Hyeongjin Kim

Ph.D. Candidate · Condensed Matter Theory · Computational Physics · Quantum Computing

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Education

Boston University *590 Commonwealth Ave., Boston, MA 02215*

Ph.D. in Physics | GPA: 3.96 | Anticipated graduation date: May 2026 *September 2021 – present*

Advisor: Professor Anatoli Polkovnikov
Thesis: Quantum and Classical Chaos through Adiabatic Transformations

Williams College *880 Main Street, Williamstown, MA 01267*

B.A. in Physics | GPA: 3.98 *September 2017 – May 2021*

Advisor: Professor Frederick Strauch
Thesis: Optimal Control and Circuit Synthesis of Quantum Gates
Academic Honor Societies: Phi Beta Kappa, Sigma Xi

Publications

** denotes equal contribution*

"Defining classical and quantum chaos through adiabatic transformations." 2026
Hyeongjin Kim, Cedric Lim, Kirill Matriko, Anatoli Polkovnikov, Michael O. Flynn.
Journal of Physics A: Mathematical and Theoretical **59**, 075702. *DOI*

"Quantum Computing Technology Roadmaps and Capability Assessment for Scientific Computing – An analysis of use cases from the NERSC workload." 2025
Daan Camps, Ermal Rrapaj, Katherine Klymko, **Hyeongjin Kim**, Kevin Gott, Siva Darbha, Jan Balewski, Brian Austin, Nicholas J. Wright.
arXiv:2509.09882. *DOI* | *PDF*

"Confined and deconfined chaos in classical spin system." 2025
Hyeongjin Kim*, Robin Schäfer*, David M. Long, Anatoli Polkovnikov, and Anushya Chandran.
arXiv:2507.07168. *DOI* | *PDF*

"Variational Adiabatic Transport of Tensor Networks." 2024
Hyeongjin Kim, Matthew T. Fishman, and Dries Sels.
PRX Quantum **5**, 020361. *DOI* | *PDF*

"Integrability as an attractor of adiabatic flows." 2024
Hyeongjin Kim and Anatoli Polkovnikov.
Phys. Rev. B **109**, 195162. **Editors' Suggestion**. *DOI* | *PDF*

Research Experience

Research Scientist Intern – Center for Quantum Computing, Amazon (AWS) *525 Market Street, San Francisco, CA 94105*

Advisors: Dr. Philipp Dumitrescu, Dr. Ash Milsted *September 2025 - December 2025*

- Investigated theoretical methods and numerical algorithms for describing open quantum systems with dissipative dynamics.

Graduate Research Fellow – Department of Physics, Boston University *590 Commonwealth Ave., Boston, MA 02215*

Advisor: Professor Anatoli Polkovnikov *January 2022 – present*

- Developed a scaling theory for the transition between integrability and chaos in quantum many-body systems by studying quantum geometric tensors, establishing that integrability acts as an attractor of adiabatic flows.
- Investigated the time scales associated with chaos and thermalization in classical many-body spin systems, discovering a new mechanism for the emergence of chaos.
- Simulated classical two-spin clusters to show that the fidelity susceptibility can be used a probe for classical chaos.
- Extensive numerical experience by performing exact diagonalization and linear algebra operations on large matrices ($d = 10^6 \times 10^6$), parallelizing numerical integrations, and organizing and analyzing 1TB+ of scientific data.
- Expertise in scheduling large batch jobs on the computing cluster (Open Grid Scheduler) using batch scripts.

Student Assistant – NERSC, Lawrence Berkeley National Laboratory *1 Cyclotron Rd., Berkeley, CA 94720*

Advisors: Dr. Daan Camps, Dr. Jan Balewski *June 2025 - August 2025*

- Implemented and benchmarked various quantum algorithms for solving partial differential equations on IBM hardware to assess the near-term and long-term quantum advantages over classical algorithms.

Summer Research Associate – CCQ, Flatiron Institute, Simons Foundation *162 5th Ave., New York, NY 10010*

Advisors: Dr. Matthew Fishman, Professor Dries Sels *June 2022 – August 2022*

- Developed a novel tensor network method to propagate matrix product states of many-body quantum spin systems over the parameter space via the adiabatic gauge potential. The software is publicly available as a Github repository in ITensorAGP.jl.

