

Trey Cole

Curriculum Vitae

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🎵 Trey Cole
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Given Name: Billy J. Cole III

Education

- 2023–Present **Ph.D. in Physics**, *Rutgers University*, New Brunswick, NJ
Condensed Matter Theory – topological insulators, axion insulators, Wannier obstructions
- 2021–2023 **M.S. in Applied Physics**, *Delft University of Technology*, Delft, NL
Track: Quantum Devices & Quantum Computing
Thesis: “Position Dependent Perturbation Theory”
- 2016–2020 **B.S. in Physics (summa cum laude)**, *West Virginia University*, Morgantown, WV
Emphasis: Computational Physics
Thesis: “Electrostatic Potentials in Topological Josephson Junctions”

Publications

- 2024 **T. Cole**, D. Vanderbilt, “Reduced Wannier representation for topological bands”, *arXiv:2412.17084* (publication pending). [arXiv link](#), [GitHub link](#).
- 2021 P. Paudel, **T. Cole**, B. Woods, T. Stanescu, “Enhanced topological superconductivity in planar Josephson junctions”, *Phys. Rev. B* **104**, 155420. [PRB link](#), [arXiv link](#)

Research Experience

- 2023–Present **Graduate Researcher**, *Rutgers University*, Center for Materials Theory, New Brunswick, NJ
Advisor: David Vanderbilt
- Proposed a projection-based method for decomposing a set of topologically obstructed bands into an exponentially localized Wannier-represented subspace and a subspace inheriting the topology.
 - Developing algorithms to compute the Chern-Simons axion angle and study its dynamic response.
 - Leading the development of PythTB v2 for constructing tight-binding models, characterizing band structures based on quantum geometry, and computing maximally localized Wannier functions. [GitHub link](#).
- 2022–2023 **Researcher**, *TU Delft*, Dept. of Quantum Nanoscience, Delft, NL
Advisor: Anton Akhmerov
- Developed a theory for treating position-dependent perturbations adiabatically in crystalline insulators.
 - Implemented numerical simulations using Kwant and symbolic tools based on SymPy.
 - Contributed to the early stages of a Python package for computing Schrieffer-Wolff transformations.
- 2017–2021 **Undergraduate Researcher**, *West Virginia University*, Dept. of Physics, Morgantown, WV
Advisor: Tudor Stanescu
- Investigated topological planar Josephson junctions as a platform for Majorana bound states and topological qubits.
 - Co-authored a *Phys. Rev. B* paper demonstrating enhanced topological robustness in geometrically modulated Josephson junctions.
 - Developed a Python package to construct mean-field BdG Hamiltonians, compute topological phase diagrams, and efficiently extract topological gaps to high resolution. [GitHub link](#).

- 06/2020 – **Research Intern, National Institute of Standards & Technology (NIST)**, Gaithersburg, MD
08/2020
 - Analyzed vibrational eigenmodes of an AFM cantilever using COMSOL.
 - Presented results as part of the Society of Physics Students summer internship.

Industry Experience

- 05/2023 – **Software Development Intern, Orange Quantum Systems**, Delft, NL
08/2023
 - Developed a Python application for the Quantify software for real-time visualization of quantum computing hardware measurements.
 - Employed Asyncio, Tornado, and PyZMQ for concurrent data handling in a single-threaded Python program; used Bokeh for plotting in a remotely accessible browser environment.
 - Utilized GitLab CI/CD for testing and development.

