Kyle Sherbert

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OBJECTIVE

A theoretical position studying the fundamental role of information in physics.

STATEMENT

Expert in multi-disciplinary sciences (▼ quantum physics, ♥ biochemistry, ♦ information theory); algorithm development with ♣ classical and ■ quantum computers; communicating arcane concepts through teaching and writing; and in walking to unwalkable places.

EDUCATION

Ph.D - **Physics**
University of North Texas, Denton, TX — exp. May 2022

MS - **Physics**
University of North Texas, Denton, TX — Dec 2020

MS - **Computer Science**
Towson University, Towson, MD — May 2017

BS *cum laude* - **Physics**; **Molecular Biology, Biochemistry and Bioinformatics**
Towson University, Towson, MD — Aug 2015

PRESENTATIONS

▼♥♦■ - An adaptive pulse-level variational quantum eigensolver. — Talk, *APS March Meeting*. 2024; Poster, *VTQ Symposium*. 2023

▼♥♣■ - Julianic simulations of a pulse-level VQE. — Talk, *JuliaCon*. 2023

♦■ - Quantum compressive sensing. — Talk, *VTQ Internal Seminar*. 2022; Talk, *SCaN Breakout Intern Seminar*. 2021; Talk, *NASA/NRO Intern Symposium*. 2021; Talk, *SCaN Intern Symposium*. 2021

▼■ - Band theory on a quantum computer. — Invited Talk, *ES22*. 2022

▼♥♦■ - Band theory and beyond. — Poster, *UNT MRS Poster Competition*. 2022; Talk, Sandia National Labs. 2022; Talk, Lawrence Berkeley National Labs. 2022; Talk, Dartmouth College. 2022; Talk, Virginia Tech. 2022; Dissertation defense. 2022

▼■ - Implementing Trans. Quantum Subspace Expansion with fewer qubits. — Talk, *APS March Meeting*. 2022

▼♥■ - Applying present-day quantum computers to materials science. — Dissertation proposal. 2021

▼■ - Band structure in a quantum computer. — Talk, *APS March Meeting*. 2021

▼■ - A tutorial in variational quantum computing. — End-of-term presentation. 2019

♥ - Seeking complexity in a nonlinear equilibrium chemical potential. — Student lecture. 2019

▼ - Predicting electron spin from scratch. — End-of-term presentation. 2019

♦♣ - Information reconciliation for erasure channels. — Thesis defense. 2017

▼♦♣ - Information entropy of 1D quantum systems. — Poster, *TU Research Expo*. 2015

- Surviving abroad without a smartphone. — Poster, *TU Honors College Expo*. 2015

♥♣ - Exploring natural product formation with structural biology. — Talk, *MB3 Club Seminar*, 2015; Poster, *CTRC Summer Research Colloquium*, 2014; Talk, *HWI Weekly Seminar*, 2014

▼♣ - Computational simulation of electron diffraction. — Poster, *TU Research Expo*. 2014; Poster, *APS March Meeting*. 2014

PUBLICATIONS

- On the scalability of pulse-level VQE with chemical complexity (TBP)
- Avoiding symmetry roadblocks in pulse-level VQE (TBP)
- An adaptive pulse-level variational quantum eigensolver (TBP)
- Degrees of freedom in pulse-level VQE (TBP)
- Quantum compressive sensing: mathematical machinery... *Appl. Sci.* (**12**: 15). 2022
- Band theory and beyond: ... quantum algorithms for quantum chemistry. Poster and dissertation.* 2022
- Quantum algorithm for ... band structures with local tight-binding orbitals. *Scientific Reports* (***12***). 2022
- A systematic ... band theory in a quantum computer. *RSC Adv.* (**11**). 2021
- Quantum computation of silicon ... band structure. *Phys. Chem. Chem. Phys.* (**22**). 2020
- Seeking complexity in a nonlinear equilibrium chemical potential. Report.* 2019
- Music theory: methods for mathematical music. Report.* 2018
- Hello, World!—Code Responsibly. *IEEE Security & Privacy* (**16**: 1). 2018
- Information reconciliation for erasure channels. Master's thesis.* 2017
- Information entropy of 1D quantum systems. Poster and report.* 2015
- Surviving abroad without a smartphone. Poster.* 2015
- An analysis of the PLAST model for quasars. Term paper.* 2014
- The Circus Game. Pedagogical short story.* 2014
- Scarlet's Letters. Pedagogical short story.* 2014
- Exploring natural product formation with structural biology. Poster and report.* 2014
- Computational simulation of electron diffraction. Poster.* 2014

