Matthew D. Stearns

Contact Information

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Research Interests

Theoretical Physics, Numerical Relativity, General Relativity, Quantum Field Theory, High Energy Theory, Stochastic Processes, Quantum Information & Computing.

Education

Master of Science in Physics Aug. 2025 - May 2026
University of Massachusetts Dartmouth, North Dartmouth, MA
GPA: 4.000/4.000
Advisors: Dr. Scott Field and Dr. Vijay Varma.

Bachelor of Science in Physics; Bachelor of Science in Mathematics Aug. 2021 - May 2025
University of Massachusetts Dartmouth, North Dartmouth, MA
GPA: 3.447/4.000
Thesis: *Continuum Limits of Discrete Quantum Systems and Their Algebras of Observables*
Advisors: Dr. David Kagan and Dr. Dana Fine.

Awards and Honors

NASA Space Grant Graduate Fellowship	Fall 2025
NSF S-STEM Scholar	2025 - 2026
NSF ACCOMPLISH Scholar	2024 - 2025
Departmental Service Award, Physics Dept.	2023, 2024, 2025
Summer Research Grant, Office of Undergraduate Research	2023

Professional Collaborations

Active research contributor through UMassD-based projects.

Simulating eXtreme Spacetimes (SXS) Collaboration	Sept. 2025 - present
LIGO Virgo Kagra (LVK) Collaboration	Sept. 2025 - present
UMass-URI Gravity Research Consortium (U2GRC)	Sept. 2025 - present

Research Experiences

Numerical Relativity & Surrogate Modeling Sept. 2025 - present
University of Massachusetts Dartmouth
Advised by Dr. Scott Field, and Dr. Vijay Varma

- Implementing and validating new gravitational-wave surrogate models within the open-source `gwsurrogate` framework, including integration of the NRSur3dq8_test model.
- Adding numerical relativity waveforms to `binaryBHexp` by developing SXS-driven waveform generation functions for direct comparison with existing surrogates. Developing tools for rapid, interactive visualization of eccentric orbits.
- Contributing to model benchmarking, parameter estimation, and next-generation GW analysis pipelines.

July 2025 - present

Entanglement Swapping via Stochastic-Quantum Correspondence
University of Massachusetts Dartmouth
Advised by Dr. David Kagan

- Extending the stochastic–quantum (S/Q) correspondence framework to model entanglement swapping, analyzing correlation transfer and measurement-induced updates through stochastic transition rules.
- Developing an algebraic formulation connecting S/Q dynamics with standard quantum-information descriptions of bipartite and tripartite systems.
- Drafting a manuscript on the S/Q interpretation of nonlocal correlations and their evolution under composition and measurement.

Continuous Stochastic Quantum Correspondence April 2024 - May 2025
University of Massachusetts Dartmouth
Advised by Dr. David Kagan

- Investigated the implications of continuous stochastic processes that reproduce quantum dynamics, focusing on how locality, information flow, and emergent behavior arise from discrete models.
- Applied tools from functional analysis, Clifford and von Neumann algebras, and operator methods to study how discrete stochastic systems converge to continuum quantum systems.
- Developed theoretical foundations for my senior thesis on continuum limits of integrable lattice models, using the Bethe Ansatz and Algebraic Bethe Ansatz to analyze how discrete spin-chain observables converge to continuum quantum field-theoretic structures.

June 2024 - Aug. 2024
Single Photon Blockade in Nanocavities with Weak Kerr Type Nonlinearity
Institute for Nuclear Theory, University of Washington
Advised by by Dr. Arka Majumdar

- Modeled photon blockade in weakly nonlinear nanocavities using the Lindblad master equation and numerical simulations in `QuTiP`.
- Computed Fock-state populations and second-order correlation functions $g^{(2)}(0)$ to identify regimes of strong antibunching and single-photon emission.
- Evaluated realistic drive and cavity parameters to assess the feasibility of silicon-based single-photon sources.

April 2023 - April 2024
Exploring Applications of Quantum Conditional Probabilities and Entropies
University of Massachusetts Dartmouth
Advised by Dr. David Kagan

- Investigated recently developed measures of quantum information based on conditional probability distributions that can describe information flow in open quantum systems.
- This research developed new mathematical frameworks for these new measures and validated their effectiveness through simulations using `Qiskit`.

Publications

2. **M. D. Stearns**, D. Kagan, "Entanglement Swapping via Stochastic-Quantum Correspondence", *in prep.*
1. R. Dong, A. Kala, A. Lingenfelter, M. Polania, **M. D. Stearns**, and A. Majumdar, "Triply Resonant Photonic Crystal Nanobeam Cavities for Unconditional Photon Blockade", *in prep.*

Conference Contributions

4. "Visualizing Binary Black Hole Mergers in Eccentric Orbits", ASEE Northeast Section Conference, Southern New Hampshire University, Hooksett, NH 27-28 Mar. 2026
3. "Visualizing Binary Black Hole Mergers in Eccentric Orbits", APS Global Physics Summit, Denver, CO 14-20 Mar. 2026

2. "Continuum Limits of Discrete Quantum Systems and their Algebras of Observables", SPS Zone 1 Meeting, Tufts University, Medford, MA 12 Apr. 2025

