

Spencer Lee

Curriculum Vitae

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Experience

- 2021–Present **Graduate Research Assistant**, *Michigan State University*, East Lansing, MI.
- Created the Julia software package `QuantumGateDesign.jl`, for optimal control of quantum systems using smooth pulses. Finds ideal pulses quickly using high-order time steps and second-order optimization.
 - Derived discrete adjoint equations for high-order Hermite methods applied to Schrödinger's equation, enabling fast and exact gradient computations for quantum optimal control.
 - Investigated using Filon methods to efficiently integrate high-frequency systems of ODEs, e.g. Schrödinger's equation for superconducting qubits.
 - Researched using neural ODEs to learn computationally cheap Magnus expansion solutions to Schrödinger's equation for accelerated simulation of quantum systems under external control.
- 2023, 2025 **Long Workshop Participant**, *Institute for Pure and Applied Mathematics*, *University of California, Los Angeles*, Los Angeles, CA.
- Collaborated with a diverse group of mathematicians, physicists, and computer scientists from academia and industry on problems in quantum computing (2023) and non-commutative optimal transport (2025).
 - Organized a working group exploring optimal-transport-inspired objective functions for quantum control.
- 2024 **Project Manager, G-RIPS**, *Advanced Institute for Materials Research*, *Tohoku University*, Sendai, Japan.
- Led a group of five graduate students from the United States and Japan in developing novel classical parameter-setting strategies for the Quantum Approximate Optimization Algorithm (QAOA).
 - Cooperated with researchers from Mitsubishi Electric, who sponsored this project.
- 2023 **Visiting Scholar**, *Los Alamos National Laboratory*, Los Alamos, NM.
- Studied physical and numerical considerations for the simulation of plasmas.
 - Accelerated simulation of runaway electrons in Tokamak fusion reactors using CUDA-enabled GPUs.
 - Visualized electron behavior using Poincaré plots to identify computationally challenging regions of the reactor.

- 2022 **Computing Student Intern**, *Lawrence Livermore National Laboratory*, Livermore, CA.
- Used compositional techniques to create high-order integration methods from low-order, symmetric ones in the quantum control package Jqbox.jl.
 - Demonstrated by numerical experiments that high-order methods accurately simulate the physics of relevant 2-qubit systems at one-tenth the computational cost of second-order Störmer-Verlet.
 - Achieved similar results using the implicit midpoint rule, a more stable alternative, as the base method.
- 2020–2021 **Post-Baccalaureate Research Associate**, *Michigan State University*, East Lansing, MI.
- Member of the FEX-Hub project for development of hardware to manage the flow of trigger data from the ATLAS detector of the Large Hadron Collider.
 - Wrote object-oriented Python scripts to conduct Integrated Bit Error Ratio Tests (IBERT) of multi-gigabit transceivers on FPGA and generate eye diagrams to analyze accuracy when transmitting at high bandwidths.
 - Added new features to FPGA firmware using VHDL in Vivado Design Suite.
- 2019 **Summer Research Associate**, *CERN*, Geneva, Switzerland.
- Analyzed C firmware of a microcontroller for ATCA compliance as part of upgrades to the Level 1 Calorimeter Trigger of the Large Hadron Collider.
- 2016–2020 **Undergraduate Research Associate**, *Michigan State University*, East Lansing, MI.
- Created an interactive Python GUI to run and display perfSONAR network measurement tests, manage Ethernet switch stress tests, and generate automated reports.
 - Organized and configured Linux test nodes for use in network stress tests.

Education

- 2021–Present **Ph.D. in Computational Mathematics, Science, & Engineering**, *Michigan State University*, East Lansing, MI, *GPA – 3.94/4.0*.
- 2016–2020 **Dual Bachelor of Science in Advanced Mathematics and Physics**, *Michigan State University*, East Lansing, MI, *GPA – 3.97/4.0*.
Graduated with High Honors, Member of Honors College.

Awards

- 2022–2027 **National Science Foundation Graduate Research Fellowship**
- 2021 Michigan State University Rasmussen Fellowship Award
- 2019 McCartney Endowed Educational Enrichment Fund
- 2018 Lawrence W.Hantel Endowed Fellowship Fund
- 2018 Paul and Wilma Dressel Endowed Scholarship for Mathematics

Publications

- 2026 Spencer Lee and Daniel Appelö. *High-order Hermite optimization: Fast and exact gradient computation in open-loop quantum optimal control using a discrete adjoint approach*. *Journal of Computational Physics*, 552, p. 114697. [Link]