* Available on my personal website, kmsherbert.neocities.org

RESEARCH EXPERIENCE

Post-doctoral Researcher Fall 2022-Present

Departments of Chemistry, Physics, Virginia Tech, Blacksburg, VA

Faculty Mentors: Nick Mayhall, Sophia Economou, Ed Barnes

- Explored alternative pool choices for sc-ADAPT-VQE in characterizing the Schwinger model.
- Adapted the ADAPT-VQE algorithm to use Renyi divergence as a cost function.
- Assisted in the development of a dedicated Julia package representing Pauli operators.
- Supported fellow postdoc in applying the BKSF qubit mapping to ADAPT-VQE
- Supervised graduate student in implementing ctrl-VQE in available quantum hardware.
- Developed novel adaptive algorithm to strategically add in parameters in ctrl-VQE.
- Derived symmetry no-go conditions when starting ctrl-VQE from an inert pulse.
- Characterized impact of frequency and phase degrees of freedom on ctrl-VQE.
- Implemented optimized Julia code to simulate ctrl-VQE experiments.
- **Presented work** at *APS March Meeting*, *JuliaCon*, and *VTQ Symposium*.

Doctoral Dissertation Fall 2019-Spring 2022

Department of Physics, University of North Texas, Denton, TX

Faculty Mentor: Marco Buongiorno Nardelli

- Adapted quantum algorithms for quantum chemistry to solve problems in materials science (band structures) and information theory (compressive sensing).
- Developed novel strategy to locate excited states in variational quantum algorithms.
- Developed quantum circuits and protocols for compressive sensing in a quantum computer.
- Developed three distinct quantum algorithms for band structure calculations using qiskit, cirq.
- Validated quantum algorithm using IBMQ Experience quantum computers.
- Derived statistical error for quantum variational excitation algorithm.
- **Presented work** at *UNT MRS Poster Competition* and numerous academic seminars.

Virtual Intern Summer 2021-Spring 2022

NASA Goddard Space Flight Center, Greenbelt, MD

Mentor: Harry Shaw

- Simulated molecular candidates for quantum oscillator in GAMESS.
- Designed quantum compressive sensing protocol for LIDAR imaging with Born machines.
- Implemented classical approximation to quantum compressive sensing protocol using tensor networks in Python.
- Developed quantum circuits and protocols for compressive sensing in a quantum computer.

- **Presented work** in *VTQ Internal Seminar* and multiple NASA seminars.
- **Published article** in *Appl. Sci.* (**12**).

Research Assistant Fall 2019-Spring 2022
Department of Physics, University of North Texas, Denton, TX
Faculty Mentor: Marco Buongiorno-Nardelli

- Developed novel strategy to locate excited states with variational quantum algorithms.
- Developed systematic quantum algorithm for band structure calculations using qiskit, cirq.
- Validated quantum algorithm using IBMQ Experience quantum computers.
- Calculated band structure of silicon with variational quantum eigensolver.
- Derived statistical error for quantum variational excitation algorithm.
- **Presented work** at *APS March Meeting 2021, 2022* and *ES22* Invited Talk.
- **Published articles** in *Scientific Reports* (**12**), *RSC Adv.* (**11**) and *Phys. Chem. Chem. Phys.* (**22**).

Research Assistant Spring 2019
Department of Physics, University of North Texas, Denton, TX
Faculty Mentor: Paolo Grigolini

- Modeled and simulated non-linear Langevin dynamics of model enzyme reaction using Python.
- Studied temporal complexity by approximating reaction wait-time distribution using stochastic calculus.
- **Presented work** in student lecture for PHYS 6500.

Research Assistant Fall 2018
Department of Physics, University of North Texas, Denton, TX
Faculty Mentor: Marco Buongiorno-Nardelli

- Investigated metamolecular dynamics of small Lennard-Jones clusters using Python.
- Surveyed existing libraries for developing quantum algorithms.
- Verified validity of Fourier differentiation in PAOFLOW electronic structure software.

