# Justin Yirka

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## 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)                    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

**Quantum Computing Consultant** | Blanqet                    August 2025–Present
Researcher and consultant for a new startup focused on quantum computing applications.

**R&D Intern** | Sandia National Laboratories                    June 2023–May 2025
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.

**Research Assistant** | Quantum Computing Lab, VCU                                March 2015–Aug 2016
    Advised by Sevag Gharibian
    Topic: Complexity theory. Studied quantum oracle classes (e.g. $\mathrm{P}^{\mathrm{QMA[log]}}$) and Hamiltonian complexity.
    Helped develop a "quantum PH" and "quantum Toda's Theorem" ($\mathrm{QCPH} \subseteq \mathrm{P}^{\mathrm{PP}^{\mathrm{PP}}}$).

## 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.

Dissertation: *Quantum Complexity of Physically Inspired Problems and Computational Resources*.
    – doi:10.26153/tsw/61157, May 2025.

B. Holman, R. Ramachandran, and J. Yirka.   Quantum search with in-place queries.
    ○ In Proceedings of *20th Conference on the Theory of Quantum Computation, Communication, and Cryptography* (*TQC*), Bengaluru, India, September 2025.   doi:10.4230/LIPIcs.TQC.2025.1.
    – arXiv:2504.03620, April 2025.

J. Yirka.   A note on the complexity of the spectral gap problem.
    – Preprint. arXiv:2503.02747, March 2025.

J. Yirka.   Even quantum advice is unlikely to solve PP.
    – *Theory of Computing*, 21(7), 2025.   doi:10.4086/toc.2025.v021a007.
    – arXiv:2403.09994 and ECCC:TR24-052, 2024.

S. Grewal and J. Yirka.   The Entangled Quantum Polynomial Hierarchy collapses.
    ○ In Proceedings of *39th Computational Complexity Conference* (*CCC*), Ann Arbor, USA, 2024. doi:10.4230/LIPIcs.CCC.2024.6.
    – arXiv:2401.01453 and ECCC:TR24-006, 2024.

J. Kallaugher, O. Parekh, K. Thompson, Y. Wang, and J. Yirka.   Complexity classification of product state problems for local Hamiltonians.
    • In 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, 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, 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, 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.
  o Contributed talk at Asian Quantum Information Science Conference (AQIS), Nagoya, Japan, 2018. — **"Long"/plenary talk: top 7% of submissions**.
  o 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.
  o 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"**

**Posters**.................................................................................................................

Filled labels ▸ indicate I presented the poster.

  ▸ J. Kallaugher, 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. Kallaugher, 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

- • Quantum search with in-place queries. QISES Seminar at UChicago, 2025.
- • Quantum search with in-place queries. Infleqtion (Chicago), 2025.
- • PhD Defense. UT Department of Computer Science, 2025.
- • 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.)

## Workshops, Visits, and Other Conferences

| | |
|---|---|
| Attendee \| Chicago Quantum Summit. Chicago, USA.<br>Chicago Quantum Exchange | 2025 |
| Attendee \| IEEE Quantum Week (QCE). Albuquerque, USA.<br>    Included the Quantum Algorithms for Financial Applications workshop. | 2025 |
| Attendee \| Quantum to Business (Q2B). San Francisco, USA. | 2024 |
| Workshop \| All-hands meeting. Albuquerque, USA.<br>Quantum Systems Accelerator, a DOE QIS Research Center | 2024 |
| Workshop \| Quantum Complexity: Theory and Application. Berkeley, USA.<br>Simons Institute for the Theory of Computing | March 2024 |
| Invited Workshop \| Quantum Complexity: Theory and Application. Virtual.<br>Schloss Dagstuhl | June 2021 |
| Visiting Researcher \| Collaboration with Sevag Gharibian<br>University of Paderborn, Germany.<br>    Topic: $QMA_1$-hardness of the quantum satisfaction problem ($k$-QSAT) on qudits of lower dimensions. | November 2018 |

# 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                                       Sep 2024–May 2025
$10,000, NSF CIQC
Invited speakers: Chinmay Nirkhe (Prof. at Univ. of Washington), Dorian Rudolph (University of Paderborn, Germany), Jackson Morris (UCSD)

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

Mark A. Sternheimer Capstone Design Award                                            Nov 2017
$660, VCU School of Engineering
Grant for developing and testing senior project app: Android, iOS, RasberryPi, AWS, Bluetooth LE.

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**................................................................................

o $600 for CCC 2024 in Ann Arbor, USA. CCC travel allowance / NSF.

o $1,425 for Simons Institute workshop in Berkeley, CA, USA. NSF CIQC, 2024.

o $500 for QIP 2024 in Taipei, Taiwan. UT Graduate School.

o $1,600 for QIP 2024 in Taipei, Taiwan. QIP student stipend.

o $1,100 for QIP 2020 in Shenzhen, China. QIP student support / NSF.

o $400 for QIP 2019 in Boulder, CO, USA. QIP student support / NSF.

o $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    Aug 2015

**Launch Award for Outstanding Research Poster**    March 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

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

**PC Member**: YQIS 2021

**Conference subreviewer**: STACS 2026, 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
    o GRACS representative to UTCS Diversity, Equity, and Inclusion (DEI) Council.
    o 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
    o Participated in hiring interviews for new faculty in 2017.

**Founder and President**    Apr 2016–May 2018
| 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.

**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
    o 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**......................................................................................

- **Talk**: My career from VCU and an introduction to quantum computing.    VCU Linux User Group, Virtual, 2025.

- **Panelist** for Quantum ATX meetup as a quantum industry professional in Austin, TX.    Austin Forum on Technology and Society, 2025.

- **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, LIQ$Ui|\rangle$).    VCU RamDev software development club, 2017.