Ishaun Datta

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PhD Candidate, Computer Science Theory Group
Quantum complexity, esp. quantum {*advantage, learning, simulation*}

EDUCATION

Stanford University
PhD Candidate in Computer Science; Advisor: Professor Adam Bouland — 2021 – 2026
MS in Computational and Mathematical Engineering — 2019 – 2021

Awards: NSF Graduate Research Fellowship, Gerald J. Lieberman Fellowship

Relevant Coursework: CS 259Q Quantum Computing, Phys 234 Quantum Computation & Information Theory, CME 305 Discrete Math and Algorithms, CS 265 Randomized Algorithms, CS 254B Complexity Theory II, CS 359A Research Seminar in Complexity Theory, CME 302 Numerical Linear Algebra.

Teaching Assistant: CS 359D Quantum Complexity Theory, Spring 2023.

Massachusetts Institute of Technology — 2014 – 2018
BS in Mathematics with Computer Science and B.S. in Physics

Montgomery Blair High School, Maryland — 2010 – 2014
Science Talent Search Finalist, National Merit Scholar, National AP Scholar, Debate Team Captain

RESEARCH INTERESTS

I have wide-ranging interests in **quantum computing**. In particular, my PhD research **bridges the "asymptopia" of complexity theory with real-world experiments, in the contexts of quantum advantage, simulation, and learning**. Two such results are:

- My work establishing the complexity theory of linear optics with a number of modes linear in the number of photons, answering an open question of Aaronson and Arkhipov from 2010.
- The first average-case hardness of sampling theorem for quantum advantage experiments and state-of-the-art "robustness," exponentially improving upon prior work and approaching a proof of the Permanent-of-Gaussians Conjecture (PGC).

PUBLICATIONS

(Authorship is by default alphabetical)

A. Bouland, **I. Datta**, B. Fefferman, F. Hernández. Exponential improvements to the average-case hardness of BosonSampling. arXiv:2411.04566.

D. Harley, **I. Datta**, F.R. Klausen, A. Bluhm, D.S. França, A. Werner, M. Christandl. Going beyond gadgets: the importance of scalability for analogue quantum simulators. arXiv:2306.13739. Contributed talk at QIP 2024. *Nature Communications* **15**, 1 (2024).

A. Bouland, D. Brod, **I. Datta**, B. Fefferman, D. Grier, F. Hernández, M. Oszmaniec. Complexity-theoretic foundations of BosonSampling with a linear number of modes (2023). arXiv:2312.00286. Contributed talk at QIP 2024.

M.C. Caro, **I. Datta**.† Pseudo-dimension of quantum circuits. *Quantum Mach. Intell.* **2**, 14 (2020). † Equal contributors. arXiv:2002.01490.

Shapes of Possibility: Interview between Felicitas Rohden and Shaun Datta about Quantum Computing, *Unbag Magazine* **3** (2018). Discussed our collaboration on an art exhibit conveying key principles of quantum information, which premiered in Oct. 2017 at Kunst im Tunnel Museum in Düsseldorf.

I. Datta. Quantum Mechanics as a Stimulus for American Theoretical Physics, *APS News* **27**, 7 (2018). Published as APS History of Physics Essay Contest Winner.

P. Adhikari, T.D. Cohen, **I. Datta**. Density of saturated nuclear matter at large N_c and heavy quark mass limits. *Phys. Rev. C* **89**, 065201 (2014). arXiv:1312.3339.

SELECTED TALKS

(By invitation unless otherwise noted)

"Exponential improvements to the average-case hardness of BosonSampling"

- MIT, Seminar organizers: Profs. Aram Harrow, Soonwon Choi 03/2025
- Tufts University, Host: Prof. Saeed Mehraban 03/2025
- Harvard University, Prof. Anurag Anshu's group meeting 02/2025
- University of Texas at Austin, Host: Prof. Scott Aaronson 02/2025
- Quantum-Safe Internet Workshop (Contributed talk), Technical University of Denmark (DTU) (upcoming) 05/2025

"The computational complexity of linear optics with linear modes"

- University of Texas at Austin, Host: Prof. Scott Aaronson 02/2025
- The Power of Near-Term Quantum Experiments, IMSI Workshop, UChicago 09/2024
- QIP 2024 (Contributed talk), Taipei 01/2024

"What's the simplest quantum computation to surpass classical computers?"

