Martin Suchara

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RESEARCH AREAS

- Quantum error correction, noise mitigation, and modeling of open quantum systems
- Quantum communication and applications in distributed computing, sensing, and security
- Scalable simulations of quantum communication networks and quantum circuits

EDUCATION

Princeton University, Ph.D. in Computer Science	*2011*
Princeton University, M.A. in Computer Science	*2008*
California Institute of Technology, B.S. with Honor in Computer Science	*2006*

CITIZENSHIP

U.S. Citizen

PROFESSIONAL EXPERIENCE

Argonne National Laboratory – Computational Scientist RD3. Perform research in quantum computing and quantum networking. Help develop strategic plan in quantum information science. *2018–present*

University of Chicago – Scientist and Ph.D. Advisor at the Pritzker School of Molecular Engineering. Advise graduate students and participate in collaborative research projects. *2018–present*

AT&T Labs Research – Principal Inventive Scientist. Developed a new research program in quantum networking and advised management on the role of quantum technologies in telecommunications. *2015–2018*

IBM T. J. Watson Research Center – Postdoctoral Scholar in the Theory of Quantum Computing and Information Group. Developed new quantum error-correcting codes and performed their numeric evaluations on an IBM Blue Gene supercomputer. *2013–2015*

University of California Berkeley – Postdoctoral Scholar at the Berkeley Quantum Information & Computation Center. Took ownership of part of an IARPA funded research project, mentored students, performed technical work, and presented results to program managers. *2011-2013*

PH.D. STUDENTS, POSTDOCTORAL AND RESEARCH ADVISEES

- Dr. Zain Saleem, postdoctoral scholar, 2019 – present
- Dr. Eugene Ching Wang, software developer, 2019 – present
- Kaiwen Gui, Ph.D. candidate, 2019 – present
- Alexander Kolar, undergraduate research aide, 2019 – present

SHORT-TERM VISITORS

- Bradley Pearlman, visiting Ph.D. student from University of Colorado – Boulder, June – August 2019
- Wei Tang, visiting Ph.D. student from Princeton University, June – August 2019
- Teague Tomesh, visiting Ph.D. student from Princeton University, June – August 2019
- Xiaoliang Wu, visiting Ph.D. student from Illinois Institute of Technology, June – August 2019

GRANTS AND CONTRACTS AWARDED

- "Hybrid Quantum-Classical Computing Architectures", January 2019 – December 2020, PI, LDRD, total budget $500k, budget for Argonne $500k.
- "Investigating Quantum Chemistry Circuits with OpenFermion", April 2019 – September 2019, PI, LDRD Advanced Computing Expedition, total budget $37.5k, budget for Argonne $37.5k.
- "A Scalable Toolkit for Noisy-Qubit Simulation", September 2019 – September 2020, Co-PI, LDRD, total budget $240k, budget for Argonne $240k.
- "Quantum Computing for Fusion Energy Materials", September 2019 – September 2021, Co-PI, DOE FES (LAB 19-2078), total budget $2,214k, budget for Argonne $545k.
- "Advancing Integrated Development Environments for Quantum Computing through Fundamental Research (AIDE-QC)", September 2019 – September 2024, Co-PI, DOE ASCR (LAB 19-2081), total budget $23,250k, budget for Argonne $3,000k.

RESEARCH COMMUNITY LEADERSHIP AND SERVICE

Services to Argonne National Laboratory:

- Member of the QIS Incubator team as an advisor to the Laboratory Director to help develop a strategy in quantum information sciences
- QIS Working Group Steering Committee member as a CELS representative with responsibility to help set up collaborations, organize seminars, investigate research directions and collect funding agency plans

Committees and Working Groups:

- Member of the IEEE Framework for Metrics and Benchmarks of Quantum Computing working group
- Program Committee Member: International Conference on Systems and Networks Communications (ICSNC 2011)

Conference and Workshop Organization:

- Co-organizer, Quantum Information Science Workshop, Argonne, September 2019
- Organizer, QIS Student Workshop for Argonne summer students, August 2019

Proposal Reviews:

- DOE SBIR/STTR Quantum Technologies Panel, November 2018
- DOE Career-Net-Science Panel, May 2019

External Reviewer:

- npj Quantum Information; Physical Review Letters; Physical Review A; Communications of the ACM; IEEE Transactions on Very Large Scale Integration Systems; IEEE Transactions on Parallel and Distributed Systems; IEEE/ACM Transactions on Networking; ACM SIGCOMM CCR; Optimization and Engineering, Springer; Software: Practice and Experience, Wiley; Computer Communications, Elsevier; Computer Networks, Elsevier; Journal of Computer Networks and Communications, Hindawi; IEEE/ACM ISCA 2013; ACM SIGCOMM 2011; NSDI 2011, 2010, 2009; IEEE ICFIN 2009; International Conference on High Performance Scientific Computing

PUBLICATIONS

More than 35 publications and 1,000 citations in total, with an H-index 14 (Google scholar).

Quantum Computing, Physics of Information, Physics:

1. X. Wu, J. Chung, A. Kolar, E. Wang, T. Zhong, R. Kettimuthu and **M. Suchara**, "Simulations of Photonic Quantum Networks for Performance Analysis and Experiment Design". In the PHOTONICS workshop, collocated with SC19, November 2019.
2. X. Wu, J. Chung, A. Kolar, E. Wang, T. Zhong, R. Kettimuthu and **M. Suchara**, "Photon-Level Simulation of Quantum Key Distribution with Picosecond Accuracy." In the 2019 Single Photon Workshop, October 2019.
3. P. Gokhale, O. Angiuli, Y. Ding, K. Gui, T. Tomesh, **M. Suchara**, M. Martonosi and F. Chong, "Minimizing State Preparations in Variational Quantum Eigensolver by Partitioning into Commuting Families". In submission at ASPLOS 2020. Preprint available as arXiv:1907.13623.
4. **M. Suchara**, Y. Alexeev, F. Chong, H. Finkel, H. Hoffmann, J. Larson, J. Osborn, and G. Smith, "Hybrid Quantum-Classical Computing Architectures". In The 3rd International Workshop on Post-Moore Era Supercomputing, November 2018.
5. **M. Suchara**, A. Cross and J. Gambetta, "Leakage Suppression in the Toric Code". In Quantum Information and Computation, Vol. 15, No. 11 & 12, pp. 0997-1016, 2015. Also available as arXiv 1410.8562 and as a conference paper in the Proceedings of IEEE ISIT, June 2015.
6. S. Bravyi, **M. Suchara** and A. Vargo, "Efficient Algorithms for Maximum Likelihood Decoding in the Surface Code". In Physical Review A 90, 032326, 2014. Also available as arXiv 1405.4883.
7. **M. Suchara**, A. Faruque, C. Lai, G. Paz, F. Chong and J. Kubiatowicz, "Comparing the Overhead of Topological and Concatenated Quantum Error Correction". Preprint available as arXiv 1312.2316.
8. **M. Suchara**, A. Faruque, C. Lai, G. Paz, F. Chong and J. Kubiatowicz, "QuRE: The Quantum Resource Estimator Toolbox". In Proceedings of IEEE International Conference on Computer Design, 2013.
9. C. Lai, G. Paz, **M. Suchara** and T. Brun, "Performance and Error Analysis of Knill's Postselection Scheme in a Two-Dimensional Architecture". In Quantum Information and Computation, Vol. 14, No. 9 & 10, pp. 807-822, 2014.
10. **M. Suchara**, A. Faruque, C. Lai, G. Paz, F. Chong and J. Kubiatowicz, "Estimating the Resources for Quantum Computation with the QuRE Toolbox". UC Berkeley Technical Report UCB/EECS-2013-119, 2013.
11. S. Bravyi, G. Duclos-Cianci, D. Poulin and **M. Suchara**, "Subsystem Surface Codes with Three-Qubit Check Operators". In Quantum Information and Computation, Vol. 13, No. 11 & 12, pp. 0963, 2013.
12. **M. Suchara**, S. Bravyi and B. Terhal, "Construction and Noise Threshold of Topological Subsystem Codes". In Journal of Physics A: Mathematical and Theoretical, Vol. 44, Issue 15, pp. 155301, 2011. **Paper included in the Highlights of 2011 Collection.**
13. M. Grocky, **M. Suchara**, Z. Kluiber, V. Janovec and Z. Zikmund, "Structure of Ferroelastic Domain Walls and Antiphase Boundaries in Crystals of β-K2SO4". XV-Czech-Polish seminar: "Structural and Ferroelectric Phase Transitions", 2002.

