Jianxin Chen

Curriculum Vitae

Summary/Objective

Accomplished leader with two decades of experience in quantum computing, spearheading an interdisciplinary team comprising experts in computer science, physics, and electrical engineering. My leadership is marked by a strong commitment to building a fault-tolerant quantum computer system, aiming to harness the full potential of quantum computing for practical applications. Renowned for pioneering innovative solutions and strategies, I have successfully navigated the complexities of this cutting-edge field to make significant strides towards realizing the practical advantages of quantum technology.

Education

2005–2010 M.S. and Ph.D. in Computer Science, Tsinghua University, Beijing, P.R.China, Combined Masters/PhD program.

2001–2005 B.Eng. in Computer Science, Tsinghua University, Beijing, P.R.China, Graduate School admission exam exempted.

Experience

2018.8–present Head of Quantum Computer Systems, Quantum Laboratory, DAMO Academy, Alibaba Group USA, Bellevue, WA, United States.

2017.9–2018.8 Quantum Scientist, Alibaba Quantum Laboratory, Alibaba Group, Hangzhou, Zhejiang, P.R.China.

2014.10–2017.8 Hartree Fellow, University of Maryland, College Park, MD 20740, United States.

2010.10–2014.8 Postdoctoral Fellow, Joint Appointment at the Institute for Quantum Computing, University of Waterloo, and the University of Guelph, Waterloo, ON N2L 3G1/N1G 2W1, Canada.

Research Interests

Quantum Computer Architecture, Quantum Error Correction, Quantum Hardware-Software Co-Design, Quantum Instruction Set.

Selected Projects

The overarching aim of the quantum computing community is to develop a fault-tolerant quantum computer, a crucial and currently the most viable route to realizing practical quantum advantages. In my capacity, I lead a team dedicated to designing and implementing an advanced system, fortified with state-of-the-art quantum error correction firmware, which is vital for performing substantial computational tasks. We have achieved several significant milestones in pursuit of this objective. The following are key recent accomplishments:.

- The First Scalable Real-time Decoding Firmware: Fast classical processing is essential for most quantum fault-tolerance architectures. We pioneered the slicing-window parallel decoding approach that provides fast classical processing for the surface code through parallelism. This scheme significantly accelerates classical processing by leveraging parallelism, effectively overcoming a major bottleneck in fault-tolerant quantum computing for the first time. Our work has garnered widespread recognition within the scientific community. It has been featured in presentations at leading institutions like MIT and Duke. Additionally, our team has been honored with an invitation to speak at the QEC23, a prominent conference on quantum error correction.
- The First Prototype System for Fault-Tolerant Quantum Computing: We developed a prototype system, a trailblazer in supporting fault-tolerant quantum computing. Its design ingeniously addresses scalability, ensuring that control overhead does not increase with the number of qubits. Integrated with our modular decoding firmware, this system demonstrates unparalleled scalability potential in the realm of fault-tolerant quantum computing. We have established and rigorously tested a comprehensive end-to-end system using our in-house fluxonium quantum chip. This work has been recognized and published in the ACM Transactions on Quantum Computing.
- Enhancing Performance through Quantum Instruction Set Refinement: The intersection of quantum hardware and software is epitomized in the quantum instruction set, a pivotal factor in system performance. We have been at the vanguard of designing and implementing quantum instruction sets that optimize system efficiency. Our PMW scheme has gained widespread adoption in the industry. Notably, our SQiSW scheme has been published in the prestigious Physical Review Letters and then adopted by Google. Furthermore, our recent AshN scheme has been accepted by ASPLOS24 and is currently being implemented by several leading hardware teams.
- Efficient Classical Simulation: We have significantly improved the performance of classical simulation. At present, classical simulation serves as a crucial tool for benchmarking large quantum chips and influencing their design iterations. Our algorithm, tested across a range of random quantum circuits, has realized an acceleration surpassing 100,000 times the original simulation cost estimates. This significant advancement has been acknowledged in a publication in Nature Computational Science and further highlighted in a "News and Views" article titled "Boosting Simulation of Quantum Computers". Our simulation technique has been widely embraced in both academic and industrial sectors.
- YAQCS Initiative: Motivated by the growing importance of quantum computing, the YAQCS (Yet Another Quantum Computing Suite) project is dedicated to establishing a robust foundational infrastructure. Our primary aim is to facilitate the development and ongoing enhancement of digital quantum computers. We are committed to providing a platform that fosters innovation and plays a vital role in the progressive evolution of quantum computing technology. At present, we are collaborating with multiple partners on this initiative.

