

Tatum “Tate” G. Middleton

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RESEARCH INTERESTS

Quantum information, quantum and classical machine learning, diffusion models, physics of AI, AMO physics

EDUCATION

University of Colorado Boulder - Physics B.S., Computer Science Minor

08/2023-12/2026

Relevant Courses:

- Quantum Information and Computing (Graduate), Quantum Mechanics 2, Thermodynamics and Statistical Mechanics, Classical Mechanics + Math Meth. 2, Electricity + Magnetism 2, Modern Physics, Experimental Physics, Electronics for the Physical Sciences
- Probability Theory (Graduate), Linear Algebra, Discrete Math, Calculus and Differential Equations
- Algorithms, Data Structures, Computer Systems, Software Development

Awards and Honors:

- Hale Esteemed Scholarship (2023-2027)
- CU Boulder Quantum Hackathon - 3rd place (2023/2024)
- **Google Fellow** - Corporate Computing Affiliates Program (2024/2025)
- **SPIE (International Society for Optics and Photonics) Fellow, Monroe Fellow, and Jennifer Turner-Valle Fellow** - Quantum Scholars Cohort (2024-2027)
- Bowman Physics Scholarship (2026/2027)

Gene Golub SIAM Summer School, Duke University - *Fault Tolerant Algorithms in Quantum Computing* July 2026

- Graduate student and postdoctoral summer school on quantum computing, accepted with full financial support
- Covered various core techniques in quantum computing and quantum algorithms, with focus sessions for theory
- Focused on a variety of research-level topics in majority of lectures including Hamiltonian learning and simulation, quantum error correction, and applications on quantum hardware
- Conducted literature review project on quantum error correction, specifically LDPC codes and the Clifford hierarchy

Summer School on Formal Techniques, SRI International

May 2026

- Received an introduction to Yices and PVS, formal methods languages created by SRI International in collaboration with NASA JPL
- Learned about application of formal methods to quantum compilers by Aws Albarghouthi

PUBLICATIONS AND PREPRINTS

- *Observing Gravity Waves in the Thermosphere through Solar Occultations*, 2025 – Under Review
- *Quantum MRF MAP Inference on Extended Bose-Hubbard Machines*, 2026 - In preparation
- *Semantic Geometry of Datasets via Speciation Times* - In preparation (honors thesis)

TALKS & PRESENTATIONS

- **CU Boulder Undergraduate Research Expo (Sp. '26)**, “[Inference on Bose-Hubbard Machines via MRF MAP](#)”
- **Colorado Undergraduate Physics Conference (Fall 2025)**, Quantum Information Theory Section: “*Computer Vision and Image Restoration on Bose-Hubbard Machines*”
- **CU Boulder AI Club (VP of Technology), technical lecture series (Fall 2025):**
 - “*Coding Foundations & Why AI Matters*” - introduction to Python and AI
 - “*Data, ML, and AI - What are they?*” - introduction to supervised, unsupervised, and reinforcement learning
 - “*Running AI on Your Own Device*” - introduction to local LLMs and tuning parameters (temperature, top_k, top_p, etc.)

RESEARCH EXPERIENCE

SRI International, Boulder, CO

05/2026 - Present

Applied Physics Intern

- Designed an optics experiment to **test and verify attacks against BB84 quantum key distribution systems**, collaborated with theory team to validate models of attacks, measured outputs with single photon counters and tracked with FPGAs
- Designed, simulated, and tested **photonic integrated circuits**, including ring resonators and optical phased arrays
- **Simulated ring resonators in Tidy3D, to verify properties**, such as modes, wavelengths, and quality factor
- Built a 64-channel photonic hardware control system: **PySide6/Qt** panel with live telemetry plotting, communicating with a **Zynq FPGA** over TCP sockets for real-time channel control and gain persistence

JILA, Xun Gao Group - University of Colorado (ML/QML)

09/2024 - Present

Undergraduate Researcher

- Analyzed the semantic geometry underlying datasets using diffusion models dynamics, informed by conditional mutual information phase transitions along denoising paths, continuing work of arxiv.org/pdf/2605.04830 (honors thesis work)
- Adapting classical MRF MAP into quantum adiabatic algorithms targeting quantum advantage on neutral-atom hardware
- Created an experimental topological Hopfield network model for Bose-Hubbard quantum computers
- Simulating neutral atom lattice dynamics and quantum-analogous dynamics using tensor-network methods with **DMRG** and **TDVP** via **TeNPy**
- Explored applying stochastic path-integral methods (Martin-Siggia-Rose) to characterize the source and limits of computational advantage for ML on quantum and thermodynamic sampling platforms
- Created initial ML models for novel diffusion model methods, utilizing novel approaches to data usage to allow for significant speedups and quality improvements in generation of images, precursor work to arxiv.org/pdf/2508.06614
- Created models using **Pytorch**, and **TensorFlow**