Technical Reports & White Papers

- 2025 White paper: *Non-commutative Optimal Transport*. Institute for Pure and Applied Mathematics (IPAM), UCLA. [Link]
- 2024 Rie Fujii et al. Technical Report: *G-RIPS Mitsubishi-B Project: Final Report*. Tohoku University Advanced Institute for Materials Research (AIMR). [Link]
- 2024 White paper: *Mathematical and Computational Challenges in Quantum Computing*. Institute for Pure and Applied Mathematics (IPAM), UCLA. [Link]
- 2022 Spencer Lee, Stefanie Guenther, and N. Anders Petersson. Technical Report: *Compositional Methods for Schrödinger's Equation with Application to Optimal Control*. Lawrence Livermore National Laboratory (LLNL). [Link]
- 2018 Dan Edmunds et al. Technical Specification: *ATLAS Level-1 Calorimeter Trigger Update, HUB Firmware Specification*. Michigan State University.
- 2018 Dan Edmunds et al. Technical Specification: *ATLAS Level-1 Calorimeter Trigger Upgrade, FEX System Switch Module (FEX Hub) Prototype*. Michigan State University.

Talks

- 2025 *Building Blocks of Quantum Computing: QuantumGateDesign.jl - Quantum Optimal Control Tutorial*. Talk at Society for Industrial and Applied Mathematics (SIAM) Annual Meeting 2025, Montreal, Quebec.
- 2025 *High-Order Hermite Optimization for Quantum Gate Design*. Talk at Society for Industrial and Applied Mathematics (SIAM) Annual Meeting 2025, Montreal, Quebec.
- 2025 *HOHO - High-Order Hermite Optimization for Quantum Optimal Control*. Talk at CMSE 10th Anniversary Workshop & 5th Data Science Student Conference, Michigan State University, East Lansing, Michigan.
- 2025 *Quantum Optimal Control, Barren Plateaus, and Wasserstein Distances*. Talk at Institute for Pure and Applied Mathematics (IPAM) NOT2025 Culminating Retreat, Lake Arrowhead, California.
- 2025 *Quantum Optimal Control: How It's Done and Why You Should Use My Software*. Talk at Institute for Pure and Applied Mathematics (IPAM) CQC2023 Reunion, Lake Arrowhead, California.
- 2024 *Classical Parameter-Setting Strategies for the Quantum Approximate Optimization Algorithm (QAOA)*. Talk at Graduate-level Research in Industrial Projects for Students (GRIPS) Final Presentation, Tohoku University Advanced Institute for Materials Research (AIMR), Sendai, Japan.
- 2024 *Designing Quantum Gates Using High-Order Hermite Methods*. Talk at Society for Industrial and Applied Mathematics (SIAM) Annual Meeting 2024, Online.
- 2024 *Fast, High-Order Solvers for Quantum Optimal Control*. Talk at Quantum Information and Computation (QuIC) Seminar, Michigan State University, East Lansing, Michigan.

- 2023 *Classically-Simulated Quantum Optimal Control Methods for Designing Gates using Continuous Control Functions*. Talk at Institute for Pure and Applied Mathematics (IPAM) CQC2023 Student Seminar Series, IPAM, Los Angeles, California.
- 2023 *Implicit Filon Methods for Highly Oscillating Problems, Gate Design for Controlled Qubits*. Talk at American Mathematical Society (AMS) 2023 Spring Sectional, University of Cincinnati, Cincinnati, Ohio.
- 2022 *Implicit Filon Methods for Highly Oscillating Problems, Gate Design for Controlled Qubits*. Talk at Waves 2022, ENSTA-Paris, Palaiseau, France.

Posters

- 2025 *QuantumGateDesign.jl: High-Order Methods, Fast Gate Design*. Poster at International conference on Quantum Simulation and Quantum Walks (QSQW) 2025, Naples, Italy.
- 2024 *QuantumGateDesign.jl: Higher-Order Methods for Faster Gate Design*. Poster at Kernel Methods in Uncertainty Quantification and Experimental Design workshop, Institute for Mathematical and Statistical Innovation, Chicago, Illinois.
- 2023 *Filon Time Integration for Gate Design*. Poster at Accelerated Research in Quantum Computing (ARQC) All-hands Meeting, Berkeley National Lab, Berkeley, California.
- 2022 *Numerical Methods for Highly Oscillatory Problems in Quantum Computing: Quantum State Evolution Simulated using Implicit Filon Quadrature*. Poster at Midwest Numerical Analysis Day 2022, University of Michigan, Ann Arbor, Michigan.

Skills

Programming	JULIA, PYTHON, C, C++, CUDA, GIT, L ^A T _E X, CLAUDE CODE, LINUX OS, VHDL, MATLAB, MATHEMATICA
Interests	Quantum Optimal Control, Simulating Physics, Scientific Software, Visualizing Information, Applied Research, Pedagogy, Computer Graphics
Soft Skills	Leadership, Independent Learning, Communication, Presentation, Teamwork