

Shoumik Chowdhury

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Education

Yale University, New Haven, CT

(Aug 2017 - May 2021)

Major: Mathematics and Physics, B.S.

GPA: 3.94.

Relevant Coursework: Quantum Many-Body Theory** (see [evaluation](#)); Quantum Noise, Dissipation, & Amplification**;
Intro Light-Matter Interactions**; Quantum Computation & Information**; Classical Mechanics**; Thermodynamics &
Statistical Mechanics; Electrodynamics; Quantum Mechanics I & II; Differential Geometry; Linear & Abstract Algebra;
Mathematical Linguistics**; Data Structures; Complex Analysis I & II**; Stochastic Processes. [** = *graduate-level class*]

Aditya Birla World Academy (ABWA), Mumbai, India

(Aug 2013 - Jun 2017)

Coursework: Physics, Mathematics, Chemistry, English Language and Literature, Economics, Spanish.

Score: 44/45 (IB Diploma); Valedictorian.

Senior Essay (in Mathematics): Convergence of Fourier series' coefficients and application to digital music compression.

Publications

- [1] J. Venkatraman, X. Xiao, Y. Zhang, **S. Chowdhury**, and M. H. Devoret, "Onset of multi-stability for non-linear resonances of a driven oscillator: classical versus quantum regimes," *Currently In Preparation*, (2021).
- [2] **S. Chowdhury**, M. Zhang, and L. Jiang. "Engineering arbitrary two-mode Gaussian control interactions in a hybrid multimode device," *Currently In Preparation*, (2021).
- [3] J. A. Valery, **S. Chowdhury**, G. Jones, N. Didier, "Dynamical sweet spot engineering via two-tone flux modulation of superconducting qubits", [arXiv:2104.07835](#) (2021).
- [4] M. Zhang, **S. Chowdhury**, and L. Jiang. "Interference-based universal decoupling and swapping for multimode bosonic systems," [arXiv:2007.02385](#) (2020).
- [5] **S. Chowdhury**. "Comparing weak and projective measurements for quantum state tomography of a single-qubit system," [arXiv:1711.03645](#) (2017).

**One additional publication with Devoret group expected, 2021-22. Nb: I also have a few unpublished pedagogical notes and guides. Topics include quantum computing ([link](#)), quantum many-body theory ([link](#)) and nonlinear dynamics with complex variables ([link](#)).

Work and Research Experience

Undergraduate Researcher, Yale Qnantronics Laboratory, New Haven, CT

(Sept 2019 - Present)

Advisor: Prof. Michel Devoret

- I study the nonlinear dynamics of driven, dissipative superconducting qubits. Currently developing numerical Python simulations and analytic theory based on Floquet-Markov master equations to characterize the effect of quantum dissipation on driven multiphoton resonance phenomena and the onset of dynamical instabilities.
- Developed a theoretical [technique](#) to use complex coordinates in classical mechanics to characterize nonlinear dynamics of *classical* anharmonic oscillators. This maps back onto the analogous quantum oscillator (i.e. qubit) problem using a quantum-classical correspondence to yield key insights [\[1\]](#).
- Currently designing novel driven qubit-cavity experiments with superconducting circuits to test theory.

Undergraduate Researcher, Yale Quantum Institute, New Haven, CT
Advisor: Prof. Liang Jiang

(Dec 2018 - Present)

- I develop theoretical protocols for quantum transduction and bosonic mode control. Co-invented a new scheme to efficiently construct SWAP and decoupling operations in hybrid multimode systems using interference [2, 4]. Currently investigating possible generalizations to engineer two-mode Gaussian control in hybrid systems.
- Wrote simulation code in Mathematica/Python to model quantum transduction via symplectic algebra.
- I attend regular transduction research discussions and have presented [results](#) at weekly group meetings.

Junior Quantum Engineer, Rigetti Computing, Berkeley, CA
Advisors: Nicolas Didier, Prasahnt Sivarajah

(Jun 2019 - Jun 2020)

- Project 1 (**physics**): Designed and performed experiments to investigate the coherence properties of tunable transmon qubits under bichromatic flux modulation at dynamical sweet spots. Experimentally verified previous theoretical [results](#). Worked with senior quantum engineers to demonstrate high-fidelity two-qubit parametric gates using bichromatic pulses and developed a practical implementation within Rigetti software stack [3].
- Project 2 (**software**): Worked with software engineers to refactor core low-level measurement and control scripts in the Rigetti stack. Participated in code reviews, wrote unit-tests, and learned to write production level code.