1. "Continuum Limits of Discrete Quantum Systems and their Algebras of Observables", APS Global Physics Summit, Anaheim, CA 17 Mar. 2025

Seminars, Colloquia & Exhibitions

2. "Continuum Limits of Discrete Quantum Systems and their Algebras of Observables", Sigma Xi Research Exhibition, University of Massachusetts Dartmouth, Dartmouth, MA 16-17 Apr. 2025

1. "Single Photon Blockade in Nanocavities with Weak Kerr Type Nonlinearity", Summer Colloquium, Institute for Nuclear Theory, Seattle, WA 15 Aug. 2024

Teaching & Mentorship

Teaching Assistant, Jan. 2026 - May 2026
University of Massachusetts Dartmouth, Dept. of Physics

- Led recitation and laboratory instruction for calculus-based mechanics and E&M, guiding problem-solving and experiment-based learning.
- Assisted with grading, lab supervision, and in-class support for two large introductory sections.

Teaching Assistant, Aug. 2025 - Dec. 2025
University of Massachusetts Dartmouth, College of Engineering

- Served as the sole lab instructor for 2 of 8 sections of Introduction to Engineering & Computing, teaching Arduino programming, C++, CAD in Fusion360, and basic circuit design (≈60 students).
- Graded all assignments for both sections and assisted with course coordination under the Assistant Dean.

Learning Assistant, Jan. 2025 - May 2025
University of Massachusetts Dartmouth, Dept. of Physics

- Led the initial transition of calculus-based mechanics homework to `MyOpenMath`, developing algorithmic PHP-style problem sets and modernizing assessments in collaboration with the instructor.

Supplementary Instructor (Peer Assisted Learning) Aug. 2023 - Dec. 2024
University of Massachusetts Dartmouth, Dept. of Mathematics

- Led three 1-hour active-learning workshops per week for Precalculus (Fall 2023), Calculus I (Spring 2024), and Calculus II (Fall 2024).
- Designed problem-solving activities, facilitated group collaboration, and supported 30–50 students per semester.

Peer Mentor, STEM Transfer Students May 2023 - Dec. 2023
University of Massachusetts Dartmouth

- Supported STEM transfer students via weekly office hours, transition programming, and panel discussions.

Relevant Coursework

Physics: Gravitational Waves, General Relativity, Quantum Field Theory I, Elementary Particle Physics, Quantum Information & Computing, Quantum Mechanics I–II, Electromagnetism I–II, Classical Mechanics

Mathematics: Real Analysis, Complex Analysis, Abstract Algebra, Linear Algebra, Differential Equations, Probability

Computing Skills

Languages: Proficient in Python, Git, Mathematica, LaTeX. Moderate in Java, C++, HTML, PHP, SQL. Learning Julia.

Operating systems: Mac OS, Linux/*nix. Experience with working on high performance supercomputers

Outreach

Organizer, Solar Eclipse Viewing Party — April 2024
University of Massachusetts Dartmouth

- Led a campus–community eclipse event with ∼4,000 attendees, securing cross-department funding and organizing educational activities for public engagement.
- Recognized by the Provost's office for the event's impact.

Volunteer, Monthly Observation Nights — Sept. 2023 - present
University of Massachusetts Dartmouth

- Support public telescope nights by setting up observatory equipment and guiding attendees through astronomical observations.
- Explain astrophysical concepts and create accessible demonstrations to engage a diverse public audience.

Volunteer, Annual STEM4GIRLS Event — 2023, 2024
University of Massachusetts Dartmouth

- Developed "Quarks to Cosmos" educational content with a faculty advisor, including 12 posters on topics from particle physics to cosmology.
- Presented complex physics concepts in accessible ways to engage and inspire underrepresented middle-school students.

Miscellaneous

- *Panelist* for College of Arts and Sciences Open House — Dec. 2023
  University of Massachusetts Dartmouth.

Extracurricular Activities

Society of Physics Students — Sept. 2021 - present
University of Massachusetts Dartmouth

- **President** (2023-2025): Reestablished our chapter's connection with the National Society of Physics Students.
- Awarded the 2023-2024 Outstanding Chapter Award getting national recognition.

Student Government Association — Sept. 2024 - May 2025
University of Massachusetts Dartmouth

- **Library, Research, and Technology Committee Chair** (2024-2025): Collaborated with administrators to advocate for and address students' research needs on campus.
- **Transfer Student Senator** (2024-2025): Represent the interests of transfer students while serving on the Finance and Student Affairs committee, developing policies to better impact campus resources and student well-being.

News

- May 2025: The University of Massachusetts Dartmouth did a feature story on me. Matthew Stearns '25: Taking the fear out of quantum physics.

Professional Memberships

American Physical Society (APS)
American Association of Physicists in Medicine (AAPM)
Society of Physics Students (SPS)
Society of Industrial and Applied Mathematics (SIAM)
American Society for Engineering Education (ASEE)

Projects

Early Technical & Computational Projects 2022 - 2024
University of Massachusetts Dartmouth

- Built an active sonar detector using Arduino, integrating sensor control, circuit design, and real-time data visualization.
- Modeled spin polarization and NMR signals in Python, connecting simulated data to clinical spectroscopy concepts.
- Explored quantum-computing–based diagnostic workflows, implementing basic qubit simulations and TensorFlow image-processing pipelines.