- Jadavpur University, Calcutta (Online) 12/2024
- Pint of Science Festival, Palo Alto 05/2025

"Going beyond gadgets: the importance of scalability for analogue quantum simulators"

- Dartmouth University, Host: James D. Whitfield (Online) 05/2024
- QIP 2024 (Contributed talk), Taipei 01/2024
- University of Technology Sydney, QSI Seminar (Online) 12/2023

RESEARCH VISITS & INTERNSHIPS

Long-term Invited Visitor Feb – May 2024
Simons Institute for the Theory of Computing *Berkeley, CA*

Quantum Research Scientist Summer Intern Summer 2022
IBM Almaden, Demonstrations Team *San Jose, CA*

- Theory of noisy Trotter error, in preparation.

Visiting PhD Student Spring 2022
QMATH, Københavns Universitet *Copenhagen, Denmark*

- Hosts: Profs. Matthias Christandl and Albert Werner. Project: establishing a mathematical framework for analogue quantum simulation. The main results were that existing attempts to capture analogue

simulation using perturbative gadgets from Hamiltonian complexity necessarily produce unphysical, system-size dependent scalings in the interaction terms. Therefore, any mathematical theory of analogue simulation must go beyond the Hamiltonian complexity toolkit. As a first step toward building that toolkit, we provide an experimentally-realizable protocol using the quantum Zeno effect that can evade these lower bounds. Published in *Nature Communications.*

Quantum Research Scientist Summer Intern Summer 2019
Intel Labs *Santa Clara, CA*

· Classical simulation of Instantaneous Quantum Polynomial (IQP) circuits using Neural Network Quantum State (NQS) ansätze.

German Academic Exchange Service (DAAD) Research Fellow 2018 – 2019
Technische Universität München

· Yearlong grant for quantum learning theory research under the auspices of Prof. Michael Wolf.
· One of only two pre-doctoral students to receive award; all others were PhDs or postdoctoral fellows.

AWARDS

Gerald J. Lieberman Fellowship 2024 – 2025

· One of 12 fellows selected across all graduate and professional schools for research, service, and teaching.
· Intended for "the next generation of academic leaders" with "promising careers in university research and teaching."

ICME Student Leadership Award 2022

· Received $1,500 award for founding and leading ICME's student advocacy group.

NSF Graduate Research Fellowship 2019 – 2022
National Science Foundation

· $138,000 over three years. Approx. 2,000 fellowships awarded among more than 12,000 applicants.

MIT Memorial Scholarship 2016

Tenth Place nationally at Intel Science Talent Search 2014

· Received $21,000 scholarship among $\sim$ 3,000 applicants and 40 national finalists as a result of my nuclear physics research and five rounds of judging interviews on broader scientific knowledge and creativity.

VOLUNTEERING & SERVICE

Reviewer for {ITCS, QIP, TQC} 2024, {QIP, TQC, AQIS, Quantum Journal} 2025.

Created and led ICME's student advocacy group 2020 – 2022. Accomplishments: wrote and disseminated the first comprehensive student survey for ICME, implemented PhD Individual Development Plan, streamlined core curriculum and qualifying exams, refocused CME 300 seminar on aligning with research advisor.

MIT interviewer: interview undergraduate applicants and submit detailed evaluations to Admissions.

Stanford Engineering Graduate Advisory Council, 2019 – 2021

Volunteer middle- and high-school teacher at MIT Splash, MIT HSSP, and Institut Salvador Espriu in Barcelona. Created from scratch lessons on special relativity, particle physics, radioactivity, and other topics. Materials available upon request.