JILA, Adam Kaufman Group - University of Colorado (Quantum Computing/AMO Physics)

05/2024 - 08/2025

Undergraduate Researcher

- Simulated and built a Fabry-Perot optical cavity, tuned to integer wavelength length for atomic control
- Created a novel numerical simulation of Gaussian beam propagation through complex optics, with ABCD matrices and numerical linear algebra accurate to **0.001 mm**
- Used **Python**, a **Raspberry Pi**, and **USB serial** to create a closed loop **PID** system, to correct positional drift by lasers with **97% accuracy** and **millisecond compute and correction times**, for neutral atom quantum computers

Laboratory for Atmospheric and Space Physics, Thiemann Group - University of Colorado

08/2022 - 05/2023

Student Researcher

- Contributed to ongoing research at LASP by creating an image processing program in MATLAB, to directly observe high altitude gravity waves **for the first time**, in images taken by NASA satellites
- Researched causes of weather phenomena related to gravity waves, as well as their effects on the weather on Earth, in space, and on other planets
- **Co-authored journal paper** "*Observing Gravity Waves in the Thermosphere through Solar Occultations*" (under review) on successful results of the project with mentor, Edward Thiemann
- **MATLAB, technical writing, technical presentations**

INDUSTRY EXPERIENCE

Pure Fishing (AI for Businesses)

05/2025 - Present

AI Intern

- Independently built a full-stack LLM web app generating marketing material end-to-end; engineered system prompts and refined outputs, saving an estimated **\$1.1M/year** in marketing overhead cost
- Managed a team of six other interns to deploy web app to offices over 12 brands and 12 countries
- Helped build a marketing-material reference database for senior staff
- Used **OpenAI API**, **Flask**, **Jinja**, **Tailwind**, **JavaScript**

PROJECTS

- [M24 Quantum Cryptography Encoding Scheme](#): Designed a quantum cryptography scheme based on quantum random walks for eavesdropping protection, for PHYS 2170
- [Quantum Perceptron](#) - Created a single node quantum NN to read digits from MNIST, **85%** accuracy, *Qiskit*
- [Stock Price Predictor](#): Created a script to try and predict stock price based on Shannon Entropy of stock price
- [Powerwash](#): Created a full stack web app for automatic data cleaning, with functions such as normalization, and classification

SKILLS

- **Mathematics & Theory**: Linear algebra, probability theory, optimization, numerical methods
- **Physics**: Quantum information theory, AMO physics, optics, laser physics, statistical mechanics
- **Machine Learning & AI**: Diffusion models, neural networks, entropy-based methods
- **Programming Languages**: Python, C++, SQL, JavaScript, HTML, CSS, MATLAB, SystemVerilog
- **Frameworks & Scientific Libraries**: PyTorch, TensorFlow, Qiskit, PennyLane, OpenCV, Pandas, PIL, TeNPy
- **Systems & Hardware**: Arduino, Raspberry Pi, FPGAs Quartus
- **Development & Tooling**: Git/GitHub, Docker, Flask, Node.js/Express.js

ACADEMIC SERVICE

AI Club at CU Boulder - VP of Technology

01/2025 - Present

- Created the club's first technical development curriculum, in a series of talks to teach basic fluency with Python and LLMs
- Creating club's first research cohort with goal of researching AI safety for LLMs, currently working on investigating where hallucination phase transitions occur in LLMs and how the critical point changes over distillation
- Helped plan weekly club meetings and speakers, with speakers including Apple, Cisco, Plante Moran, Coinbase, Red Bull, Quadratic, and Drive Capital, sourced and presented AI news for weekly meetings

Partnerships for Informal Science Education in the Community (PISEC)

08/2025 - Present

- Visited high schools in the greater Boulder Valley area, and helped with science and engineering instruction in the classroom, and gave mentoring on paths to pursuing STEM in college

Quantum Scholars, Alice and Bob Mentorship Program

09/2025 - Present

- Was paired up with another physics student and gave mentoring on physics at CU, including research, academics, and life outside of the physics major

Tutoring

09/2024 - Present

- Tutored high school students and peers in a variety of physics topics, MCAT topics, computer science, math and Spanish

Triangle Engineering and Science Fraternity - Co-Founder

08/2023 - 10/2024

- Helped to found the premier social STEM fraternity on campus, now up to ~70 members
- Helped plan rush, philanthropy, and chapter events, recruited members for first rush class