Summer Undergraduate Researcher, Yale Wright Laboratory, New Haven, CT
Advisor: Prof. David C. Moore

(Jun 2018 - Nov 2018)

- Worked on a tabletop dark matter detection [experiment](#) using levitated microspheres as optomechanical force sensors. Designed and prototyped novel mechanisms for loading microspheres into optical trap, increasing the sphere trapping probability from $1/10^4$ to ~ 1 . Also helped assemble a new vacuum chamber for the lab.
- Presented preliminary [results](#) at Yale Undergraduate Research Symposium and the Greater Boston Physics Conference (at MIT).

Research Intern, Tata Institute of Fundamental Research, Mumbai, India
Advisor: Prof. Rajamani Vijayaraghavan

(Nov 2015 - Jan 2017)

- Developed stochastic Monte Carlo simulations to study projective and weak measurements for quantum state tomography. Programmed a quantum software library in C to handle density matrices and other quantum operations. Evaluated the efficiency of different measurement schemes for single-qubit tomography [5].
- Only high-school student intern at the Quantum Measurement & Control Laboratory (see group [webpage](#)).

Research Intern, Homi Bhabha Centre for Science Education, Mumbai, India
Advisor: Prof. Nagarjuna Gadiraju

(Jan 2015 - Oct 2016)

- Developed an agent-based complex-systems dynamical model (using Processing) to replicate swarming patterns of *P. redivivus* nematodes. Compared simulation results to live lab-grown cultures using videographic analysis.
- Presented [results](#) to 100+ researchers and students at the annual HBCSE public science symposium.

Student Technician, Yale Information Technology Services, New Haven, CT

(Oct 2017 - Nov 2019)

- As a Lenovo-certified student tech, I helped to diagnose and repair hardware- and software-related IT problems for students and other members of the Yale community.

Teaching Experience

Head of Curriculum, QxQ + The Coding School (Non-Profit Org)

(June 2020 - Present)

- Developed course materials and notes for The Coding School's *Qubit x Qubit* (QxQ) [initiative](#) to train the future diverse quantum workforce. Currently leading a team of curriculum developers to write a high-school level quantum textbook [exp. to be published by Princeton University Press]. In 2020-21, our QxQ "Intro to Quantum Computing" high-school course has 9000+ students enrolled across 125 countries. We have [partnered](#) with IBM Quantum Education to develop coding labs, practice problems, and other resources.
- Presented at TCS "Tech Talks" Panel Discussion on quantum computing for middle-/high-school students.

Physics Peer Tutor, Yale Centre for Teaching and Learning, New Haven, CT
Supervisor: Prof. Steven Girvin

(Aug 2018 - May 2019)

- Led weekly peer tutoring and walk-in homework help sessions for students of PHYS 260 & PHYS 261: Intensive Introductory Physics. On average 15-25 students (out of 55) regularly attended. Also provided extra one-on-one tutoring. Co-wrote a set of [course notes](#) with Prof. Girvin on quantum mechanics and quantum computing.

Volunteer Math Instructor, Yale MathCounts Outreach Program, New Haven, CT

(Sept 2017 - Sept 2018)

- Tutored 7th and 8th grade students in mathematics in preparation for the MathCounts National Competition.
- Devised weekly lesson plans for providing extra enrichment to supplement regular classroom learning.

Extracurricular and Leadership Experiences

President, Yale Society of Physics Students (SPS)

(Jan 2019 - Present)

- I organize weekly study sessions, dinners with faculty, and other academic and social events for members of the Yale Physics community. I also lead the SPS board and oversee various projects. We liaise with national SPS/ΣΠΣ as well as Yale Pathways to Science for outreach/demos to New Haven schools. We have a mentorship program, host informational workshops (e.g. grad admissions panel with Yale alumni) and maintain resources and student-oriented guides on our [website](#).
- In charge of managing logistics & finances for the Howard Schultz and Beatrice Tinsley student prize [lectures](#) (these involve bringing distinguished physicists to campus to lecture and spend time with undergraduate students).
- I communicate student feedback directly to the Physics Dept. chair as part of the undergrad advisory council.
- Awarded an SPS National “Outstanding Chapter” distinction (given to top 15% of chapters) for AY 2019-20.

Board Member, Yale Undergraduate Quantum Computing (YuQC)

(Nov 2020 - Present)

- As a newly-appointed board member, I am currently helping establish the YuQC club during its inception year at Yale. I curate and develop open educational resources for the YuQC website, and host workshops / tutorials.

