Yuxiang Yang

Personal Data

Name in Chinese:	杨宇翔
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Research Interest

My research is at the interface between quantum information, quantum metrology, and quantum computation. I am interested in how tools from quantum information and metrology can be used to optimize the design of near-term quantum computers, and, in the longer term, I work towards the realization of quantum artificial intelligence.

Employment

2021.07 - Present	*Assistant Professor,* Department of Computer Science, The University of Hong Kong.
2018.10 - 2021.07	*Postdoctoral Scholar,* Institute for Theoretical Physics, ETH Zürich. Supervisor: Renato Renner.
2018.08 - 09	*Senior Research Assistant,* Department of Computer Science, The University of Hong Kong.

Education

2015-2018	PhD in Computer Science, Department of Computer Science, The University of Hong Kong. Supervisor: Giulio Chiribella.
2013-2015	PhD student in Physics, Institute for Interdisciplinary Information Sciences, Tsinghua University. Supervisor: Giulio Chiribella.
2009-2013	Bachelor in Physics (with distinction), Department of Physics, Tsinghua University.

Visiting Positions

2018.11 - 2021.07	QICI Visiting Fellow, Department of Computer Science, The University of Hong Kong.
2017.05 - 06	Academic Guest, Institute for Theoretical Physics, ETH Zürich.
2015.01	Visiting Student, the Quantum Computation Laboratory, QCIS, the University of Technology Sydney.
2013.05	Visiting Student, Perimeter Institute for Theoretical Physics.

Honors

2023	Excellent Young Scientist Hong Kong & Macau (港澳优青) National Natural Science Foundation of China (NSFC);
2021	Emerging Talents (JPA), selected by *Editorial board, Journal of Physics A (IOP)*;
2017	Microsoft Research Asia Fellowship, awarded by *Microsoft Research Asia*; 10 awardees out of 107 applicants from 38 leading universities in the Asia-Pacific region.
2016	Hong Kong and China Gas Company Limited Postgraduate Scholarship, awarded by *Hong Kong and China Gas Company*.
2015	Computer Science Postgraduate Scholarship, awarded by *Department of Computer Science, The University of Hong Kong*.
2015 - 2018	Postgraduate Scholarship, awarded by *The University of Hong Kong*.
2014	The Jiang Nan-Xiang Prize (蒋南翔奖学金), a top honor of *Tsinghua University*.
2013	Excellent Graduate of *Tsinghua University*.
2013	Chi-Sun YEH Prize for undergraduate research (叶启孙奖). The top honor for graduates of *the Department of Physics, Tsinghua University*.
2012	Prize for Academic Excellence, awarded by *Tsinghua University*.
2011	Prize for Academic Progress, awarded by *Tsinghua University*.
2008	First prize for Provincial Final (Beijing), 25th China Physics Olympiads, *Chinese Physical Society*.

Funding

3. General Research Fund (GRF) project no. 17303923,
   "Optimised Quantum Metrology with Noisy and Intermediate-Scale Quantum (NISQ) Techniques."
   Research Grants Council (RGC) of Hong Kong SAR,
   2024.01 - 2026.12.
   Role: PI.
   Amount: HK$ 792,532

2. Early Career Scheme (ECS) project no. 27310822,
   "Multiparameter non-Markovian quantum metrology."
   Research Grants Council (RGC) of Hong Kong SAR,
   2023.01 - 2025.12.
   Role: PI.
   Amount: HK$ 738,110

1. General project no. 2022A1515010340,
   "Quantum resource lifting: quantum computing and metrology under the resource theory framework."
   Guangdong Basic and Applied Basic Research Foundation, China
   2022.01 - 2024.12.
   Role: PI.
   Amount: CNY 100,000

Publications

Underline for the corresponding author. See Google Scholar for the up-to-date list.

Featured.

34. Yunlong Xiao, **Yuxiang Yang**, Ximing Wang, Qing Liu, Mile Gu.
"Quantum Uncertainty Principles for Measurements with Interventions."
Phys. Rev. Lett. **130,** 240201 (2023).

33. Peng Yin, Xiaobin Zhao, **Yuxiang Yang**, Yu Guo, Wen-Hao Zhang, Gong-Chu Li, Yong-Jian Han, Bi-Heng Liu, Jin-Shi Xu, Giulio Chiribella, Geng Chen, Chuan-Feng Li, and Guang-Can Guo.
"Experimental super-Heisenberg quantum metrology with indefinite gate order."
Nat. Phys. (2023).