Press and Media Coverage

2022 An alternative superconducting qubit achieves high performance for quantum computing, Phys.org, [link], Jul. 27.

2018 Google, Alibaba Spar Over Timeline for 'Quantum Supremacy', Wired.com, [link], May. 19.

2012 Pipes unclogged: The Quantum Physics Way!, Optics & Photonics Focus , [link], Feb. 22.

2011 Defeating Bedlam, Physics 4, s189, [link], Dec. 15.

Publication and Preprints

* denotes that I am either the first author or the corresponding author.
Certain publications are authored in alphabetical order.
Publications highlighted in blue indicate works of significant impact.

Journal Papers: Refereed

*62 Fang Zhang, Xing Zhu, Rui Chao, Cupjin Huang, Linghang Kong, Guoyang Chen, Dawei Ding, Haishan Feng, Yihuai Gao, Xiaotong Ni, Liwei Qiu, Zhe Wei, Yueming Yang, Yang Zhao, Yaoyun Shi, Weifeng Zhang, Peng Zhou, Jianxin Chen, A Classical Architecture For Digital Quantum Computers. ACM Transactions on Quantum Computing, to appear in.

*61 Jianxin Chen, Dawei Ding, Cupjin Huang and Qi Ye, Compiling arbitrary single-qubit gates via the phase shifts of microwave pulses. Physical Review Research, 5 (2), L022031

*60 Cupjin Huang, Tenghui Wang, Feng Wu, Dawei Ding, Qi Ye, Linghang Kong, Fang Zhang, Xiaotong Ni, Zhijun Song, Yaoyun Shi, Hui-Hai Zhao, Chunqing Deng, Jianxin Chen, Quantum instruction set design for performance. Physical Review Letters, 130, 070601

*59 Xinyu Tan, Fang Zhang, Rui Chao, Yaoyun Shi, Jianxin Chen , Scalable surface code decoders with parallelization in time. Physical Review X Quantum, to appear in.

*58 Xiaotong Ni, Hui-Hai Zhao, Lei Wang, Feng Wu, Jianxin Chen, Integrating quantum processor device and control optimization in a gradient-based framework. npj Quantum Information, 8(106)

*57 Jianxin Chen, Dawei Ding, Cupjin Huang, Randomized benchmarking beyond groups. Physical Review X Quantum, 3, 030320

*56 Jianxin Chen, Dawei Ding, Cupjin Huang, Linghang Kong, Linear cross entropy benchmarking with clifford circuits, Physical Review A, to appear in.

55 Feng Bao, Hao Deng, Dawei Ding, Ran Gao, Xun Gao, Cupjin Huang, Xun Jiang, Hsiang-Sheng Ku, Zhisheng Li, Xizheng Ma, Xiaotong Ni, Jin Qin, Zhijun Song, Hantao Sun, Chengchun Tang, Tenghui Wang, Feng Wu, Tian Xia, Wenlong Yu, Fang Zhang, Gengyan Zhang, Xiaohang Zhang, Jingwei Zhou, Xing Zhu, Yaoyun Shi, Jianxin Chen, Hui-Hai Zhao and Chunqing Deng, Fluxonium: an alternative qubit platform for high-fidelity operations. Physical Review Letters (Editors' Suggestion), 129, 010502

*54 Cupjin Huang, Fang Zhang, Michael Newman, Xiaotong Ni, Dawei Ding, Junjie Cai, Xun Gao, Tenghui Wang, Feng Wu, Gengyan Zhang, Hsiang-Sheng Ku, Zhengxiong Tian, Junyin Wu, Haihong Xu, Huanjun Yu, Bo Yuan, Mario Szegedy, Yaoyun Shi, Hui-Hai Zhao, Chunqing Deng and Jianxin Chen, Efficient Parallelization of Tensor Network Contractions for Simulating Quantum Computation. Nature Computational Science, 1(9), 578-587.