Master's Thesis Fall 2016-Spring 2017
Department of Computer and Information Sciences, Towson University, Towson, MD
Faculty Mentor: Marius Zimand

- Reviewed literature on Slepian-Wolf coding, information erasure reconciliation.
- Simulated information erasure reconciliation using various protocols using Python.
- Proposed novel probabilistic protocol for reconciling erasures.
- Measured protocol's empirical error-rate and optimal communication efficiency.
- Approximated theoretical error-rate and optimal communication efficiency.

Graduate Assistant Fall 2015-Spring 2017
Department of Computer and Information Sciences, Towson University, Towson, MD
Faculty Mentors: Siddharth Kaza, Blair Taylor

- Created Data Hiding module for Security Injections repository.
- Designed and supervised development of Security Injections 3.0.
- Maintained web resources for Towson University's Cyber4All initiative.
- Wrote NSF Grant Report assessing progress and project outlook.
- **Published article** in *IEEE Security and Privacy* article.

Research Assistant Spring 2015
Dept. of Physics, Astronomy, and Geosciences, Towson University, Towson, MD
Faculty Mentor: Jia-An Yan

- Studied information entropy of scattering quantum systems using Matlab.
- Analytically solved information entropy of free particle as a function of time.
- Replicated *Phys. Rev. Lett.* work studying fractional revivals in bound quantum systems.
- **Presented work** at 2015 Towson University Research Expo.

Research Intern Summer 2014
Univeristy at Buffalo, Hauptman-Woodward Medical Research Institute, Buffalo, NY
Principal Investigator: Andrew Gulick
Laboratory Mentor: Geoffrey Lippa

- Performed site-directed mutagensis to introduce point mutations in *E. coli* plasmid.
- Mutated, expressed, and purified a bacterial enzyme for crystallization.

- Conjectured reaction pathway based on product/byproduct elution patterns.
- Proposed deletion experiment based on predicted structure to test conjecture.
- **Presented work** at *HWI Weekly Seminar*, *CTRC Summer Research Colloquium*, and *MB3 Club Seminar*.

Capstone Project Winter 2014
Dept. of Physics, Astronomy, and Geosciences, Towson University, Towson, MD
Faculty Mentor: Jia-An Yan

- Numerically solved Schrödinger's wave equation for a diffracting electron using Matlab.
- Calculated reflection and transmission coefficients from energy transformation.
- Compared optical Talbot effect with electron-beam analogue.
- **Presented work** at *APS March Meeting 2014* and *TU Research Expo*.

TEACHING EXPERIENCE

Instructor Summer 2024
Brookhaven National Laboratory, Yaphank, NY

- Adapted curriculum for quantum information and quantum computing using a pictoral formalism.
- Delivered lectures, activities, and assignments for intensive and engaging one-week summer course.
- Mentored a graduate student in developing communication and organization skills.

Instructor Summers 2022-2023
Center for Talented Youth, Johns Hopkins University

- Developed curriculum for intensive summer courses for many subjects: *Data Structures and Algorithms*, *Cryptography*, *Special Relativity*.
- Delivered lectures, activities, and assignments for intensive and engaging three-week summer course.
- Mentored a teaching assistant in developing communication and organization skills.
- Tracked student progress in content, critical thinking, and engagement, for end-of-session evaluations.

Online Instructor Summer 2020-Spring 2022
Center for Talented Youth, Johns Hopkins University

- Guided students through asynchronous *Programming in Python for Middle-school Students* online course.
- Tutored students all around the globe one-on-one in programming concepts and Python syntax.
- Executed, debugged, graded, and provided feedback on programming assignments.
- Tracked student progress in content, critical thinking, and engagement, for end-of-course evaluations.

Teaching Assistant Fall 2018-Spring 2020
Department of Physics, University of North Texas, Denton, TX

- Assisted lecturer in *Musical Acoustics* course with 100+ students.
- Laboriously graded daily quizzes and quarterly exams.
- Learned every student's name so they knew they were loved.
- Adapted course format to online learning when global pandemic struck mid-semester.
- Facilitated labs for *General Physics I*.
- Supervised students in *Computational Physics* and provided guidance as needed.