Undergraduate Research Assistant – Department of Physics, Williams College *880 Main Street, Williamstown, MA 01267*

Advisor: Professor Frederick Strauch *June 2019 – May 2021*

- Analytically developed and numerically optimized gate pulses for fast, high-fidelity two-qubit gates ($\sqrt{i\mathrm{SWAP}}_\varphi$ gates) in quantum computers by using MATLAB, achieving gate errors (including leakage effects) below 10^{-3} for any gate times between 5 ns and 60 ns.
- Developed a quantum circuit that implements the CNOT gate with two $\sqrt{i\mathrm{SWAP}}_\varphi$ gates and six single-qubit gates.

Undergraduate Research Assistant – Department of Physics, Williams College *880 Main Street, Williamstown, MA 01267*

Advisor: Professor Katharine Jensen *February 2018 – August 2018*

- Investigated the mechanics of adhesive contacts of rigid glass spheres with silicone gel surfaces using MATLAB.

Invited Talks

"Solving linear PDEs using the quantum singular value transform on NISQ hardware." 2025
Quantum Days 2025. Lawrence Berkeley National Laboratory. Berkeley, CA.

"Adiabatic evolution of matrix product states with the adiabatic gauge potential." 2023
Center for Computational Quantum Physics. New York, NY.

"Adiabatic evolution of matrix product states with the adiabatic gauge potential." 2023
Boston University. Boston, MA.

Talks

"Confined and deconfined chaos in classical spin systems." 2025
Boston University. Boston, MA.

"Chaotic prethermal regimes and their time scales in nearly integrable many-body spin systems" 2025
Global Physics Summit 2025. Anaheim, CA.

"Connecting Lyapunov exponents and spectral functions in central spin models" 2024
APS March Meeting 2024. Minneapolis, MN.

"Universality in relaxation dynamics of systems near integrability" 2024
APS March Meeting 2024. Minneapolis, MN.

"Integrable Attractors in the Adiabatic Landscape of Chaotic Systems" 2023
APS March Meeting 2023. Las Vegas, NV.

"Optimal Control and Circuit Synthesis of Quantum Gates" 2021
Williams College. Williamstown, MA.

Projects

Simple DMRG *Github repository link*

Skills: C++, CUDA, Tensor Networks *August 2024 – October 2024*

- Created a simple implementation of the density matrix renormalization group (DMRG) in C++ to compute the ground states and energies of many-body quantum systems by using matrix product states and operators.
- Utilized CUDA by using cuTENSOR for tensor contractions and cuSOLVER for singular value decompositions.

ITensorAGP.jl *Github repository link*

Skills: Julia, Tensor Networks *June 2022 – November 2023*

- Developed a Julia package that computes the adiabatic gauge potential as a matrix product operator using ITensor.jl.

Awards and Honors

2021 **Phi Beta Kappa Induction**, PBK
2018-2020 **Summer Science Research Fellowship**, Williams College

Teaching

2022 **Graduate Teaching Fellow**, CAS PY 211: General Physics I *Boston University*
2021 **Graduate Teaching Fellow**, CAS PY 105: Physics I *Boston University*
2020 **Undergraduate Teaching Assistant**, CSCI 256: Algorithm Design and Analysis *Williams College*
2019 **Undergraduate Teaching Assistant**, PHYS 210: Mathematical Methods for Scientists *Williams College*

Service

2020-2021 **Co-Chair**, Williams College Society of Physics Students
2018-2019 **Finance Committee Member**, Williams College Student Council

Skills

Courses **Quantum Mechanics, Quantum Computing, Computational Physics, Nonlinear Physics, Statistical Mechanics, Thermodynamics, Classical Mechanics, Electrodynamics, Mathematical Physics**
Languages **Python, Julia, C++, Mathematica, MATLAB**
Libraries **Numpy, Scipy, ITensors.jl, cuTENSOR, cuSOLVER, Qiskit, QuantumOptics.jl**
Tech **Git, Linear Algebra, High Performance Computing, Parallel Computing, Tensor Networks, CUDA**