev. Lett.. Phys Rev X. New Journal of Physics, Nature Partner Journal: Quantum information), 2008 – present

Publications:

Refereed

NOTES:

Citation counts are based on Google Scholar as of 1/3/2018

1. **Kang-Da Wu, Zhibo Hou, Yuan-Yuan Zhao, Guo-Yong Xiang, Chuan-Feng Li, Guang-Can Guo, Jiajun Ma, Qiong-Yi He, Jayne Thompson, Mile Gu.** Experimental cyclic inter-conversion between Coherence and Quantum Correlations. arXiv:1710.01738. Accepted for publication in Phys. Rev. Lett.

2. **Jayne Thompson, Andrew Garner, John Mahoney, James Crutchfield, Vlatko Vedral, Mile Gu.** Causal Asymmetry in a Quantum World, Physical Review X 8, 3, 031013, Featured in New Scientist, ***Top 5% of all publications by Altmetric***

3. **Felix Binder, Jayne Thompson, Mile Gu,** A practical, unitary simulator for non-Markovian complex processes. Phys. Rev. Lett. 120, 240502, 2018

4. **Adán Cabello, Mile Gu, Otfried Gühne, Zhen-Peng Xu.** Optimal Classical Simulation of State-Independent Quantum Contextuality. *Physical Review Letters 120, 130401, 2018*

5. **Thomas Elliott and Mile Gu.** Occam's Vorpal Quantum Razor: Memory Reduction When Simulating Continuous-Time Stochastic Processes with Quantum Devices. *Nature Partner Journal: Quantum Information, 4, 18, 2018.* ***Top 5% of all publications by Altmetric***

6. **Jayne, Thompson, Kavan Modi, Vlatko Vedral, and Mile Gu.** Quantum plug n'play: modular computation in the quantum regime." *New Journal of*

Physics 20, no. 1, 013004, 2018

7. **Xiao Yuan, Hongyi Zhou, Mile Gu, and Xiongfeng Ma.** Unification of nonclassicality measures in interferometry, Phys. Rev. A 97, 012331, 2018

8. **Suen Whei Yeap, Jayne Thompson, Andrew Garner, Vlatko Vedral, Mile Gu,** The classical-quantum divergence of complexity in the Ising spin chain, *Quantum 1, 25, 2017*

9. **Andrew Garner, Qing Liu, Jayne Thompson, Vlatko Vedral, and Mile Gu.** "Provably unbounded memory advantage in stochastic simulation using quantum mechanics." New Journal of Physics, 19, 103009 2017

10. **Andrew Garner, Jayne Thompson, Vlatko Vedral, and Mile Gu.** "Thermodynamics of complexity and pattern manipulation." Physical Review E 95, 4. 042140, 2017

11. **Matthew Palsson, Mile Gu, Joseph Ho, Howard Wiseman, Geoff Pryde** Experimental quantum processing enhancement in modelling stochastic processes, Science Advances Vol. 3, no. 2, e160130 , 2017, ***Top 5% of all publications by Altmetric***

12. **Jayne Thompson, Andrew Garner, Vlatko Vedral, Mile Gu***, Using quantum theory to reduce the complexity of input-output processes, *Nature partner journal: Quantum Information*, 3, 1, 2017 ***Top 5% of all publications by Altmetric***

13. **Mark Bradshaw, Syed M. Assad, Jing Yan Haw, Si-Hui Tan, Ping Koy Lam, Mile Gu*,** Overarching framework between Gaussian quantum discord and Gaussian quantum illumination, *Phys. Rev. A 95, 022333, 2017*

14. **Jiajun Ma, Benjamin Yadin, Davide Girolami, Vlatko Vedral, and Mile Gu*** Converting Coherence to Quantum Correlations. *Physical review letters 116, 16 160407, 2016* ***100+ Citations.***

15. **Cabello, Adán, Mile Gu, Otfried Gühne, Jan-Åke Larsson, and Karoline Wiesner.** Thermodynamical cost of some interpretations of quantum theory. *Physical Review A 94, 05212, 2016* (Featured in Physics Today, DOI:10.1063/PT.5.7331)

16. **Nana Liu, Jayne Thompson, Christian Weedbrook, Seth Lloyd, Vlatko Vedral, Mile Gu, and Kavan Modi.** *Power of one qumode for quantum computation.* Physical Review A 93, 5 052304, 2016

17. **Hugo Cable, Mile Gu, Kavan Modi,** Power of one bit of quantum information in quantum metrology, Physical Review A 93, 4, 040304, 2016

18. **B. Yadin, J. Ma, D. Girolami, M. Gu, V. Vedral,** Quantum processes which do not use coherence, *Physical Review X 6, 041028, 2016* ***60+ Citations.***

