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Junaid Aftab

Education

2020– **Ph.D. Candidate**, *University of Maryland, College Park*, Applied Mathematics.
2018–2020 **M.S.**, *Kansas State University*, Mathematics.
2013–2017 **B.S.**, *Lahore University of Management Sciences (LUMS)*, Economics & Mathematics.

Publications & Pre-Prints

Preprints

- **Junaid Aftab**, Christoph Schwab, Haizhao Yang, Jakob Zech. Quantum Circuit Encodings of Polynomial Chaos Expansions. Submitted to *Quantum*, arXiv:2506.01811.
- **Junaid Aftab**, Dong An, Konstantina Trivisa. Multi-product Hamiltonian simulation with explicit commutator scaling. Submitted to *Communications in Mathematical Physics*, arXiv:2403.0892.

Publications

- **Junaid Aftab**, Haizhao Yang. Approximating Korobov functions via quantum circuits. *Communications in Mathematical Sciences* 23(8), pp. 2077–2101, (2025).
- **Junaid Aftab**, Adam Zaman Chaudhry. Analyzing the quantum Zeno and anti-Zeno effects using optimal projective measurements. *Scientific Reports* 7, 11766 (2017).

Research Projects: In Preparation and In Progress

- **Junaid Aftab**, 2D Hyperbolic Matter via Non-Commutative Geometry, The project aims to classify phases of matter in hyperbolic lattices using techniques from non-commutative geometry.
- **Junaid Aftab**, Topological Phases of Free Fermions in 2D Hyperbolic Matter via Freed–Moore K-Theory. The project aims to classify free-fermion phases in hyperbolic lattices using K-Theory.
- **Junaid Aftab**, Multi-Product Formula Enhanced Linear Combination of Hamiltonian Simulation Algorithm. The project analyzes the error scaling of the integrated multi-product formula and linear combinations in Hamiltonian simulation algorithms..
- **Junaid Aftab**, Non-Uniform Quantum Fourier Transform. The purpose of this project is to propose a quantum algorithm for the non-uniform discrete Fourier transform.

Research Internships

2023 **Quantum Computing Summer School**, Los Alamos National Laboratory.
- Used tools from representation theory to investigate the effect of noise in quantum neural networks

Awards & Fellowships

2024–2026 **Math Quantum Research Training Program Fellowship**, *University of Maryland, College Park*.
2024 **Herbert A. Hauptman Summer Fellowship**, *University of Maryland, College Park*.
2020–2022 **Dean's Fellowship**, *University of Maryland, College Park*.
2017 **NMF Gold Medal**, *Lahore University of Management Sciences*.
2013–2017 **Dean's Honour List**, *Lahore University of Management Sciences*.

Talks

2024–2025 **Multi-product Hamiltonian simulation with explicit commutator scaling**.
- MathQuantum Symposium 2025, University of Maryland
- TQC Conference 2024, Okinawa Institute of Science and Technology

2022–2025 **Research Interaction Team (RIT)**, *University of Maryland*.
- RIT on Geometry and Physics. March 2023, March 2025.
- RIT on Machine Learning. Oct. 2022.

2022 **Quantum Error Correction Reading Group**, *University of Maryland*, Homological Product Codes.

Conferences, Summer Schools

June 2025 **QFT and Topological Phases via Homotopy and Operator Algebras**, *Harvard University*.

August 2024 **C*-Algebraic Quantum Mechanics and Topological Phases of Matter**, *CU Boulder*.

July 2024 **Groundwork for Operator Algebras Lecture Series**, *Institute for Pure & Applied Math (IPAM)*.

July 2023 **PCMI Graduate Summer School**, *Park City Mathematics Institute (PCMI)*.

Teaching

2022, 2024 **Instructor**, *University of Maryland*,
As the main instructor, I developed syllabi, quizzes, exams, and homework for the courses listed below. A star indicates I was ranked excellent by student course evaluations.
- MATH 120: Elementary Calculus. Summer 2024*
- MATH 141: Calculus II. Summer 2022*

2020– **Graduate Teaching Assistant**, *University of Maryland*,
I organized weekly recitation sessions which were designed to go over worksheets and homework problems. My goals were for students to learn through guided exploration.
- MATH 240: Linear Algebra. Fall 2023
- MATH 140: Calculus I. Fall 2022
- MATH 135: Discrete Mathematics for Life Sciences. Fall 2021
- MATH 141: Calculus II. Spring 2021, Spring 2023
- MATH 120: Elementary Calculus. Fall 2020

Mentoring

2025– **Research Mentor**, *University of Maryland*.
I have mentored undergraduate students as part of the MathQuantum RTG.
- Ava Petusky, Spring '25. Presented poster on quantum simulation at MathQuantum Symposium.

2022– **Directed Reading Program**, *University of Maryland*.
The Directed Reading Program (DRP) pairs undergraduate students with graduate student mentors for semester-long independent study projects. I have mentored the following students:
- Kelin Zhu, Fall '25. K-Theory.
- Aiden Higgs, Fall '24. Categories in Quantum Theory.
- Nashita Bhuiyan, Spring '24. Learning Theory: PAC-Learning & VC dimension.
- Koran Bailey, Spring '23. Classical & Quantum random walks.
- Matthew Cimerola, Fall '22. Neural Networks and Their Applications.

Service

2024–2025 **MathQuantum RTG Outreach**, *University of Maryland*.
I volunteered for various outreach activities promoting quantum computing to a general audience as part of the MathQuantum RTG program.
- Maryland Day 2025.
- "Spooky Math" Halloween Science Fest 2024 in Virginia.

2024 **Course Staff**, *University of Maryland*.
I assisted professors in designing the course materials for AMSC 698: Mathematics of Quantum Information.

2024 **Guest Lecturer**, *University of Maryland*.
I was asked to deliver two lectures for a graduate-level course on differential geometry.

Software

Programming	`Python, Julia, MATLAB, Qiskit, Mathematica, LaTeX`
Data Analysis	`PyTorch, Pandas, Scikit-Learn, Seaborn, Jupyter`
Mathematics	`SageMath, SymPy, SciPy`