*53 Jianxin Chen, Muxin Han, Youning Li, Bei Zeng and Jie Zhou,Local density matrices of many-body states in the constant weight subspaces. Reports on Mathematical Physics , 83(3), 273-292, 2019.

*52 Jianxin Chen, Zhengfeng Ji, David Kribs, Bei Zeng and Fang Zhang, Minimum entangling power is close to its maximum. Journal of Physics A: Mathematical and Theoretical, 52(21), 215302,2019.

51 Shilin Huang, Jianxin Chen, Youning Li and Bei Zeng, Quantum state tomography for generic pure states. Science China Physics, Mechanics & Astronomy, 61 (11), 1-7, 2018.

50 Sirui Lu, Shilin Huang, Keren Li, Jun Li, Jianxin Chen, Dawei Lu, Zhengfeng Ji, Yi Shen, Duanlu Zhou and Bei Zeng, Separability-entanglement classifier via machine learning. Physical Review A, 98 (1), 012315, 2018.

*49 Jianxin Chen, Andrew M. Childs, Shih-Han Hung , Quantum algorithm for multivariate polynomial interpolation. Proceedings of the Royal Society A, 474 (2209), 20170480, 2018.

48 Tao Xin, Dawei Lu, Joel Klassen, Nengkun Yu, Zhengfeng Ji, Jianxin Chen, Xian Ma, Guilu Long, Bei Zeng and Raymond Laflamme ,Quantum state tomography via reduced density matrices. Physical Review Letters, 118 (2), 020401, 2017.

*47 Jianxin Chen, Cheng Guo, Zhengfeng Ji, Yiu-Tung Poon, Nengkun Yu, Bei Zeng and Jie Zhou, Joint product numerical range and geometry of reduced density matrices. Science China Physics, Mechanics & Astronomy, 60 (2), 1-9, 2017.

*46 Jianxin Chen, Shane Grogan, Nathaniel Johnston, Chi-Kwong Li and Sarah Plosker, Quantifying the coherence of pure quantum states. Physical Review A,94(4), 042313, 2016.

45 Dawei Lu, Tao Xin, Nengkun Yu, Zhengfeng Ji, Jianxin Chen, Guilu Long, Jonathan Baugh, Xinhua Peng, Bei Zeng, Raymond Laflamme,Tomography is necessary for universal entanglement detection with single-copy observables. Physical Review Letters, 116(23), 230501, 2016.

44 Xian Ma, Tyler Jackson, Hui Zhou, Jianxin Chen, Dawei Lu, Michael D Mazurek, Kent AG Fisher, Xinhua Peng, David Kribs, Kevin J Resch, Zhengfeng Ji, Bei Zeng, Raymond Laflamme,Pure-state tomography with the expectation value of Pauli operators. Physical Review A, 93(3), 032140, 2016.

*43 Jianxin Chen, Zhengfeng Ji, Nengkun Yu, Bei Zeng,Detecting consistency of overlapping quantum marginals by separability. Physical Review A, 93(3), 032105, 2016.

*42 Jianxin Chen, Zhengfeng Ji, Chi-Kwong Li, Yiu-Tung Poon, Yi Shen, Nengkun Yu, Bei Zeng, Duanlu Zhou, Discontinuity of maximum entropy inference and quantum phase transitions. New Journal of Physics, 17(8), 083019, 2015.

*41 Jianxin Chen and Nathaniel Johnston, The minimum size of unextendible product bases in the bipartite case (and some multipartite cases). Communications in Mathematical Physics, 333 (1), 351-365, 2015.

40 Lin Chen, Jianxin Chen, Dragomir Ž Doković, Bei Zeng,Universal subspaces for local unitary groups of fermionic systems. Communications in Mathematical Physics, 333 (2), 541-563, 2015.

*39 Jianxin Chen, Zhengfeng Ji, David Kribs, Norbert Lütkenhaus and Bei Zeng, Symmetric extension of two-qubit states. Physical Review A, 90 (3), 032318, 2014.

*38 Jianxin Chen, Lin Chen and Bei Zeng, Unextendible product bases for Fermionic systems. Journal of Mathematical Physics, 55 (8), 082207,2014.