Engineering Team Member, Yale Bulldogs Racing (Formula SAE Team)

(Sept 2017 - Feb 2018)

- Worked on the mechanical engineering subgroup to build the steering system components for the [team](#) electric vehicle. Helped to design parts in SolidWorks, create prototypes, and fabricate them along with other students.

Founder and President, ABWA Science Club, Mumbai, India

(Feb 2016 - July 2017)

- I founded the club my junior year and served as the president of the executive board for AY 2016-17. Activities included hands-on group science / engineering projects, weekly presentations on new developments in STEM, and peer mentoring. Along with the board, I developed a weekly plan of activities and projects, raised \$2000 in club funding, and helped provide guidance to 24 students from grades 7-12.

Awards, Honors, and Fellowships

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| • National Science Foundation (NSF) Graduate Research Fellowship (\$138,000) | (Mar 2021) |
| • MIT Irwin Mark Jacobs and Joan Klein Jacobs Presidential Fellowship | (Feb 2021) |
| • Semifinalist for Hertz Foundation Fellowship (top 10% of applicants) | (Jan 2021) |
| • Inducted to Sigma Pi Sigma National Honor Society for outstanding scholarship in physics | (Oct 2020) |
| • Awardee — Yale Domestic Summer Award (for remote research with Jiang group) (\$4000) | (Jun 2020) |
| • Awardee — Yale College Dean's Summer Research Fellowship (\$2500) | (May 2020) |
| • Awardee — Society of Physics Students Travel Award (\$300) | (Mar 2020) |
| • Recipient of American Physical Society (APS) Braslau Family Travel Grant (\$900) | (Feb 2020) |
| • <i>Yale Nominee</i> for Barry Goldwater Scholarship (1 of 4). | (Dec 2019) |
| • Scholarship Recipient — Rivkin-Tolson Endowed Scholarship Fund at Yale (~\$65,000 ×2) | (2019; 2020) |
| • Awardee — Yale First-Year Summer Research Sciences & Engineering Fellowship (\$4300) | (May 2018) |
| • Semifinalist (Top 300 of 1200+) — Regeneron Science Talent Search (STS) Competition (\$4000) | (Jan 2017) |

Talks and Conferences

- [1] **S. Chowdhury**, M. Zhang, and L. Jiang. “Engineering arbitrary two-mode Gaussian control using a multi-mode coupler” — **Talk** at American Physical Society (APS) March Meeting, 2021. See [abstract](#).
- [2] **S. Chowdhury**, M. Zhang, and L. Jiang. “*Decoupling Modes using Sequential Quantum Transducers*” — **Talk** at American Physical Society (APS) March Meeting in Denver, CO, 2020. In-person conference ultimately cancelled due to COVID-19, but my virtual [presentation](#) and [abstract](#) are available online. Likewise for talk [3] below.
- [3] M. Zhang, **S. Chowdhury**, and L. Jiang. “*Constructing Perfect Quantum Transducers Using Multi-Mode Imperfect Transducers*”— **Talk** at American Physical Society (APS) March Meeting in Denver, CO, 2020. [See [abstract](#)].
- [4] **S. Chowdhury**. “*Decoupling Modes using Sequential Quantum Transducers*” — **Poster presentation** at SPS & Sigma Pi Sigma National Physics Congress (“SPS PhysCon”) in Providence, RI, Nov. 2019. See [poster](#).
- [5] **S. Chowdhury**, F. Monteiro, and D. C. Moore. “*Novel techniques for trapping optically levitated microparticles*” — **Poster presentation** at Greater Boston Physics Conference (hosted at MIT), Nov. 2018. See [poster](#).
- [6] **S. Chowdhury**, F. Monteiro, and D. C. Moore. “*Novel techniques for trapping optically levitated microparticles*” — **Poster presentation** at Yale Undergraduate Research Symposium, Sept. 2018. See [poster](#).
- [7] **S. Chowdhury**. “*Modelling growth patterns of *P. redivivus* nematodes*” — **Talk** at Homi Bhabha Centre for Science Education Annual Public Symposium in Mumbai, India, Oct. 2016.

Skills and Other Info

Languages:	English, Hindi (<i>native</i>), Spanish, Bengali (<i>conversational</i>).
Programming/Tools:	Python + NumPy/SciPy/QuTiP, Mathematica, C, Processing, Unix/Linux, Git, LaTeX, CorelDRAW, IBM Qiskit (completed Qiskit Summer School with distinction), Rigetti Quil.
Other Activities @ Yale:	Yale Scientific Magazine (see article), Yale Club Squash, Yale Blockchain Collective.
Hobbies/Skills:	Woodworking; Reading novels; Music (Piano, Harmonica); Hiking and Squash.