Spencer Lee

Curriculum Vitae

Dept. of Comp. Math, Science, & Engineering
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Education

2021–Present **Ph.D. in Computational Mathematics, Science, & Engineering**, *Michigan State University*, East Lansing, MI, *GPA – 3.94/4.0*.
Course Highlights: Numerical Methods for Differential Equations, Quantum Mechanics, Applied Machine Learning, Numerical Linear Algebra, Data Science, Parallel Computing.

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.

Experience

2021–Present **Graduate Research Assistant**, *Michigan State University*, East Lansing, MI.
Researching mathematical problems in quantum computing with Dr. Daniel Appelö.

- 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 Univeristy*, 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 Juqbox.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.

Publications

2026 Spencer Lee and Daniel Appelo. *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*.

Other Technical Writing

2025 White paper: *Non-commutative Optimal Transport. Institute for Pure and Applied Mathematics (IPAM), UCLA.*

2024 Rie Fujii et al. Technical Report: *G-RIPS Mitsubishi-B Project: Final Report. Tohoku University Advanced Institute for Materials Research (AIMR).*

2024 White paper: *Mathematical and Computational Challenges in Quantum Computing. Institute for Pure and Applied Mathematics (IPAM), UCLA.*

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).*

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.*

Oral Presentations

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.

Poster Presentations

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.

Awards

2022–2027 **National Science Foundation Graduate Research Fellowship**

2021 Michigan State University Rasmussen Fellowship Award

2020 Lawrence W.Hantel Endowed Fellowship Fund

2019 McCartney Scholarship Award

2018 Paul and Wilma Dressel Endowed Scholarship for Mathematics

Skills

Programming Julia, Python, C, C++, CUDA, Git, LaTeX, 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