*37 Jianxin Chen, Hillary Dawkins, Zhengfeng Ji, Nathaniel Johnston, David Kribs, Frederic Shultz and Bei Zeng, Uniqueness of Quantum States Compatible with Given Measurement Results. Physical Review A, 88:012109, 2013.

*36 Jianxin Chen, Zhengfeng Ji, David Kribs, Zhaohui Wei, and Bei Zeng. Ground-state Spaces of Frustration-free Hamiltonians. Journal of Mathematical Physics, 53:102201, 2012.

*35 Jianxin Chen, Zhengfeng Ji, Bei Zeng, and Duanlu Zhou. From Ground States to Local Hamiltonians. Physical Review A, 86:022339, 2012.

*34 Jianxin Chen, Zhengfeng Ji, Mary Beth Ruskai, Bei Zeng and Duan-Lu Zhou. Comment on Some Results of Erdahl and the Convex Structure of Reduced Density Matrices. Journal of Mathematical Physics. 53(7):072203, 2012.

*33 Jianxin Chen, Zhengfeng Ji, Zhaohui Wei and Bei Zeng. Correlations in Excited States of Local Hamiltonians. Physical Review A (rapid communication), 83:050301R, 2012.

*32 Jianxin Chen, Zhengfeng Ji, Alexander Klyachko, David Kribs, and Bei Zeng. Rank Reduction for Local Consistency Problem. Journal of Mathematical Physics, 53(2):022202, 2012.

31 Cheng Lu, Jianxin Chen, and Runyao Duan. Some Bounds on the Minimum Number of Queries Required for Quantum Channel Perfect Discrimination. Quantum Information and Computation, 12(1&2):0138–0148, 2012.

*30 Jianxin Chen, Toby Cubitt, Aram Harrow, and Graeme Smith. Entanglement can Completely Defeat Quantum Noise. Physical Review Letter (Featured in Physics, Editors' Suggestion), 107:250504, Dec 2011.

*29 Jianxin Chen, Xie Chen, Runyao Duan, Zhengfeng Ji, and Bei Zeng. No-go Theorem for One-way Quantum Computing on Naturally Occurring Two-level Systems. Physical Review A (rapid communication), 83:050301R, 2011.

28 Toby S Cubitt, Jianxin Chen, and Aram W Harrow. Superactivation of the Asymptotic Zero-error Classical Capacity of a Quantum Channel. Information Theory, IEEE Transactions on, 57(12):8114–8126, 2011.

27 Zhengfeng Ji, Jianxin Chen, Zhaohui Wei, and Mingsheng Ying. The LU-LC Conjecture is False. Quantum Information and Computation, 10(1&2), 2010.

*26 Jianxin Chen and Mingsheng Ying. Ancilla-assisted Discrimination of Quantum Gates. Quantum Information and Computation, 10(1&2), 2010.

*25 Jianxin Chen, Runyao Duan, Zhengfeng Ji, Mingsheng Ying, and Jun Yu. Existence of Universal Entangler. Journal of Mathematical Physics, 49:012103, 2008.

24 Mingsheng Ying, Jianxin Chen, Yuan Feng, and Runyao Duan. Commutativity of Quantum Weakest Preconditions. Info. Proc. Lett., 104(4):152–158, 2007.

Journal Papers: Not Refereed

23 Lirong Xia, Jianxin Chen, Xiaotong Zhang. A Solution for Student Interview Problem (in Chinese), Mathematics in Practice and Theory, 37(14):145, 2007.

Conference Papers: Refereed

*22 Jianxin Chen, Dawei Ding, Weiyuan Gong, Cupjin Huang, Qi Ye, One Gate Scheme to Rule Them All: Introducing a Complex Yet Reduced Instruction Set for Quantum Computing. ACM Conference on Architectural Support for Programming Languages and Operating Systems (ASPLOS) 2024, San Diego, United States, April 27- May 1, 2014. to appear in

21 Matthew Amy, Jianxin Chen, Neil J Ross, A finite presentation of CNOT-dihedral operators. 14th International Conference on Quantum Physics and Logic and IQSA Quantum Structures Workshop, Nijmegen, The Netherlands, July 2017.

