


Justin Yirka

Ph.D. Candidate in Computer Science, Graduating in 2025

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JustinYirka.com

arXiv.org/a/yirka_j_1.html

 linkedin.com/in/justinyirka

 scholar.google.com/citations?user=UxIpR_UAAAAJ

 youtube.com/@JustinYirka/playlists

Research Interests

Quantum computing and Theoretical computer science

Computational complexity theory, Hamiltonian complexity, Quantum algorithms

Education

Ph.D. in Computer Science | The University of Texas at Austin (UT) Expected May 2025
Advised by Scott Aaronson

Dissertation: *Quantum Complexity of Physically Inspired Problems and Computational Resources*

M.S. in Computer Science | The University of Texas at Austin 2022

B.S. in Computer Science | Virginia Commonwealth University (VCU) 2018

B.S. in Mathematical Sciences Concurrent degrees

Specialization in Data Science & Concentration in Pure Math

Minor in Physics

University Honors

Research Positions

R&D Intern | Sandia National Laboratories June 2023–present
Advised by Ojas Parekh and John Kallaugher

Topic: Hardness of estimating optimal product states of local Hamiltonians. Quantum Max-Cut, Vector Max-Cut, and Quantum constrained optimization problems. Alternative query models.

Summer School Fellow | Los Alamos National Laboratories Summer 2019

Advised by Yiğit Subaşı

Topic: Near-term (NISQ) quantum algorithms. Studied use of mid-circuit measurements and resets to construct circuits for entanglement spectroscopy which were noise-resilient *and* low-width.

Implemented noisy simulations with Qiskit, Python, Unix, Jupyter. Managed project with git. Tested algorithms on Honeywell quantum hardware.

Research Assistant | Graph Theory Computational Discovery Lab, VCU Summer 2018

Supervised by Craig Larson

Topic: Automated conjecturing software applied to graph theory.

Maintained database of graphs, their properties, and known theorems. Managed open-source project and programmed using git, GitHub, and Sage/Python.

Undergraduate Researcher | QuICS, University of Maryland Summer 2017

Advised by Andrew Childs, Jianxin Chen, and Amir Kalev

Part of NSF REU CAAR

Topic: Quantum tomography. Investigated minimum number of Pauli observables necessary to identify a quantum pure state.

Advised by Sevag Gharibian

Topic: Complexity theory. Studied quantum oracle classes (e.g. $P^{QMA[log]}$) and Hamiltonian complexity. Helped develop a “quantum PH” and “quantum Toda’s Theorem” ($QCPH \subseteq P^{PP^{PP}}$).

Research Papers and Talks

Authors are listed alphabetically, as is standard in TCS, unless marked *.

Some conference talks are accompanied by published proceedings. Filled labels • indicate I gave the talk.

Links to recordings, slides, etc. are available at justinyirka.com.

J. Yirka. A Note on the complexity of the spectral gap problem.

– Preprint. [arXiv:2503.02747](https://arxiv.org/abs/2503.02747), March 2025.

J. Yirka. Even quantum advice is unlikely to solve PP.

– Preprint. [arXiv:2403.09994](https://arxiv.org/abs/2403.09994) and [ECCC:TR24-052](https://eccc.weizmann.edu/report/2024/052), 2024.

S. Grewal and J. Yirka. The Entangled Quantum Polynomial Hierarchy Collapses.

○ Proceedings of *39th Computational Complexity Conference (CCC)*, Ann Arbor, USA, 2024.
doi:10.4230/LIPIcs.CCC.2024.6.

– [arXiv:2401.01453](https://arxiv.org/abs/2401.01453) and [ECCC:TR24-006](https://eccc.weizmann.edu/report/2024/006), 2024.

J. Kallaughar, O. Parekh, K. Thompson, Y. Wang, and J. Yirka. Complexity Classification of Product State Problems for Local Hamiltonians.

• Proceedings of *16th Innovations in Theoretical Computer Science conference (ITCS)*, New York, USA, 2025. doi:10.4230/LIPIcs.ITCS.2025.63.

• Contributed talk at Conference on Quantum Information Processing (QIP), Taiwan, 2024.

– [arXiv:2401.06725](https://arxiv.org/abs/2401.06725), 2024.