19. **Christian Weedbook, Stefano Pirandola, Jayne Thompson, Vlatko Vedral, and Mile Gu***. How discord underlies the noise resilience of quantum illumination. *New Journal of Physics 18, 4, 043027, 2016* ***15+ Citations.***

20. **Su, Hong-Yi, Changliang Ren, Jing-Ling Chen, Fu-Lin Zhang, Chunfeng Wu, Zhen-Peng Xu, Mile Gu, Sai Vinjanampathy, and Leong Chuan Kwek.** Beating the Clauser-Horne-Shimony-Holt and the Svetlichny games with optimal states. *Physical Review A 93, 022110, 2016:*

21. **Xiao Yuan, Syed M. Assad, Jayne Thompson, Jing Yan Haw, Vlatko Vedral, Timothy C. Ralph, Ping Koy Lam, Christian Weedbrook and Mile Gu*** *Replicating the benefits of closed timelike curves without breaking causality".* Nature Partner Journal*: Quantum Information 1, 15007, 2015 (Named Research Highlight in* Nature Physics 12, 20*).* ***Top 1% of all publications by Altmetric***

22. **F. Franchini, J. Cui, L. Amico, H. Fan, M.Gu, V. Korepin, L. Kwek, V. Vedral.** *Local convertibility and edge states in quantum many body systems,* Phys. Rev. X *4, 041028* 2014

23. **M. de Almeida, M Gu, A Fedrizzi, M.A. Broome, T.C. Ralph, A. White.** *Entanglement-free certification of entangling gates,* Physical Review A 89, 042323, 2014

24. **S.Sridharan, M. McEneaney, M.Gu, M. James.** *A reduced complexity min-plus solution method to the optimal control of closed quantum systems*. Applied Mathematics & Optimization, 1-42, 2014

25. **Tan, Ryan, Daniel R. Terno, Jayne Thompson, Vlatko Vedral, and Mile Gu** *Towards Quantifying Complexity with Quantum Mechanics*. EPJ Plus 129, 9, 1-12, 2014

26. **X. Cai, C. Weedbrook, Z. Su, M. Chen, M. Gu, M. Zhu, L. Li, N. Liu, C. Lu, J. Pan.** *Experimental Quantum Computing to Solve Systems of Linear Equations* Phys. Rev. Lett, 2013, ***50+ Citations.***

27. **J. Cui, L. Amico, H. Fan, M. Gu, A. Hamma, V. Vedral.** *Local characterization of 1d topologically ordered states.* Phys. Rev. B. 88, 125117, 2013

28. **M. Gu, H. Chrzanowski, S. Assad, T. Symul, K. Modi, T. C.Ralph, V.Vedral, P.K. Lam***. *Observing the operational significance of discord consumption,* Nature Physics 8, 671–675, 2012. ***170+ Citations*** *(Featured on Nature Photonics, and New Scientist)*

29. **M. Gu, K. Wiesner, E. Rieper, V. Vedral.** *Quantum Mechanics can reduce the complexity of classical models.* Nature Communications 3, 762, 2012 *(Featured in New Scientist)* ***25+ Citations.***

30. **J. Cui, M. Gu, L.C. Kwek, M.F. Santos, H. Fan, V. Vedral.** *Quantum phases with differing computational power.* Nature Communications 3, 812, 2012. ***50+ Citations.***

31. **K. Modi, M. Gu.** *Coherent and Incoherent Contents of Correlations,* International Journal of Modern Physics B, 27 , 2012.

32. **M. Gu, A. Perales.*** *Encoding Universal Computation in the Ground States of Ising Lattices,* Phys. Rev. E. 86, 1:011116, 2012.

33. **K. Wiesner, M Gu, E. Rieper, V. Vedral.** *Information-theoretic bound on the energy cost of stochastic simulation,* Proceedings of the Royal Society A, 468, 4058–4066, 2012

COVER IMAGE FOR THE PAPER 'OCCAM'S QUANTUM RAZOR'. PUBLISHED IN NAT. COMM 3, 762

34. **M. Gu, C.Weedbrook, P. van Loock, and N.Menicucci, Timothy C. Ralph.** *Computing with continuous variable clusters.* Phys. Rev. A, 79:063218, 2009. ***150+ Citations***

35. **S. Sridharan, M. Gu, M.R. James, W. M. McEneaney.** *Reduced-complexity numerical method for optimal gate synthesis.* Phys. Rev. A, 82:042319, 2010.

36. **S. Sridharan, M. Gu, M.R. James, W. M. McEneaney** *An efficient computational method for the optimal control of higher dimensional quantum systems.* 2010 49th IEEE Conference on Decision and Control (CDC), 2010.