Optimizations of Multipath Routing:

14. **M. Suchara,** D. Xu, R. Doverspike, D. Johnson and J. Rexford, "Network Architecture for Joint Failure Recovery and Traffic Engineering". In Proceedings of ACM SIGMETRICS, 2011. **Paper won the Best Student Paper Award.**
15. W. Fisher, **M. Suchara** and J. Rexford, "Greening Backbone Networks: Reducing Energy Consumption by Shutting Off Cables in Bundled Links". In ACM SIGCOMM Workshop on Green Networking, 2010.
16. J. He, **M. Suchara**, M. Bresler, J. Rexford and M. Chiang, "Rethinking Traffic Management: From Multiple Decompositions to a Practical Protocol". In Proceedings of CoNEXT, 2007.

17. U. Javed, **M. Suchara**, J. He and J. Rexford, "Multipath Protocol for Delay-Sensitive Traffic". Invited paper in COMSNETS, 2009.

Routing Safety, Security and Reliability:

18. **M. Suchara**, A. Fabrikant and J. Rexford, "BGP Safety with Spurious Updates". In Proceedings of IEEE INFOCOM, 2011. Longer version also available as Technical Report TR-881-10, Dept. of Computer Science, Princeton University, July 2010.
19. I. Avramopoulos and **M. Suchara**, "Protecting DNS from Routing Attacks: A Comparison of Two Alternative Anycast Implementations". In IEEE Security & Privacy, Issue on Securing the Domain Name System, September/October 2009.
20. I. Avramopoulos, **M. Suchara** and J. Rexford, "How Small Groups Can Secure Interdomain Routing". Technical Report TR-808-07, Dept. of Computer Science, Princeton University, December 2007.
21. **M. Suchara**, I. Avramopoulos and J. Rexford, "Securing BGP Incrementally". In CoNEXT Student Workshop, 2007.

Congestion Control:

22. **M. Suchara**, L. Andrew, R. Witt, K. Jacobsson, B. Wydrowski and S. Low, "Implementation of Provably Stable MaxNet". In Proceedings of BROADNETS, 2008.
23. B. Wydrowski, S. Hegde, **M. Suchara**, R. Witt and S. Low, "Grid networks and TCP services, protocols, and technologies". In Grid Networks: Enabling Grids with Advanced Communication Technology, F. Travostino, J. Mambretti, G. Karmous-Edwards (Eds.), John Wiley & Sons, Ltd., 2006, ISBN: 0-470-01748-1.
24. **M. Suchara**, R. Witt and B. Wydrowski, "TCP MaxNet – An Implementation and Experiments on the WAN in Lab". In Proceedings of IEEE International Conference on Networks, 2005.

PATENTS

- Patent application "Multi-Stage Object Detection and Categorization of Antenna Mount Locations", filled with USPTO in 2019
- U.S. patent 8,422,379 – "Method of Simple and Efficient Failure Resilient Load Balancing", issued in 2013

SELECTED TALKS

32 distinct institutions or meetings.

- **Simulation-Driven Design of Photonic Quantum Communication Networks**
  Plenary Talk, PHOTONICS Workshop at SC19, Denver, CO (11/2019)
- **SeQUeNCe - Simulator of Quantum Network Communication**
  Invited Talk, Quantum Computing User Forum, Oak Ridge, TN (04/2019), Indiana University (11/2019)
- **Hybrid Quantum-Classical Computing Architectures**
  Argonne QIS Workshop, Lemont, IL (09/2019), Intel PCC Invited Talk (02/2019), The 3rd International Workshop on Post-Moore Era Supercomputing, Dallas, TX (11/2018)
- **Distributed Quantum Computing Architectures**
  APS March Meeting, Boston, MA (03/2019)
- **Introduction to Quantum Error Correction**
  Argonne Quantum Computing Tutorial, Lemont, IL (12/2018)
- **Introduction to Quantum Networking**
  Argonne Quantum Computing Tutorial, Lemont, IL (12/2018)