32. Qiushi Liu, Zihao Hu, Haidong Yuan and **Yuxiang Yang**.
"Optimal strategies of quantum metrology with a strict hierarchy."
Phys. Rev. Lett. **130,** 070803 (2023).

31. Anian Altherr and **Yuxiang Yang**.
"Quantum Metrology for Non-Markovian Processes."
Phys. Rev. Lett. **127,** 060501 (2021).

30. Giulio Chiribella, **Yuxiang Yang**, and Renato Renner.
"Fundamental Energy Requirement of Reversible Quantum Operations."
Phys. Rev. X **11,** 021014 (2021).

29. **Yuxiang Yang** and Masahito Hayashi.
"Representation matching for delegated quantum computing."
PRX Quantum **2,** 020327 (2021).

28. **Yuxiang Yang**, Renato Renner, and Giulio Chiribella.
"Optimal Universal Programming of Unitary Gates."
Phys. Rev. Lett. **125,** 210501 (2020). (Editors' Suggestion)

27. Xiaobin Zhao, **Yuxiang Yang**, and Giulio Chiribella.
"Quantum metrology with indefinite causal order."
Phys. Rev. Lett. **124,** 190503 (2020).

26. **Yuxiang Yang**.
"Memory effects in quantum metrology."
Phys. Rev. Lett. **123,** 110501 (2019).

25. **Yuxiang Yang**, Giulio Chiribella, and Masahito Hayashi.
"Attaining the ultimate precision limit in quantum state estimation."
Commun. Math. Phys. **368(1)**, 223-293 (2019).

24. **Yuxiang Yang**, Giulio Chiribella, and Masahito Hayashi.
"Quantum stopwatch: how to store time in a quantum memory"
Proc. R. Soc. A **474:** 20170773 (2018).
Featured by New Scientist and PHYS.ORG.

23. **Yuxiang Yang**, Ge Bai, Giulio Chiribella, and Masahito Hayashi.
"Compression for quantum population coding."
IEEE Transactions on Information Theory **64**, 4766-4783 (2018).
QIP2018 oral presentation.

22. **Yuxiang Yang**, Giulio Chiribella, and Masahito Hayashi.
"Optimal compression for identically prepared qubit states."
Phys. Rev. Lett. **117,** 090502 (2016).
QIP2017 oral presentation.

21. **Yuxiang Yang**, Giulio Chiribella and Daniel Ebler.
"Efficient quantum compression for ensembles of identically prepared mixed states."
Phys. Rev. Lett. **116,** 080501 (2016).

20. Giulio Chiribella, **Yuxiang Yang** and Cupjin Huang.
"Universal Superreplication of Unitary Gates."
Phys. Rev. Lett. **114,** 120504 (2015).

19. Giulio Chiribella, **Yuxiang Yang** and Andrew Chi-Chih Yao.
"Quantum replication at the Heisenberg limit."
Nat. Comm. **4,** 2915 (2013).
Introduces the phenomenon of quantum super-replication, whereby quantum clock states are cloned at a quadratic rate with a vanishing error. See a Nature Physics "News and View" by John Calsamiglla for a popular commentary on this work.

Topical reviews.

18. Jun Suzuki, **Yuxiang Yang**, and Masahito Hayashi.
"Quantum state estimation with nuisance parameters"
J. Phys. A: Math. Theor. **53**,453001 (2020).

Journal articles.

17. Masahito Hayashi and **Yuxiang Yang**.
"Efficient algorithms for quantum information bottleneck."
Quantum **7,** 936 (2023).

16. **Yuxiang Yang**, Yin Mo, Joseph Renes, Giulio Chiribella, and Mischa Woods.
"Optimal universal quantum error correction via bounded reference frames."
Phys. Rev. Research **4 (2),** 023107 (2022).

15. Fereshte Mozafari, Giovanni De Micheli, and **Yuxiang Yang**.
"Efficient deterministic preparation of quantum states using decision diagrams."

Phys. Rev. A **106 (2)**, 022617 (2022).

14. **Yuxiang Yang**, Giulio Chiribella, and Masahito Hayashi.
"Communication Cost of Quantum Processes."
IEEE J. Sel. Areas Inf. Theory **1(2)**, 387-400 (2020).

13. Christian Bertoni, **Yuxiang Yang**, and Joseph M. Renes.
"Entropic time-energy uncertainty relations: An algebraic approach."
New J. Phys. **22,** 083010 (2020).

12. Ge Bai, **Yuxiang Yang**, and Giulio Chiribella.
"Quantum compression of tensor network states."
New J. Phys. **22,** 043015 (2020).