20 Joel Klassen, Jianxin Chen and Bei Zeng, Universal Entangler for Bosonic and Fermionic Systems. In The 8th Conference on the Theory of Quantum Computation, Communication and Cryptography (TQC), Guelph, ON, Canada, May, 2013.

19 Salman Beigi, Jianxin Chen, Markus Grassl, Zhengfeng Ji, Steven Wang, and Bei Zeng, Symmetry of Codeword Stabilized Quantum Codes. In The 8th Conference on the Theory of Quantum Computation, Communication and Cryptography (TQC), Guelph, ON, Canada, May, 2013.

*18 Jianxin Chen, Toby Cubitt, Aram Harrow, and Graeme Smith.Super-duper-activation of the Zero-error Quantum Capacity.In Information Theory Proceedings (ISIT), 2010 IEEE International Symposium on, Austin, Texas, United States, Jun., 2010.

Workshop Papers: Refereed

*17 Jianxin Chen, and Andreas Winter, Non-Additivity of the Entanglement of Purification (Beyond Reasonable Doubt). in 12th Asian Quantum Information Science Conference, Suzhou, P.R.China, Aug. 2012.

*16 Jianxin Chen, Xie Chen, Runyao Duan, Zhengfeng Ji, Zhaohui Wei and Bei Zeng. On the Solution Space of Quantum 2-SAT Problems. in 14th Workshop on Quantum Information Processing, The Capella, Sentosa Singapore, Jan. 2011.

*15 Jianxin Chen, Toby Cubitt, Aram Harrow, and Graeme Smith.Super-duper-activation of the Zero-error Quantum Capacity. In 13th Workshop on Quantum Information Processing, Zurich, Switzerland, Jan. 2010.

*14 Jianxin Chen, Toby Cubitt, Aram Harrow, and Graeme Smith.Super-duper-activation of the Zero-error Quantum Capacity. In 10th Asian Quantum Information Science Conference, Tokyo, Japan, Aug. 2010.

13 Zhengfeng Ji, Jianxin Chen, Zhaohui Wei, and Mingsheng Ying. The LU-LC Conjecture is False.In The 11th Workshop on Quantum Information Processing, New Delhi, India, Dec. 2007.

Preprint

12 Bujiao Wu, Xiaoyang Wang, Xiao Yuan, Cupjin Huang, Jianxin Chen, Leakage Benchmarking for Universal Gate Sets. arXiv preprint, arXiv:2304.07884

*11 Cupjin Huang, Dawei Ding, Feng Wu, Linghang Kong, Fang Zhang, Xiaotong Ni, Yaoyun Shi, Hui-Hai Zhao and Jianxin Chen, Towards ultra-high fidelity quantum operations: SQiSW gate as a native two-qubit gate. arXiv:2105.06074.

*10 Cupjin Huang, Fang Zhang, Michael Newman, Xiaotong Ni, Dawei Ding, Junjie Cai, Xun Gao, TenghuiWang, Feng Wu, Gengyan Zhang, Hsiang-Sheng Ku, Zhengxiong Tian, Junyin Wu, Haihong Xu, HuanjunYu, Bo Yuan, Mario Szegedy, Yaoyun Shi, Hui-Hai Zhao, Chunqing Deng and Jianxin Chen, Classical simulation of quantum supremacy circuits. arXiv:2005.06787.

*9 Cupjin Huang, Xiaotong Ni, Fang Zhang, Michael Newman, Dawei Ding, Xun Gao, Tenghui Wang, Hui-Hai Zhao, Feng Wu, Gengyan Zhang, Chunqing Deng, Hsiang-Sheng Ku, Jianxin Chen and Yaoyun Shi, Alibaba cloud quantum development platform: Surface code simulations with crosstalk. arXiv:2002.08918.

*8 Cupjin Huang, Mario Szegedy, Fang Zhang, Xun Gao, Jianxin Chen and Yaoyun Shi, Alibaba cloud quantum development platform: Applications to quantum algorithm design. arXiv:1909.02559.

*7 Fang Zhang, Cupjin Huang, Michael Newman, Junjie Cai, Huanjun Yu, Zhengxiong Tian, Bo Yuan, Haihong Xu, Junyin Wu, Xun Gao, Jianxin Chen, Mario Szegedy, Yaoyun Shi, Alibaba cloud quantum development platform: Large-scale classical simulation of quantum circuits. arXiv:1907.11217.