J. Yirka and Y. Subasi.* Qubit-efficient entanglement spectroscopy using qubit resets.

– *Quantum*, 5:535, 2021. doi:10.22331/q-2021-09-02-535.

• Contributed talk by J. Yirka at Conference for Young Quantum Information Scientists (YQIS), Virtual, 2021.

○ Contributed talk at APS March Meeting, Virtual, 2021.

• Contributed talk at 20th Asian Quantum Information Science Conference (AQIS), Virtual, 2020.

– [arXiv:2010.03080](https://arxiv.org/abs/2010.03080), 2020.

S. Gharibian, S. Piddock, and J. Yirka. Oracle complexity classes and local measurements on physical Hamiltonians.

○ In Proceedings of *37th Symposium on Theoretical Aspects of Computer Science (STACS)*, Montpellier, France, 2020. doi:10.4230/LIPIcs.STACS.2020.20.

• Contributed talk at Conference on Quantum Information Processing (QIP), Shenzhen, China, 2020.

• Contributed talk at Asian Quantum Information Science Conference (AQIS), Nagoya, Japan, 2018.

– [arXiv:1909.05981](https://arxiv.org/abs/1909.05981), 2019.

S. Gharibian, M. Santha, J. Sikora, A. Sundaram, and J. Yirka. Quantum generalizations of the polynomial hierarchy with applications to QMA(2).

– *Computational Complexity*, 31:12, 2022. doi:10.1007/s00037-022-00231-8.

○ Contributed talk at Asian Quantum Information Science Conference (AQIS), Nagoya, Japan, 2018. — “Long”/plenary talk: top 7% of submissions.

- In Proceedings of 43rd Symposium on Mathematical Foundations of Computer Science (MFCS), Liverpool, UK, 2018. doi:10.4230/LIPIcs.MFCS.2018.58.
– arXiv:1805.11139, 2018.
- S. Gharibian and J. Yirka. The complexity of simulating local measurements on quantum systems.
– *Quantum*, 3:189, 2019. doi:10.22331/q-2019-09-30-189.
- In Proceedings of 12th Conference on the Theory of Quantum Computation, Communication, and Cryptography (TQC), Paris, France, 2017. doi:10.4230/LIPIcs.TQC.2017.2.
– arXiv:1606.05626, 2016.

Other Research Experience

Non-quantum computing work.....

N. Bushaw, V. Gupta, C. Larson, S. Loeb, M. Norge, J. Parrish, N. Van Cleemput, J. Yirka, and G. Wu. New conditions for graph Hamiltonicity

– *Involve, a Journal of Mathematics*, 18(1):79–89, 2025. 10.2140/involve.2025.18.79.

J. Yirka. Evaluation of TCP header fields for data overhead efficiency.

- ▶ Poster at National Conference on Undergraduate Research (NCUR), Asheville, NC, USA, 2016.
- ▶ Poster at VCU Symposium for Undergraduate Research and Creativity, Richmond, VA, USA, 2015. — **Awarded “Launch Award for Outstanding Research Poster”**

Workshops and Visits.....

All-hands meeting | Quantum Systems Accelerator, a DOE Research Center June 2021
Albuquerque, USA

Workshop | Simons Institute for the Theory of Computing. Berkeley, USA. March 2024
Quantum Complexity: Quantum PCP, Area Laws, and Quantum Gravity

Invited Workshop | Schloss Dagstuhl. Virtual. June 2021
Quantum Complexity: Theory and Application

Visiting Researcher | University of Paderborn. Germany. November 2018
Collaboration with Sevag Gharibian

Topic: QMA₁-hardness of the quantum satisfaction problem (k -QSAT) on qudits of lower dimensions.

Posters.....

Filled labels ▶ indicate I presented the poster.