11. **Yuxiang Yang**, Giulio Chiribella, and Qinheping Hu.
"Units of rotational information."
New J. Phys. **19,** 123003 (2017).

10. Giulio Chiribella and **Yuxiang Yang**.
"Optimal quantum operations at zero energy cost."
Phys. Rev. A **96,** 022327 (2017).

9. Giulio Chiribella and **Yuxiang Yang**.
"Quantum superreplication of states and gates."
Front. Phys. **11(3),** 110304 (2016).

8. **Yuxiang Yang**, Giulio Chiribella and Gerardo Adesso.
"Certifying quantumness: Benchmarks for the optimal processing of generalized coherent and squeezed states."
Phys. Rev. A **90,** 042319 (2014).

7. Giulio Chiribella and **Yuxiang Yang**.
"Optimal asymptotic cloning machines."
New J. Phys. **16,** 063005 (2014). (**IOPselect**)

6. Xiao-Xiao Zhang, **Yu-Xiang Yang** and Xiang-Bin Wang.
"Lossy quantum-optical metrology with squeezed states."
Phys. Rev. A **88,** 013838 (2013).

Peer-reviewed Conference Proceedings.

5. Fereshte Mozafari, **Yuxiang Yang**, and Giovanni De Micheli.
"Efficient Preparation of Cyclic Quantum States."
2022 27th Asia and South Pacific Design Automation Conference (ASP-DAC), 460-465 (2022).

4. **Yuxiang Yang**, Giulio Chiribella, and Masahito Hayashi.
"Compression for Qubit Clocks."
2018 IEEE International Symposium on Information Theory (ISIT), 2476-2480 (2018).

3. **Yuxiang Yang**, Ge Bai, Giulio Chiribella, and Masahito Hayashi.
"Compression for quantum population coding."
2017 IEEE International Symposium on Information Theory (ISIT), 1973-1977 (2017).

2. **Yuxiang Yang** and Giulio Chiribella.
"Is Global Asymptotic Cloning State Estimation?"
Proceedings of 8th Conference on the Theory of Quantum Computation, Communication and Cryptography.
Leibniz International Proceedings in Informatics **22,** 220-234 (2013).

1. Giulio Chiribella and **Yuxiang Yang**.
"Confusability graphs for symmetric sets of quantum states."
Proceedings of the XXIX International Colloquium on Group-Theoretical Methods in Physics.
Nankai Series in Pure, Applied Mathematics and Theoretical Physics **11,** 251-256 (2013).

Preprints

Yuxiang Yang and Renato Renner.
"Ultimate limit on time signal generation."
Preprint at arXiv:2004.07857.

Yuxiang Yang, Lennart Baumgäertner, Ralph Silva, and Renato Renner.
"Accuracy enhancing protocols for quantum clocks."
Preprint at arXiv:1905.09707.

Giulio Chiribella, Rui Chao and **Yuxiang Yang**.
"Superactivation of quantum gyroscopes."
Preprint at arXiv:1411:3439.

Presentations

Invited Talks

20. "Fully optimized quantum metrology: ultimate precision and optimal protocols."
Quantum Characterization, Verification, and Validation (QCVV), Shanghai, China, 2023.

19. "Designing the most accurate quantum sensors in the NISQ era: optimization methods and implementation."
Expository Quantum Lecture Series (EQuaLS2022), Malaysia 2022 .

18. "Ultimate limit on time signal generation."
Time in Quantum Theory: from mathematical foundations to operational characterization, Zürich, Switzerland (online), 2021.

17. "Quantum Metrology."
AI PROSPECTS · YOUTH ACADEMIC FORUM, Beijing, China, 2019.

16. "Units of rotational information."
2nd Hong Kong-Shenzhen Quantum Information Workshop, Shenzhen, China, 2018.

Select contributed Talks at International Conferences

16. "Optimal Universal Programming of Unitary Gates."
24th Annual Conference on Quantum Information Processing (QIP 21) (online) Münich, Germany, 2021.

15. "Covariant Quantum Error Correcting Codes via Reference Frames."
Beyond IID 8 (online) Stanford, United States, 2020.

14. "Covariant Quantum Error Correcting Codes via Reference Frames."
Quantum 2020 (online).

13. "Memory effects in quantum metrology."
Workshop on Agency at the Interface of Quantum and Complexity Science, Singapore, 2020.

12. "The energy requirement of quantum processors."
23th Annual Conference on Quantum Information Processing (QIP 20), Shenzhen, China, 2020.

11. "Accuracy enhancing protocols for quantum clocks."
19th Asian Quantum Information Science Conference (AQIS), Seoul, Korea, 2019.