Teaching Experience

- 08/2023 – **Teaching Assistant – Electromagnetism Lab, Rutgers University**, New Brunswick, NJ
12/2023
05/2018 – **Planetarium Assistant, West Virginia University**, Morgantown, WV
07/2019
08/2018 – **Learning Assistant – Electromagnetism Lab, West Virginia University**, Morgantown, WV
12/2018

Technical Skills

Programming	Python <div><div></div><div></div><div></div><div></div><div></div><div></div></div> , Java <div><div></div><div></div><div></div><div></div><div></div><div></div></div> , Julia <div><div></div><div></div><div></div><div></div><div></div><div></div></div> , C++ <div><div></div><div></div><div></div><div></div><div></div><div></div></div> , HTML <div><div></div><div></div><div></div><div></div><div></div><div></div></div> , Mathematica <div><div></div><div></div><div></div><div></div><div></div><div></div></div> , Fortran90 <div><div></div><div></div><div></div><div></div><div></div><div></div></div> , LaTeX <div><div></div><div></div><div></div><div></div><div></div><div></div></div> , MATLAB <div><div></div><div></div><div></div><div></div><div></div><div></div></div> , COMSOL <div><div></div><div></div><div></div><div></div><div></div><div></div></div>
Libraries	NumPy, SciPy, TensorFlow, scikit-learn, SymPy, Qiskit, Kwant, PythTB, Bokeh, Tornado, PyZMQ, Asyncio
Development Tools	Git, GitHub (CI/CD), GitLab, conda
	<div><div><div></div><div></div><div></div><div></div><div></div><div></div></div> basic knowledge</div> <div><div><div></div><div></div><div></div><div></div><div></div><div></div></div> intermediate knowledge with some project experience</div> <div><div><div></div><div></div><div></div><div></div><div></div><div></div></div> extensive project experience</div> <div><div><div></div><div></div><div></div><div></div><div></div><div></div></div> deepened expert knowledge</div> <div><div><div></div><div></div><div></div><div></div><div></div><div></div></div> expert / specialist</div>

Personal Projects

- 2024 **Brick-Wall Quantum Circuit in Qiskit** — Currently developing a brick-wall quantum circuit in Qiskit to study measurement-induced phase transitions. This project explores the transition from a volume-law entanglement to an area-law entanglement beyond a critical probability rate for random measurements. [GitHub link](#)
- 2020 **Pulsar Verification ML Application** — Developed a machine learning application to verify pulsar candidates from radio telescope data. Used a random forest algorithm implemented with scikit-learn to train the model. Predicted pulsar candidates with 98 percent accuracy. [GitHub link](#).

Awards and Honors

- 2024 Excellence Fellowship, Rutgers University
2021–2023 QuTech Academy Scholarship, TU Delft
2019 Galford Memorial Research Trust Fund, WVU
2016–2020 Mountaineer and Promise Scholarships, WVU
Honors: Phi Beta Kappa, Sigma Pi Sigma

Talks and Presentations

- 2025 “Reduced Wannier Representation for Topological Bands”, APS March Meeting, Anaheim, CA (contributed talk)
- 2025 Poster, Quantum Frontiers Summer School, Institut d’Études Scientifiques, Cargèse, France

Schools and Conferences

- 2025 Quantum Frontiers Summer School, Cargèse, France
- 2024 Summer School on Condensed Matter Physics, Institute for Advanced Study, Princeton, NJ
- 2024 ES24 Electronic Structure Workshop, Boston University, Boston, MA
- 2024 New Twists of Quantum Geometry, Princeton Center for Theoretical Science, Princeton, NJ
- 2024 School on Electron-Phonon Physics, University of Texas at Austin, Austin, TX
- 2024 School on Electron Correlations and Topology, Rice University, Houston, TX
- 2024 Hunting for Anyons, Princeton Center for Theoretical Science, Princeton, NJ
- 2022 School for Master Students: From Quantum Matter to Quantum Computers, Max Planck Institute for the Physics of Complex Systems, Dresden, DE
- 2021 Searching for Topological Majorana Zero Modes, Condensed Matter Theory Center, University of Maryland, College Park, MD
- 2020 Kwant Workshop, Delft University of Technology, virtual
- 2018 Mid-Atlantic American Physical Society Conference, University of Maryland, virtual
- 2018 Wolfram Mathematica Workshop, West Virginia University, Morgantown, WV