Justin Yirka

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arXiv.org/a/yirka_j_1.html
 linkedin.com/in/justinyirka
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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
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

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. $P^{QMA[log]}$) 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.

B. Holman, R. Ramachandran, and J. Yirka.   Quantum search with in-place queries.
  ○ To appear in Proceedings of *Conference on the Theory of Quantum Computation, Communication, and Cryptography (TQC)*, Bengaluru, India, September 2025.
  – 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.
  – Preprint. 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.
○ 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: QMA_1-hardness of the quantum satisfaction problem (k-QSAT) on qudits of lower dimensions.

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..

- 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.)

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..

○ $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)   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: 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, LIQ$Ui|\rangle$). VCU RamDev software development club, 2017.