- ▶ J. Kallaughner, O. Parekh, K. Thompson, Y. Wang, and J. Yirka. Complexity Classification of Product State Problems for Local Hamiltonians. DOE Quantum Systems Accelerator All-Hands meeting. Albuquerque, USA, 2024.
- ▶ J. Kallaughner, O. Parekh, K. Thompson, Y. Wang, and J. Yirka. Complexity Classification of Product State Problems for Local Hamiltonians. Sandia Quantum Information Development Networking Day. Sandia National Laboratories, Albuquerque, USA, 2024.
- ▶ S. Grewal and J. Yirka. The Entangled Quantum Polynomial Hierarchy Collapses. Conference on Quantum Information Processing (QIP), Taipei, Taiwan, 2024.
- ▶ S. Gharibian, S. Piddock, and J. Yirka. Oracle complexity classes and local measurements on physical Hamiltonians. Conference on the Theory of Quantum Computation, Communication, and Cryptography (TQC), College Park, MD, USA, 2019.

- ▶ S. Gharibian, S. Piddock, and J. Yirka. Oracle complexity classes and local measurements on physical Hamiltonians. Workshop on Quantum Computing Theory in Practice (QCTIP), Bristol, UK, 2019.
- ▶ S. Gharibian, S. Piddock, and J. Yirka. Oracle complexity classes and local measurements on physical Hamiltonians. Conference on Quantum Information Processing (QIP), Boulder, CO, USA, 2019.
- ▷ S. Gharibian, M. Santha, J. Sikora, A. Sundaram, and J. Yirka. Quantum generalizations of the polynomial hierarchy with applications to QMA(2). Conference on Quantum Information Processing (QIP), Boulder, CO, USA, 2019.
- ▶ S. Gharibian and J. Yirka. The complexity of simulating local measurements on quantum systems. Conference on Quantum Information Processing (QIP). Seattle, USA, 2017.

Seminars.....

- PhD Proposal. UT Department of Computer Science, 2024.
- PhD Qualifying Exam talk (RPE). UT Department of Computer Science, 2024.
- Intro to Quantum Hamiltonians with old, new classical, and open questions. UT theory student seminar, 2023.
- Pure state tomography with Pauli observables. QuICS, University of Maryland, 2017.
- Quantum complexity of estimating local physical quantities. VCU Department of Computer Science, 2016. (Only undergraduate invited in previous 5 years.)

Teaching Positions

Head Teaching Assistant | UT Spring 2022, 2023, 2024

Quantum Information Science (Web-based for M.S. program) (CS 388Q)

Adapted and led entire course except for pre-recorded lectures.

I was responsible for all other content and logistics, handling office hours, student concerns, academic integrity, and final grades nearly autonomously. Supervised 4 other teaching assistants.

Spring 2022: 200 students, 1500 discussion board posts. Course evaluation 4.1 / 5.

Spring 2024: Course evaluation 4.91 / 5.

Teaching Assistant | UT Fall 2021

Introduction to Quantum Information Science (Honors course) (CS 358H)

With Scott Aaronson. Taught recitation and graded assignments.

Instructor | UT International Academy Summer 2021

Introduction to Software Engineering (Java)

Virtual. Developed entire course including lectures and assignments. Course evaluation 4.88 / 5.

Teaching Assistant | VCU (2.5 semesters) 2016–2017

Algebra with Applications (MATH 141)

Assisted with daily in-class exercises, offered tutorials, graded assignments.

Average student evaluation scores — Fall 2016: 4.78 / 5.0; Spring 2017: 4.36 / 5.0.

Instructor | Department of Parks and Recreation, Prince William County, VA 2016–2018

CPR and first-aid courses for lifeguards

Teaching Assistant | VCU Fall 2015

Honors Rhetoric (HONR 200) — first-year honors writing and research course

Scholarships and Funding

(all dollar amounts in USD)

Quantum seminar and visitor series at UT \$10,000, NSF CIQC Invited speakers: Chinmay Nirkhe (Prof. at Univ. of Washington), Dorian Rudolph (University of Paderborn, Germany), Jackson Morris (UCSD)	Sep 2024–May 2025
Grants for seminar series by VCU RamDev software development club \$1,900, VCU Student Government Association	Sep 2016–May 2018
Mark A. Sternheimer Capstone Design Award \$660, VCU School of Engineering Grant for developing and testing senior project app: Android, iOS, RaspberryPi, AWS, Bluetooth LE.	Nov 2017
VCU Presidential Scholarship \$110,000, Virginia Commonwealth University Awarded to 0.6% of admitted students. Full cost of 4-year tuition, room, and board.	2014–2018
WPI Presidential Scholarship [declined] \$80,000, Worcester Polytechnic Institute	2014
Rensselaer Medal Merit Scholarship [declined] \$100,000, Rensselaer Polytechnic Institute	2014