37. **M. Gu, C.Weedbrook, A. Perales, and M. Nielsen.*** *More really is different.* Physica D. 238, 835-839, 2009. (Featured in Nature 459, 332-334 and New Scientist 2676)

38. **P. van Loock, C.Weedbrook, and M. Gu.** *Building Gaussian cluster states by linear optics.* Phys. Rev. A, 76(3):032321, 2007. ***110+ Citations.***

39. **S. Sridharan, M. Gu, and M. James.** *Gate complexity using dynamic programming.* Phys. Rev. A, 78(5):052327, 2008.

40. **M. Gu, A. Doherty, and M. Nielsen.** *Quantum control via geometry: An explicit example.* Phys. Rev. A, 78(3):032327, 2008.

41. **NC Menicucci, P Van Loock, M Gu, C Weedbrook, TC Ralph, MA Nielsen.** *Universal quantum computation with continuous-variable cluster states.* Physical review letters 97 (11), 110501. ***350+ Citations.***

42. **M. Nielsen, M. Dowling, M. Gu, and A. Doherty.** *Quantum computation as geometry.* Science, 311(5764):1133–1135, 2006. ***100+ Citations.***

43. **M. Nielsen, M. Dowling, M. Gu, and A. Doherty.** *Optimal control, geometry, and quantum computing.* Phys. Rev. A, 311(5764):062323, 2006. ***60+ Citations***

44. **M. Gu, and A. S Parkins, and H. J. Carmichael.*** *Entangled-state cycles from conditional quantum evolution.* Phys. Rev. A. 93:043813, 2006.

45. **Stephen Clark, Amy Peng, Mile Gu, and Scott Parkins.** *Unconditional Preparation of Entanglement between Atoms in Cascaded Optical Cavities.* Phys.Rev.Lett. 91:177901, 2003. ***150+ Citations***

Book Chapters

46. **Mile Gu, Stefano Pirandola,** *Discord, quantum knowledge and private communications,* Lectures on General Quantum Correlations and their Applications, *231-239, 2017*

Conference Proceedings

47. **Helen Chrzanowski, Mile Gu, Syed Assad, Thomas Symul, Kavan Modi, Timothy Ralph, Vlatko Vedral, Ping Koy Lam.** *Discord as a quantum resource for bi-partite communication.* AIP Conference Proceedings 1633, 116-118, 2014

48. **Sara Hosseini, Saleh Rahimi-Keshari, Jing Yan Haw, Syed Assad, Helen Chrzanowski, Jiri Janousek, Thomas Symul, Timothy Ralph, Ping Koy Lam, Mile Gu, Kavan Modi, Vlatko Vedral,** *Experimental Verification of Quantum Discord and Operational Significance of Discord Consumption, CLEO:*

QELS_Fundamental Science, FTh3A. 6, 2014

49. **Thomas Symul, Helen Chrzanowski, Syed Assad, Ping Koy Lam, Timothy Ralph, Mile Gu, Kavan. Modi, and Vlatko. Vedral.** *Operational Significance of Discord Consumption*, International Quantum Electronics Conference, paper IB_6_6, 2013

50. **Syed Assad, Helen Chrzanowski, Thomas Symul, Ping Koy Lam, Tim Ralph, Mile Gu, Vlatko Vedral,** *A functional interpretation of continuous variable quantum discord,* Quantum Electronics Conference & Lasers and Electro-Optics (CLEO/IQEC/PACIFIC RIM), 2011

51. **Sara Hosseini, Saleh Rahimi-Keshari, Jing Yan Haw, Syed M Assad, Helen M Chrzanowski, Jiri Janousek, Thomas Symul, Timothy C Ralph, Ping Koy Lam, Mile Gu, Kavan Modi, Vlatko Vedral,** *Experimental verification of quantum discord in continuous-variable states and operational significance of discord consumption*, 2014 Conference on Lasers and Electro-Optics (CLEO) - Laser Science to Photonic Applications, pp. 1-2, 2014

52. **Srinivas Sridharan, Mile Gu, Matthew R James, William M McEneaney,** *An efficient computational method for the optimal control of higher dimensional quantum systems*, Decision and Control (CDC), 2010 49th IEEE Conference on, 2996-3001, 2010

Other Creative Works

53. **Gu, Mile.** *Computing with Quantum Cats: From Colossus to Qubits: Review* Physics Today 68, 1 46-47. 2015

54. **Gu, Mile, and Vlatko Vedral.** *Zen and the art of quantum complexity*. New Scientist 224, 2995, 28-29. 2014