

# Justin Yirka

**\*\*Graduating in 2025\*\*** Ph.D. Student in Computer Science

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## Research Interests

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Quantum computing, Theoretical computer science, Complexity theory and Hamiltonian complexity

## Education

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### University of Texas at Austin (UT)

Ph.D. in Computer Science

Expected graduation: May 2025

Adviser: Scott Aaronson

M.S. in Computer Science

2022

### Virginia Commonwealth University (VCU)

B.S. in Computer Science — Specialization in Data Science

2018

B.S. in Mathematical Sciences — Concentration in Pure Mathematics

Concurrent degrees

Minor in Physics, University Honors College

## Research Papers

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

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S. Grewal and J. Yirka.

The Entangled Quantum Polynomial Hierarchy Collapses.

- To appear in Proceedings of *39th Computational Complexity Conference (CCC)*, Ann Arbor, MI, USA, July 2024.
- Poster at Conference on Quantum Information Processing (QIP), Taipei, Taiwan, January 2024.
- arXiv:2401.01453, January 2024.

J. Yirka.

Even quantum advice is unlikely to solve PP.

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

J. Kallaugh, 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. (authors not ordered alphabetically)

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, 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.
- Contributed talk at Conference on the Theory of Quantum Computation, Communication, and Cryptography (TQC), Paris, France, 2017.
- 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”**

## Research Experience

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Positions.....

R&D Intern

June 2023–present

Sandia National Laboratories

Supervisors: Ojas Parekh and John Kallaugh

Topic: Hardness of estimating optimum product states of local Hamiltonians. Quantum constrained optimization problems.

Summer school / Research Assistant Summer 2019  
 Los Alamos National Laboratories Quantum Computing Summer School  
 Supervisor: Yiğit Subaşı  
 Topic: Near-term (NISQ) quantum algorithms. Studied use of qubit resets to construct circuits for entanglement spectroscopy which were noise-resilient *and* low-width.

Research Assistant Summer 2018  
 Graph Theory Computational Discovery Lab, Virginia Commonwealth University  
 Supervisor: Craig Larson  
 Topic: Automated conjecturing and graph theory. Studied conditions for graph Hamiltonicity. Assisted with programming and open-source project management.

Undergraduate Researcher (NSF REU C.A.A.R.) Summer 2017  
 Joint Center for Quantum Inform. and Computer Science (QuICS), University of Maryland  
 Supervisor: Andrew Childs  
 Topic: Quantum tomography. Investigated minimum number of Pauli observables necessary to identify a quantum pure state.

Undergraduate Research Assistant 2015–2016  
 Quantum Computing Lab, Virginia Commonwealth University  
 Supervisor: Sevag Gharibian  
 Topic: Complexity theory. Studied quantum oracle classes (e.g.  $\text{PQMA}^{\text{[log]}}$ ) and complexity of simulating local measurements. Helped develop a “quantum PH” and “quantum Toda’s Theorem” ( $\text{QCPH} \subseteq \text{P}^{\text{P}^{\text{PP}}}$ ).

## Workshops and Visits.....

All-hands meeting June 2024  
 Quantum Systems Accelerator (a Dept. of Energy Quantum Research Center)  
 Attended on behalf of my advisor at UT Austin

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

Invitation-only workshop June 2021  
 Schloss Dagstuhl — Quantum Complexity: Theory and Application

Visiting Researcher November 2018  
 University of Paderborn, Germany  
 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.

## Research Seminars.....

Research Preparation Exam on “Complexity Classification of Product State Problems for Local Hamiltonians”.  
 UT Computer Science department. 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.  
 Department of Computer Science, VCU. 2016. (Only undergraduate invited in previous 5 years.)

## Teaching Experience

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### The University of Texas at Austin (UT).....

Head Teaching Assistant Spring 2022, 2023, 2024

Quantum Information Science (Web-based for online M.S. program)

All lecture content was pre-recorded by S. Aaronson. I was responsible for all other content and logistics, handling office hours, student concerns, academic integrity, and final grades nearly autonomously, with S. Aaronson as instructor of record. Supervised 4 other teaching assistants.

For the first run of the course, I was fully responsible for modifying the homework, exams, and grading for the online format and for ensuring a successful addition to the growing MSCS program at UT.

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

Spring 2024: Course evaluation 4.91 / 5.

