Thomas Steckmann

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Education

North Carolina State University: *4.0 GPA - Physics B.S.* | *Mathematics B.S.* Raleigh, NC

University Honors; Physics Honors; Math Honors; Sigma Phi Sigma; Phi Beta Kappa; Park Scholar *Aug. 2018 – May 2022*

Research

Hamiltonian Fast-Forwarding Algorithm Summer 2020 - Spring 2021

Oak Ridge National Laboratory and North Carolina State University *Oak Ridge, TN*

- Investigated the application of Lie group decomposition to produce an efficient circuit for matrix exponentials, which has benefits in long-time simulation of quantum systems on quantum computers.
- Work lead directly to an in-review publication: Fixed Depth Hamiltonian Simulation via Cartan Decomposition
- Developed and published a python package to simplify the implementation of the decomposition algorithm and to encourage exploration into applications beyond the expertise of the authors: Cartan Quantum Synthesizer

Algorithms for Error-Prone Quantum Computers Summer 2021 - Present

Oak Ridge National Laboratory and North Carolina State University *Oak Ridge, TN*

- Using the Cartan decomposition based fast-forwarding algorithm previously developed, we successfully implemented an algorithm to compute the Mott-insulator phase transition on noisy quantum hardware
- Due to significant errors, we develop or employ a variety of error mitigation techniques to simplify the calculation of the system dynamics (Green's function).
- Lead author on an article for submission to Quantum Science and Technology, demonstrating the first successful study of the Mott phase transition on quantum hardware and one of the largest interacting systems fast-forwarded on quantum hardware: arXiv preprint

Optimization Methods for Cartan Decomposition Spring/Fall 2021

North Carolina State University *Raleigh, NC*

- Continuing work on understanding and improving the optimization methods used in Cartan decomposition
- Explored cost function calculations on quantum hardware in order to reduce the complexity of the classical cost function used in the Cartan Quantum Synthesizer
- Successfully mapped the cost function minimization problem to a parameter flow in Lax dynamics, which allows for finding a solution through numerical integration of an ordinary differential equation and reduces the calculation complexity.

Organic Electronics June 2018 – June 2020

North Carolina State University - Organic and Carbon Electronics Lab *Raleigh, NC*

- Investigated the relationship between the morphological characteristics and the electronic characteristics of organic transistors.
- We demonstrate that an efficient fabrication method using floated polymer films can be used to preserve high quality charge transport in films down to only two molecular layers. This is significant improvement compared to the existing understanding of N2200, the semiconducing polymer used, and opens up possibilities for highly material efficient, transparent, and flexible electronics.
- Experience managing a project in an experimental laboratory setting, including designing experimental procedures and working in a collaborative research setting.
- Submitted to Advanced Electronic Materials: Manuscript. Results presented at the Material Research Soceity Fall 2020 meeting.

Technical Skills and Relevant Coursework

Programming Languages: Python, Java, Mathematica, HTML, CSS, LaTeX
Libraries/Packages: Qiskit, NumPy, Scipy, Matplotlib
Featured Course Work: Graduate Level: Mathematical Foundations of Quantum Computation | Linear Algebra | Complex Analysis | Computational Physics | **Undergraduate Level:** Modern Algebra | Quantum Mechanics | Cryptography | Java Software Development

Publications and Presentations

Publications:

- **Thomas Steckmann**, Trevor Keen, Alexander F Kemper, Eugene F Dumitrescu, and Yan Wang, "A highly optimized quantum algorithm for accurate simulations of dynamical impurity models on noisy quantum hardware," (Submitted: Quantum Science and Technology December 2021) arXiv preprint
- **Thomas Steckmann**, Indunil Angunawela, Somayeh Kashani, Youqin Zhu, Masrur M. Nahid, Harald Ade, and Abay Gadisa, "Ultrathin P(NDI2OD-T2) Films With High Electron Mobility in Both Bottom-gate and Top-gate Transistors" (Submitted: Advanced Electronic Materials December 2021) Available Manuscript
- Efekan Kökcü, **Thomas Steckmann**, JK Freericks, Eugene F Dumitrescu, and Alexander F Kemper, "Fixed depth hamiltonian simulation via cartan decomposition," (In review: Physical Review Letters, April 2021) arXiv preprint arXiv:2104.00728

Presentations:

- 2nd place, "Efficient Quantum Simulation on a Quantum Computer," McCormick virtual Symposium | 2021
- "Constant Depth Exact Time Evolution of Spin Systems Based on Cartan Decomposition," National Council For Undergraduate Research | 2021
- "Scalable Fabrication of High Mobility Monolayer OFETs Using Floating Film Transfer" Virtual poster, Material Research Society | 2020
- Honorable Mention, "High Efficiency Semiconducting Polymer Self-Assembly in Organic Transistors" McCormick virtual symposium | 2020
- 3rd place. research proposal: "Aggregation Mechanisms in Low Temperature Ultrathin Water-Floated Films Future" Future of Materials IV Workshop | 2020

Quantum Computing

Undergraduate School on Experimental Quantum Information Processing | *University of Waterloo* Summer 2021

- Virtual summer program featuring lectures on the theory and implementation of quantum algorithms, qubit architectures, and quantum communication protocols

Quantum Ideas Summer School | *Duke University STAQ collaboration* Summer 2019

- Introduction to quantum computing hardware approaches including superconducting and trapped Ion systems
- Exploration of advanced variational algorithms and error correcting codes

Quantum Computing Hackathons with Qiskit 2020

- Qiskit Hackathon Global: With a team of five students, developed an easy to use function to evaluate the Quantum Volume of IBM hardware during this 24 hour invite only event
- NC IBM Q Summer Jam: Implemented an algorithm for quantum PageRank using Quantum Random Walk

Community Engagement and Leadership Development

Quantum Information Club at NC State | *Co-founder, Current President* March 2020 – Present

- Developing approachable programming in quantum computing for undergraduate students with a range of math, science, and engineering backgrounds by working closely with community partners such as the NC State Q Hub and IBM Qiskit, and university groups at UNC Chapel-Hill, Duke, Georgetown, and Georgia Tech
- Primary organizer for the 2020 North Carolina IBM Summer Jam Hackathon with over 60 participants, and a workshop co-organized with IBM Qiskit with over 40 participants

Park Scholarships 2018 -2022

- Four year, merit based scholarship awarded for excellence in Leadership, Service, Character, and Scholarship
- Development courses focusing on leadership, civic engagement, and diversity

CrowdSolv Developer 2019-2020

- Volunteer front end development (HTML, CSS, BootStrap, Javascript) for CrowdSolv, a non-profit building a collaborative platform for crowd-sourced problem solving

Habitat for Humanity | Works Project Officer 2019-Present

- Regular volunteer with Habitat Wake and the NCSU chapter to promote affordable housing access and work in home construction
- As a club officer, I assist with fundraising efforts, facilitate student involvement, and work with construction leaders to guide and train new volunteers