10. "Compression of identically prepared qudit states."
21st Annual Conference on Quantum Information Processing (QIP 18), Delft, Netherlands, 2018.

9. “Compression for quantum population coding.”
Hong Kong Workshop on Quantum Information and Foundations, Hong Kong, 2018.

8. “Compression of identically prepared qudit states.”
Beyond I.I.D. in Information Theory, NUS, Singapore, 2017.

7. “Compression for quantum population coding.”
IEEE International Symposium on Information Theory (ISIT), Aachen, Germany, 2017.

6. “Universal Superreplication and Compression of Unitary Gates.”
15th Asian Quantum Information Science Conference (AQIS), Seoul, Korea, 2015.

5. “Superactivation of quantum gyroscopes.”
15th Asian Quantum Information Science Conference (AQIS), Seoul, Korea, 2015.

4. “Quantum replication and the ultimate limits of quantum metrology.”
Workshop on Quantum Metrology, Interaction, & Causal Structure, Beijing, China, 2014.

3. “Is global asymptotic cloning state estimation?”
8th Conference on the Theory of Quantum Computation, Communication and Cryptography (TQC), Guelph, Canada, 2013.

2. “Quantum replication at the Heisenberg limit.”
International conference on Hot Topics in Physical Informatics, Changsha, China, 2013.

Student Supervision and Teaching

Student supervision

PhD students

3. Zishen Li, "Quantum metrology beyond fixed causal orders."
   2023.09 - 2027 (tentative).
   Role: Supervisor.
2. Manwen Liao, "Machine-learning-based quantum error mitigation."
   2022.09 - 2026 (tentative).
   Role: Supervisor.
1. Qiushi Liu, "Non-Markovian quantum metrology."
   2021.09 - 2025 (tentative).
   Role: Supervisor.

Master theses and student research projects

5. Fereshte Mozafari, "Efficient preparation of cyclic and hypergraph states."
   Visiting PhD student from EPF Lausanne, 2021.03-07.
   Role: Host.
4. Anian Altherr, "Quantum metrology for non-Markovian processes."
   Master thesis, ETH Zürich, 2021.
   Role: Supervisor.
3. Qiushi Liu, "Heisenberg scaling quantum metrology from scrambling."
   Master thesis, ETH Zürich, 2020.
   Role: Supervisor.
2. Anian Altherr, "Quantum stopwatches from quantum clocks."
   Semester project, ETH Zürich, 2019.
   Role: Supervisor.
1. Christian Bertoni, "Algebraic approach to entropic uncertainty relations."
   Semester project, ETH Zürich, 2019.
   Role: Co-supervisor (with Joseph M. Renes).

Teaching

COMP 3366	Lecturer *Quantum Algorithms and Computer Architecture,* Department of Computer Science, The University of Hong Kong.
COMP 2121 (2C)	Lecturer *Discrete Mathematics,* Department of Computer Science, The University of Hong Kong.
CCST 9077	co-Lecturer *The Quantum Revolution: From Secret Codes to Black Holes,* The University of Hong Kong.

Professional service

Committee service in international conferences

- Program Committee,
  Beyond IID in Information Theory 10,
  Sep 26- Sep 30, 2022 (online).

- Program Committee,
  Beyond IID in Information Theory 9,
  Sep 27- Oct 1, 2021 (online).

- Program Committee,
  Hong Kong - Shenzhen Workshop on Quantum Information Science,
  May 21-24 2018, SUSTech, Shenzhen, China.

Grants reviewed for:

- the Austrian Science Fund (FWF)
- Banff International Research Station (BIRS)

Journals reviewed for:

- Communications in Mathematical Physics (publisher: Springer)
- Physical Review Letters (publisher: APS)
- Physical Review X (publisher: APS)
- PRX Quantum (publisher: APS)
- Physical Review A (publisher: APS)
- npj Quantum Information (publisher: Nature Research)
- Scientific Reports (publisher: Nature)
- Quantum (online open-access journal)
- New Journal of Physics (publisher: IOP Science)
- Europhysics Letters (publisher: IOP Science)
- IEEE Transactions on Information Theory (publisher: IEEE Communications Society)
- Quantum Information Processing (publisher: Springer)
- Quantum Information and Computation (publisher: Rinton Press)

Conferences reviewed for:

- Annual on Quantum Information Processing (QIP)
- Beyond IID in information theory (BIID)
- Conference on the Theory of Quantum Computation, Communication and Cryptography (TQC)
- IEEE International Symposium on Information Theory (ISIT)

- The international conference on Quantum Communication, Measurement and Computing (QCMC).

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