Teaching Assistant Summers 2015-2019
Center for Talented Youth, Johns Hopkins University

- Assisted instructor in intensive summer courses for middle- and high-schoolers over many subjects: *Astrophysics*, *Fundamentals of Computer Science*, *Cryptography*, *Data Structures and Algorithms*, *Genomics*, *Investigations in Engineering*.
- Organized "lunchtime lessons" for introducing students to non-curricular scientific topics of interest.
- Tracked student progress in content, critical thinking, and engagement, for end-of-session evaluations.

Substitute Teacher Spring 2018
Archdiocese of Washington
Schools: St. Mary of the Assumption Catholic School, Cardinal Hickey Academy

- Taught Pre-K to 8th grade, all grades and all subjects, over four months.
- Awakened Kindergarten students to world geography following the story of Jonah.
- Designed curriculum for three-day stint as SMA middle-school math and science teacher.
- Substituted long-term for Spanish, all grades, at CHA.

Graduate Assistant Fall 2018-Spring 2020
Department of Computer and Information Sciences, Towson University, Towson, MD
- Assisted lecturer in *General Computer Science* and *Introduction to Computer Science I* courses.
- Supervised students in lab and provided guidance as needed.
- Executed, debugged, graded, and provided feedback on programming assignments.
- Tutored online high-school students enrolled in SPLASH program.

Grader Spring 2014
Dept. of Physics, Astronomy, and Geosciences, Towson University, Towson, MD
- Graded homeworks for *Introductory Mathematical Physics*.
- Traced students' mistakes and provided consistent feedback.

ADDITIONAL EXPERIENCE

Church Choir - Accompanist 2011-Present
- Accompanied choir on clarinet, piano for weekly Catholic Mass.

Denton Community Band, Blacksburg Community Band - Clarinetist 2018-Present
- Played clarinet in an ensemble for seasonal concerts and Santa Serenades.

Christian Graduate Fellowship - President 2018-2022
University of North Texas, Denton, TX
- Organized weekly bible study and community night.

Senior Software Developer Fall 2017
Department of Computer and Information Sciences, Towson University, Towson, MD
Supervisor: Siddharth Kaza
- Designed database for CLARK cybersecurity curriculum management system using MongoDB, Angular.
- Developed CLARK microservice to suggest and search for learning outcomes.

Society of Physics Students 2012-2016
Dept. of Physics, Astronomy, and Geosciences, Towson University, Towson, MD
- Taught physics to young (age 6-10) students in Hampden Family Center.
- Demoed "Shoot the Monkey" station at 2016 *Physics of Superheroes!* event.
- Magician's assistant in 2013 *Physics is Magic!* Saturday Science show.

College Scholarship Committee - Student Representative 2015
Jess and Mildred Fisher College of Science and Mathematics, Towson University, Towson, MD
- Selected 2015 recipients of Jess Fisher FCSM and Pre-Engineering Scholarships.

Honors College Leadership Council 2012-2014
Honors College, Towson University, Towson, MD
- Organized college-prep event hosting AVID middle-schoolers at Honors College.
- Organized "Sweets, Stars, and Structure of the Universe" planetarium event.
- Redesigned Honors College Community page on Blackboard Learn.

AWARDS

U.S. Department of Energy Grant: DE-SC0019432 (Research Assistantship) 2019-2022
UNT College of Science Travel Award 2020
Maryland Space Grant Consortium Scholar 2014-2015
Edward L. Rubendall Outstanding Physics Student 2012-2014
Jess Fisher FCSM Scholar (Full Tuition) 2011-2015
Maryland Distinguished Scholar 2011-2015
Towson University Honors Scholar 2011-2015

COMPUTER SKILLS

Languages: Julia, Python (Anaconda), Java, JavaScript (Angular), Perl, Matlab, C/C++/C#
Quantum: Cirq (Google), Qiskit (IBMQ Experience), PyQuil (Rigetti Computing)
Chemistry: GAMESS, MacMolPlt
Other: Unix, LaTeX, Git, HTML5, CSS3