Justin Yirka

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arXiv.org/a/yirka_j_1.html
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Research Interests

Quantum computing and Theoretical computer science
    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
    Summa Cum Laude

Research Positions

Quantum Computing Researcher | Blanqet   August 2025–Present
    Researcher (employee #2) at a UChicago-affiliated startup with industry pioneers (e.g. Scott Aaronson, David Awschalom, Bill Fefferman, Liang Jiang, and more).
    Pursuing real-world applications of quantum computing and quantum information.

R&D Intern | Sandia National Laboratories   June 2023–May 2025
    Advised by Ojas Parekh and John Kallaugher
    Topic: Hardness of computing product state solutions to Hamiltonian optimization problems. Quantum Max-Cut and Vector Max-Cut. Novel variant of Grover's (fault-tolerant) search algorithm in alternative query models.

Summer School Fellow | Los Alamos National Laboratories   Summer 2019
    Advised by Yiğit Subaşı
    Topic: Near-term (NISQ) quantum algorithms. Designed low-width algorithms for entanglement spectroscopy with error mitigation using mid-circuit measurements and qubit resets. Validated algorithms with noisy simulations in Qiskit and experiments on Honeywell (Quantinuum) ion-trap device.

Research Assistant | Graph Theory Computational Discovery Lab, VCU   Summer 2018
    Supervised by Craig Larson
    Topic: Automated conjecturing software applied to graph theory.

Undergraduate Researcher (REU) | QuICS, University of Maryland   Summer 2017
    Advised by Andrew Childs, Jianxin Chen, and Amir Kalev
    Topic: Pure-state quantum tomography.

Research Assistant | Quantum Computing Lab, VCU   March 2015–Aug 2016
    Advised by Sevag Gharibian
    Topic: Complexity theory. Studied Hamiltonian complexity and quantum oracle classes (e.g. $P^{QMA[\log]}$).
    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. available at justinyirka.com.

Dissertation: *Quantum Complexity of Physically Inspired Problems and Computational Resources*.
    – doi:10.26153/tsw/61157,   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, 2025.   doi:10.4230/LIPIcs.TQC.2025.1.
    – arXiv:2504.03620,   2025.

J. Yirka.   A note on the complexity of the spectral gap problem.
    – arXiv:2503.02747,   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), Taipei, 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.

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 and Visits

- Quantum Algorithms for Finance Workshop at IEEE Quantum Week (QCE). Albuquerque, USA, 2025.
- All-hands meeting. Quantum Systems Accelerator, a DOE QIS Research Center. Albuquerque, USA, 2024.
- Workshop | Quantum Complexity: Theory and Application. Simons Institute for the Theory of Computing. Berkeley, USA, March 2024.
- Invited Workshop | Quantum Complexity: Theory and Application. Schloss Dagstuhl. Virtual, June 2021.
- Visiting Researcher | Collaboration with Sevag Gharibian. University of Paderborn, Germany. November 2018.
  Topic: QMA_1-hardness of the quantum satisfaction problem (k-QSAT) on qudits of lower dimensions.

Additional talks and panels listed under **Volunteering** below.

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
    Co-Organized with Shivan Mittal. 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 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.