


# Justin Yirka

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

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arXiv.org/a/yirka\_j\_1.html

 linkedin.com/in/justinyirka

 scholar.google.com/citations?user=UxIpR\_UAAAAJ

## Research Interests

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Quantum computing and Theoretical computer science

Computational complexity theory, Hamiltonian complexity, Quantum algorithms

## Education

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**Ph.D. in Computer Science** | The University of Texas at Austin (UT) Expected May 2025

Advised by Scott Aaronson

**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

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**R&D Intern** | Sandia National Laboratories June 2023–present

Supervisors: Ojas Parekh and John Kallaugh

Topic: Hardness of estimating optimum product states of local Hamiltonians. Quantum Max-Cut and Vector Max-Cut. Quantum constrained optimization problems.

**Summer School Fellow** | Los Alamos National Laboratories Summer 2019

Supervisor: 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.

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

Supervisor: Craig Larson

Topic: Automated conjecturing software applied to graph theory. Maintained database of graphs, their properties, and known theorems. Improved open-source project management.

**NSF REU Researcher** | QuICS, University of Maryland Summer 2017

Supervisor: Andrew Childs

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

**Research Assistant** | Quantum Computing Lab, VCU 2015–2016

Supervisor: Sevag Gharibian

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

## Research Papers

Authors listed alphabetically unless noted. Filled labels indicate I gave the presentation.

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

- Preprint. arXiv:2403.09994 and ECCC:TR24-052, March 2024.

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

- Proceedings of *39th Computational Complexity Conference (CCC)*, Ann Arbor, MI, USA, July 2024. doi:10.4230/LIPIcs.CCC.2024.6.
- Poster at Conference on Quantum Information Processing (QIP), Taipei, Taiwan, January 2024.
- arXiv:2401.01453 and ECCC:TR24-006, January 2024.

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

- Contributed talk at Conference on Quantum Information Processing (QIP), Taipei, Taiwan, January 2024.
- arXiv:2401.06725, January 2024.

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

(authors not ordered alphabetically)

- *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, 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.
- Poster at Conference on the Theory of Quantum Computation, Communication, and Cryptography (TQC), College Park, MD, USA, 2019.
- Poster at Workshop on Quantum Computing Theory in Practice (QCTIP), Bristol, UK, 2019.
- Poster at Conference on Quantum Information Processing (QIP), Boulder, CO, USA, 2019.
- Contributed talk at Asian Quantum Information Science Conference (AQIS), Nagoya, Japan, 2018.
- arXiv: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.
- Poster at Conference on Quantum Information Processing (QIP), Boulder, CO, USA, 2019.
- 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.  
 • Poster at Conference on Quantum Information Processing (QIP). Seattle, USA, 2017.  
 – arXiv:1606.05626, 2016.
- 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”**

## Other Research Experience

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**Workshops and Visits**.....

**All-hands meeting** | Quantum Systems Accelerator, a DOE QIS Research Center June 2024  
 Attended on behalf of my advisor at UT Austin

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

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

**Visiting Researcher** | University of Paderborn, Germany November 2018  
 Collaboration with Sevag Gharibian  
 Topic: Complexity theory and algorithms. Studied  $\text{QMA}_1$ -hardness of the quantum satisfaction problem ( $k$ -QSAT) given qudits of lower dimensions.

**Seminars**.....

- Complexity Classification of Product State Problems for Local Hamiltonians. 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

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**Head Teaching Assistant** | UT Spring 2022, 2023, 2024  
 Quantum Information Science (Web-based for online M.S. program)  
 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.  
 For the first run of the course, I was responsible for adapting old course materials for the online format.  
 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)  
 With Scott Aaronson. Taught recitation and graded assignments.

**Instructor** | UT International Academy Summer 2021  
 Introduction to Software Engineering (Java)  
 Virtual. Developed entire course including assignments. Course evaluation 4.88 / 5.

**Teaching Assistant** | VCU (2 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)

**Co-PI** | Quantum computing seminar series at UT with invited speakers Fall 2024  
 \$10,000, CIQC (an NSF Quantum Challenge Institute)

Grants for seminar series by VCU RamDev software development club 2016–2018  
 \$1,900, VCU Student Government Association

Mark A. Sternheimer Capstone Design Award 2017  
 \$660, VCU School of Engineering  
 Grant for developing and testing senior project mobile app.

VCU Presidential Scholarship 2014–2018  
 \$110,000, Virginia Commonwealth University  
 Awarded to 0.6% of admitted students.  
 Full cost of 4-year tuition, room, and board.

WPI Presidential Scholarship [declined] 2014  
 \$80,000, Worcester Polytechnic Institute

Rensselaer Medal Merit Scholarship [declined] 2014  
 \$100,000, Rensselaer Polytechnic Institute

### Travel grants.....

- \$600 for CCC 2024 in Ann Arbor, MI, USA. CCC travel allowance / NSF.
- \$1,425 for Simons Institute workshop in Berkeley, CA, USA. CIQC (an NSF Quantum Challenge Institute).
- \$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) 2019, 2020  
 Awarded twice. Granted to top 30% of over 12,000 applicants.

**Pure Mathematics Award** | VCU College of Humanities and Sciences May 2018

Student in pure math concentration with highest graduating GPA.

**University Student Scholar Award** | Virginia Commonwealth University 2015

**Launch Award for Outstanding Research Poster** 2015

| VCU Symposium for Undergraduate Research

For poster *Evaluation of TCP header fields for data overhead efficiency*.

**Volunteer of the Year** | Grade-school robotics program, Prince William County Schools, VA 2014

## Service

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

**PC Member:** YQIS 2021

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

**Chair** | UT Graduate Representative Association of Computer Science Spring 2020–Fall 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.

**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

**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** (2 academic years) 2016–2018

| VCU Department of Computer Science

○ Participated in hiring interviews for new faculty in 2017.

**Founder and President** (2.5 academic years) 2016–2018

| 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

**Lead Dossier Reader** | VCU Honors College graduation dossiers (2 academic years) 2016–2017

Assessed dossiers and coordinated other readers.

**Judge** | Launch Award for Outstanding Research Poster 2016

VCU Symposium for Undergraduate Research and Creativity

**Co-Organizer** | Local Hack Day of Richmond, VA 2016

Event for 30 students including 12 high school students.

Sponsored by Major League Hacking (MLH).

**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

## 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,  $\text{LIQUi|}\rangle$ ). VCU RamDev software development club, 2017.