Travel grants

- \$600 for CCC 2024 in Ann Arbor, USA. CCC travel allowance / NSF.
- \$1,425 for Simons Institute workshop in Berkeley, CA, USA. NSF CIQC, 2024.
- \$500 for QIP 2024 in Taipei, Taiwan. UT Graduate School.
- \$1,600 for QIP 2024 in Taipei, Taiwan. QIP student stipend.
- \$1,100 for QIP 2020 in Shenzhen, China. QIP student support / NSF.
- \$400 for QIP 2019 in Boulder, CO, USA. QIP student support / NSF.
- \$500 for QIP 2017 in Seattle, USA. VCU Honors College.

Awards

Honorable Mention NSF Graduate Research Fellowship Program (NSF GRFP) Awarded twice. Granted to top 30% of over 12,000 applicants.	2019, 2020
Pure Mathematics Award VCU College of Humanities and Sciences Student in pure math concentration with highest graduating GPA.	May 2018
University Student Scholar Award Virginia Commonwealth University	Aug 2015
Launch Award for Outstanding Research Poster VCU Symposium for Undergraduate Research For poster <i>Evaluation of TCP header fields for data overhead efficiency</i> .	March 2015
Volunteer of the Year Grade-school robotics program, Prince William County Schools, VA	2014

Service

Journal reviewer: *Quantum* (2024, 2022, 2020)

PC Member: YQIS 2021

Conference subreviewer: STOC 2025, QIP (2025, 2024, 2022), TQC (2023, 2022), ITCS 2023, RANDOM 2023, CCC 2022

Extended commitments (> 1 month).....

Chair | UT Graduate Representative Association of Computer Science March 2020–Dec 2021

- GRACS representative to UTCS Diversity, Equity, and Inclusion (DEI) Council.
- Co-Organized Graduate Application Assistance Program mentoring under-represented applicants to Ph.D. program. Managed the volunteer mentors. Fall 2020.

Tutor for remedial math students | Manchester High School, Midlothian, VA Spring 2019
Up to 4.5 hours per week with several groups of students.

Student Advisory Board member Sep 2016–May 2018

| VCU Department of Computer Science

- Participated in hiring interviews for new faculty in 2017.

Founder and President Apr 2016–May 2018

| RamDev: Software Development at VCU

- Coordinated 46 weekly seminars including 9 corporate speakers and several hackathon trips.
- Secured and managed \$2400 in funding and resources.
- Increased weekly attendance to 20+ students, becoming largest C.S. organization at VCU.

Mentor | VCU Honors College freshman mentorship program Fall 2016

Volunteer for grade school robotics competitions (FIRST, Vex robotics) 2011–2015

| Prince William County Schools, VA

- Awarded “Volunteer of the Year”, 2014.

Mentor for middle School robotics team (FIRST robotics) Fall 2014

| Wilder Middle School, Richmond, VA

Short-term commitments (< 1 month).....

Ph.D. application reviewer | UT CS Graduate Admissions Committee Fall 2020

Committee Member | UT CS GradFest (admitted Ph.D. visit day) Spring 2020, Spring 2021

Lead Dossier Reader | VCU Honors College graduation dossiers Spring 2016, Spring 2017

Assessed dossiers and coordinated other readers.

Judge | Launch Award for Outstanding Research Poster March 2016

VCU Symposium for Undergraduate Research and Creativity

Talks and Panels.....

- **Panelist** at Grad school discussion for underrepresented undergraduates. UT CS student organizations, 2020.
- Meeting with U.S. Army Operations Group. I was asked to share my observations from AQIS 2018. November 2018.
- **Talk:** Computer Science theory *is* fun. VCU RamDev software development club, 2018.
- **Panelist** at Career workshop for freshman mentorship program. VCU Department of Computer Science, 2017.
- **Panelist** at Undergraduate conference preparation workshops. VCU Honors College, 2017.
- **Talk:** Quantum programming (e.g. IBM Q, LIQUi|)). VCU RamDev software development club, 2017.