Teaching Assistant Fall 2021

Introduction to Quantum Information Science (Honors course)

With Scott Aaronson. Taught recitation and graded assignments.

Instructor Summer 2021

UT International Academy: Software Engineering

Virtual. Introductory course for international undergraduate students. I independently designed the entire course. Course evaluation 4.88 / 5.

### Virginia Commonwealth University (VCU).....

Teaching Assistant (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.

Mentor for first-year student Fall 2016

Honors College freshman mentorship program

Teaching Assistant Fall 2015

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

### Other.....

Instructor 2016–2018

CPR and first-aid courses for lifeguards

Department of Parks and Recreation, Prince William County, VA

## Scholarships and Funding (all dollar amounts in USD)

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Co-PI: quantum computing seminar series at UT with invited speakers Expected fall 2024  
approx. \$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.

<b>Travel grants</b> .....	
Travel grant to CCC 2024 in Ann Arbor, MI, USA \$600, CCC travel allowance / NSF	2024
Travel grant to a Simons Institute workshop in Berkeley, CA, USA \$1,425, CIQC (an NSF Quantum Challenge Institute)	2024
Travel grant to QIP 2024 in Taipei, Taiwan \$500, UT Graduate School	2024
Travel grant to QIP 2024 in Taipei, Taiwan \$1,600, QIP student stipend	2024
Travel grant to QIP 2020 in Shenzhen, China \$1,100, QIP student support / NSF	2020
Travel grant to QIP 2019 in Boulder, CO, USA \$400, QIP student support / NSF	2019
Travel grant to QIP 2017 in Seattle, USA \$500, VCU Honors College	2017

## Awards

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

## Service

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<b>Journal reviewer::</b> <i>Quantum</i> (2022, 2020)	
<b>PC Member:</b> YQIS 2021	
<b>Conference subreviewer:</b> QIP (2024, 2022), TQC (2023, 2022), ITCS 2023, RANDOM 2023, CCC 2022	
Chair	Spring 2020–Fall 2021
UT Graduate Representative Association of Computer Science (GRACS) <ul style="list-style-type: none"> <li>o GRACS representative to UTCS Diversity, Equity, and Inclusion (DEI) Council.</li> <li>o Co-Organized Graduate Application Assistance Program mentoring under-represented applicants to Ph.D. program. Managed the volunteer mentors. Fall 2020.</li> </ul>	
Ph.D. application reviewer	Fall 2020
UT CS Graduate Admissions Committee	
Panelist — Grad school discussion for underrepresented undergraduates UT CS student organizations	August 2020

GradFest (admitted Ph.D. visit day) committee member UT Department of Computer Science	Spring 2020
Tutor for remedial math students at local high school Manchester High School, Midlothian, VA Up to 4.5 hours per week with several groups of students.	Spring 2019
Meeting with U.S. Army Operations Group I was asked to share my observations from AQIS 2018.	November 2018
Student Advisory Board member VCU Department of Computer Science o Participated in hiring interviews for new faculty in 2017.	(2 academic years) 2016–2018
Founder and President RamDev: Software Development at VCU o Coordinated 46 weekly seminars including 9 corporate speakers and several hackathon trips. o Secured and managed \$2400 in funding and resources. o Increased weekly attendance to 20 students, becoming largest C.S. organization at VCU.	(2.5 academic years) 2016–2018
Talk — Computer Science theory <i>is</i> fun VCU RamDev software development club	April 2018
Senior Reader for Honors program graduation dossiers VCU Honors College Coordinated other readers.	(2 academic years) 2016–2017
Panelist — Career workshop for freshman mentorship program VCU Department of Computer Science	2017
Panelist — Undergraduate conference preparation workshops VCU Honors College	2017
Talk — Quantum programming (e.g. IBM Q, LIQU <i>i</i>   )) VCU RamDev software development club	2017
Judge — Launch Award for Outstanding Research Poster VCU Symposium for Undergraduate Research and Creativity	2016
Organizer — Local Hack Day of Richmond, VA Major League Hacking (MLH) and VCU Department of Computer Science Co-organized event for 30 students including 12 high school students.	2016
Volunteer for grade school robotics competitions (FIRST, Vex robotics) Prince William County Schools, VA o Awarded “Volunteer of the Year”, 2014.	2011–2015
Mentor to middle school robotics team (FIRST robotics) Wilder Middle School, Richmond, VA	Fall 2014