*6 Fang Zhang, Jianxin Chen, Optimizing T gates in Clifford+T circuit as $\frac{\pi}{4}$ rotations around Paulis. arXiv:1903.12456.

*5 Jianxin Chen, Fang Zhang, Cupjin Huang, Michael Newman, Yaoyun Shi, Classical simulation of intermediate-size quantum circuits. arXiv:1805.01450.

4 Xinyao Wu, Jianxin Chen, Multiparty quantum data hiding with enhanced security and remote deletion. arXiv:1804.01982.

*3 Connor Paddock, Jianxin Chen, A Characterization of Antidegradable Qubit Channels. arXiv:1712.03399.

*2 Jianxin Chen, and Andreas Winter, Non-Additivity of the Entanglement of Purification (Beyond Reasonable Doubt). arXiv:1206.1307.

*1 Jianxin Chen, Zhengfeng Ji, Mary Beth Ruskai, Bei Zeng and Duanlu Zhou. Principle of Maximum Entropy and Ground Spaces of Local Hamiltonians. arXiv:1010:2739.

Recent Presentations and Talks

2023 Quantum Instruction Set Design for Superconducting Processors: A Computer Science Perspective, Zhejiang University, Hangzhou, P.R.China, Nov. 15.

2023 A Classical Architecture of Digital Quantum Computers, China National Computer Congress, Shenyang, P.R.China, Oct. 27.
Invited

2023 A Classical Architecture of Digital Quantum Computers, The second CCF Quantum Computation Conference and China Quantum Computation Industry Summit, Hefei, P.R.China, Aug. 19.
Invited

Honors and Awards

2021 DAMO Award, DAMO Academy, Tai-Zhang 2.0, Each iteration of the Taizhang Quantum Circuit Simulator significantly refreshes the world record for quantum circuit simulation.

2021 Senior Member, Institute of Electrical and Electronics Engineers (IEEE).

2020 Innovation Pioneers Award, Alibaba Group.

2017 Hundred-Talent Program (Declined), Chinese Academy of Sciences.

2006 Feitu Scholarship for Scientific Achievements, Tsinghua University.

2006 First Class Award, National Mathematical Modelling Contest for Postgraduates.

2003 Feitu Scholarship for Scientific Achievements, Tsinghua University.

2001 Outstanding Freshman Scholarship in Tsinghua University, Tsinghua University.

2001 Gold Medal in the International Mathematical Olympiad(IMO), Washington DC, United States.

2001 Silver Medal in the Chinese Mathematical Olympiad(CMO), Hong Kong, P.R.China.

2000 First-class Award(full mark), National Mathematical Olympiad, Jiangsu.

2000 First-class Award, National Mathematical Olympiad, Jiangsu.

2000 First-class Award(full mark), Provincial Mathematical Olympiad, Jintan, Jiangsu.

1999 First-class Award, Provincial Mathematical Olympiad for High School, Suzhou, Jiangsu.

Patents

3 granted, 13 pending.

Services

2023 Program Committee Chair, 1st DAMO Quantum Summer School on Quantum Error Correction and Fault-tolerance.

2022 Program Committee Member, IEEE Quantum Week.

2014 Organizing Committee Member, Canadian Summer School on Quantum Information.

2014 Program Committee Member, TQC, QIP.

2013 Organizing Committee Member, TQC.

2010- Reviewer, Phys.Rev.Lett., Phys.Rev.X Quantum, Phys.Rev.X, Nat.Phys.,ACM Transaction on Quantum Computing, IEEE Transaction on Information Theory,etc..

Students and Research Interns

2023- Xinxuan Chen, University of Technology and Science China.

2023- Hongxiang Zhu, University of Technology and Science China.

2022- Kai Zhang, Tsinghua University.

2023- Ziyuan Wang, Tsinghua University.

2022 Yihuai Gao, Tsinghua University, now at Stanford.

2022 Xinyu(Norah) Tan, Tsinghua University, now at MIT.

2021- Qi Ye, Tsinghua University.

2021 Hang Ren, Nankai University, now at UC Berkeley.

References

Available upon request.