- **Efficient Fault-Tolerant Quantum Computing**
  Fishbowl Seminar at Texas A&M University (02/2017), QES Seminar, Princeton University (11/2016), IQC at the University of Waterloo (10/2016), CE Colloquium at TU Delft, Netherlands (09/2015)
- **Qubit Leakage Suppression in the Toric Code**
  APS March Meeting, San Antonio, TX (03/2015)
- **Baseline Resource Estimates for IARPA's Quantum Computer Science Program**
  IEEE ICCD, Asheville, NC (10/2013), Microsoft Research, Redmond, WA (08/2012), IARPA QCS PI Meeting, Princeton, NJ (07/2012), IARPA QCS Workshop, Minneapolis, MN (05/2012), IARPA QCS Technical Exchange Meeting, El Segundo, CA (01/2012)
- **Fast Parallel Decoder for Topological Error-Correcting Codes**
  IBM T. J. Watson Research Center (05/2012)
- **Constructions and Noise Threshold of Topological Subsystem Quantum Error-Correcting Codes**
  IQC at the University of Waterloo (02/2011), NEC Laboratories of America, Princeton, NJ (02/2011), UC Berkeley (12/2010), IQI at Caltech (12/2010), IBM T. J. Watson Research Center (08/2010)
- **BGP Safety with Spurious Updates: The Conditions of BGP Convergence**
  IEEE INFOCOM, Shanghai, China (04/2011), Harvard University (01/2011), Stanford University (01/2011), Yale University (10/2010), Columbia University (05/2010)
- **Simple Failure Resilient Load Balancing**
  ACM SIGMETRICS, San Jose, CA (06/2011), AT&T Labs Research, Florham Park, NJ (09/2008)
- **Greening Backbone Networks: Reducing Energy Consumption**
  ACM SIGCOMM Workshop on Green Networking, New Delhi, India (09/2010)
- **Rethinking Internet Traffic Management: From Multiple Decompositions to a Practical Protocol**
  Cambridge University (09/2008), Stanford University (04/2008), UC Berkeley (04/2008)
- **How Small Groups can Secure Interdomain Routing**
  Princeton University (01/2008), CoNEXT Student Workshop, New York, NY (12/2007)
- **TCP MaxNet: Implementation and Experiments on the WAN in Lab**
  BROADNETS 2008, London, UK (09/2008), IEEE ICON, Kuala Lumpur, Malaysia (11/2005), Stanford University (08/2005)

SOFTWARE RELEASES

- Simulator of Quantum Network Communication (SeQUeNCe): software package created by a team led by Suchara, located in a GitLab repository, consisting of 2,186 lines of Python code and 169 commits. Software simulates quantum teleportation and QKD using time bin or polarization encoding.
- SeQUeNCe Go: experimental high-performance implementation of the quantum network simulator in GoLang created to explore parallelism. Code is located in a GitLab repository, consisting of 4,478 lines of code and 110 commits.
- Q-SPLIT: software package created by a team led by Suchara, consisting of a suite of algorithms that split large quantum circuits into smaller sub-circuits that solve an equivalent problem, consisting of 4,273 lines of Python code and 179 commits.

TEACHING ASSISTANTSHIPS

COS226 – Algorithms and Data Structures, Princeton	*Spring 2009*
COS424 – Interacting with Data – Machine Learning, Princeton	*Spring 2008*
COS126 – General Computer Science, Princeton	*Fall 2007*
CS21 – Decidability and Tractability, Caltech	*Winter 2005 and 2006*
CS38 – Introduction to Algorithms, Caltech	*Spring 2005*

HONORS AND AWARDS

- Best Student Paper Award at ACM Sigmetrics, 2011
- Gordon Wu Fellowship, awarded to 15 students in the School of Engineering at Princeton, 2006-2010
- Upper Class Merit Award for academic achievement and research, Caltech, 2005-2006
- Patricia B. Conklin Scholarship for academic achievement, Caltech, 2004-2005 and 2005-2006
- Marcella and Joel Bonsall Technical Writing Prize, 2005
- Arthur Rock SURF Fellowship, undergraduate research award, 2005
- Fulbright Travel Grant to U.S.A., 2003
- Bronze Medal, 15th International Young Physicists' Tournament, 2002
- Various travel grants (Travel Grant for Scholarly Travel, IEEE Infocom Travel Grant, ACM Sigcomm Travel Grant, etc.)

TECHNICAL SKILLS

- Programming and scripting: C, C++, Python, Linux shell scripting
- Simulation and optimization: Matlab, Octave, AMPL, MOSEK
- Network protocol analysis and design: TCP, BGP, MPLS, etc.

REFERENCES

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