

Andrew Cupo

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[Personal Website](#)

[Google Scholar](#)

Research Interests (Theoretical Condensed Matter Physics)

- Theoretical foundations, implementation, and application of first-principles methods like density functional theory (DFT) for structural, electronic, and vibrational (linear and non-linear) properties of molecules and materials
- Time-dependent control of quantum materials: Floquet theory, spectral unfolding, photoemission / optical conductivity / quantum anomalous Hall effect as experimental signatures, non-equilibrium occupation functions, state preparation and pulse shape engineering via quantum optimal control theory, dissipative (open system) dynamics
- 2D materials and their nanostructures: graphene, transition metal dichalcogenides, black/blue phosphorus, and van der Waals magnets

Education

Ph.D. in Physics, Rensselaer Polytechnic Institute (2015-2019) [Advisor: Vincent Meunier]

B.S. in Applied Physics, Stevens Institute of Technology (2011-2015) [Advisor: Stefan Strauf]

Professional Experience

Postdoctoral Associate, Dartmouth College, Feb 2020 - Present [Advisors: Lorenza Viola, Chandrasekhar Ramanathan, James Whitfield]

Lecturer, Dartmouth College, Fall 2022

- Instructor for senior level optics course (Physics 47) - see “Teaching Experience”

Research Assistant, Rensselaer Polytechnic Institute, Aug 2015 - Jan 2020

- Thesis Title: Electronic and Vibrational Properties of Atomically-Thin Black Phosphorus and Its Nanostructures from First-Principles

DOE Office of Science Graduate Student Research (SCGSR) Program Fellow, Oak Ridge National Laboratory, Jan - Mar 2019 [Advisor: Dr. Bobby Sumpter]

- Project Title: Temperature Dependent Vibrational Properties from Ultrashort Molecular Dynamics Simulations

Scholars Program Researcher, Stevens Institute of Technology, Jan 2013 - May 2015

- Project Title: Substrate Induced Graphene Antidot Lattices (experimental)

Projects in Progress

3. High Fidelity Topological Floquet State Preparation via Quantum Optimal Control Theory, **A. Cupo**, J. Heath, D. Lucarelli, C. Ramanathan, and L. Viola

2. [Engineering a Quantized Integer Hall Response in Non-Interacting Bosonic Hamiltonians](#), J. Heath, V. Flynn, **A. Cupo**, E. Cobanera, and L. Viola, To appear on arXiv shortly
1. [Tissue Flow and Plasticity is Driven by Regional Cell Packings and Supracellular Myosin Networks](#), C. Cupo, C. Allan, S. Ostvar, **A. Cupo**, and K. Kasza (Kasza group at Columbia University), In Preparation

Publications ([Google Scholar](#))

Note: * indicates equal contributions and (CE) indicates a collaboration with an experimental group where I was the first theoretical author

14. [Optical Conductivity Signatures of Floquet Electronic Phases](#), **A. Cupo** et al., Physical Review B, 2023
13. [Electronic and Vibrational Properties of Bulk Cr₂Ge₂Te₆ from First-Principles Calculations](#), D. Tristant, **A. Cupo** et al., Physical Review B, 2022
12. [Floquet Graphene Antidot Lattices](#), **A. Cupo** et al., Physical Review B, 2021
11. (CE) [Magnetic Proximity Coupling of Quantum Emitters in WSe₂ to van der Waals Ferromagnets](#), K. Shayan, N. Liu, **A. Cupo** et al., Nano Letters, 2019
10. [Phonon Anharmonicity in Few-Layer Black Phosphorus](#), D. Tristant, **A. Cupo** et al., ACS Nano, 2019
9. [Theoretical Analysis of Spectral Lineshapes from Molecular Dynamics](#), **A. Cupo** et al., npj Computational Materials, 2019
8. (CE) [An Unexpected Organometallic Intermediate in Surface-Confined Ullmann Coupling](#), G. Galeotti, M. Di Giovannantonio, **A. Cupo** et al., Nanoscale, 2019
7. [Shell Model Extension to the Valence Force Field: Application to Single-Layer Black Phosphorus](#), N. Hackney, D. Tristant, **A. Cupo** et al., Physical Chemistry Chemical Physics, 2018
6. [Engineering of Robust Topological Quantum Phases in Graphene Nanoribbons](#), O. Gröning, S. Wang, X. Yao, C. Pignedoli, G. Barin, C. Daniels, **A. Cupo** et al., Nature, 2018
5. [Finite Temperature Stability of Single-Layer Black and Blue Phosphorus Adsorbed on Au\(111\): a First-Principles Study](#), D. Tristant, **A. Cupo**, and V. Meunier, 2D Materials, 2018
4. [Periodic Arrays of Phosphorene Nanopores as Antidot Lattices with Tunable Properties](#), **A. Cupo***, P. M. Das* et al., ACS Nano, 2017
3. [Quantum Confinement in Black Phosphorus-Based Nanostructures](#), **A. Cupo** and V. Meunier, Journal of Physics: Condensed Matter, 2017 (Invited Review Article)
2. (CE) [Nonmagnetic Quantum Emitters in Boron Nitride with Ultranarrow and Sideband-Free Emission Spectra](#), X. Li, G. Shepard, **A. Cupo** et al., ACS Nano, 2017
1. (CE) [Controlled Sculpture of Black Phosphorus Nanoribbons](#), P. M. Das*, G. Danda*, **A. Cupo*** et al., ACS Nano, 2016 (Cover for Issue)

Invited Talks

6. Ultrafast Control of Quantum Materials: Floquet Band Engineering and Beyond, Pro-QM Seminar, Columbia University, Aug 2023

5. Static and Dynamical Control of 2D Materials from First-Principles, Theory and Computation Group Seminar, Brookhaven National Laboratory, Apr 2023
4. [Electronic and Vibrational Properties of Nanostructured 2D Materials from First-Principles](#), Quantum/Nano Seminar, Dartmouth College, Nov 2021
3. Nanostructures and Phonon Anharmonicity in Atomically-Thin Phosphorus Allotropes, Department of Physics Colloquium, Stevens Institute of Technology, Nov 2018
2. Practical Quantum Mechanics on Supercomputers for Condensed Matter, Undergraduate Physics Seminar, Stevens Institute of Technology, Nov 2018
1. Nanostructures and Phonon Anharmonicity in Atomically-Thin Black Phosphorus, Department of Physics, Applied Physics, and Astronomy Colloquium, Rensselaer Polytechnic Institute, Oct 2017

Conference Proceedings

22. Optical Conductivity Signatures of Floquet Electronic Phases, **A. Cupo** et al., Poster, ITAMP Workshop on Topological Phases and Strong Correlations in Many-Body Systems and Light-Matter Hybrids (Harvard University), Nov 2023
21. Optical Conductivity Signatures of Floquet Electronic Phases, **A. Cupo** et al., Talk, APS March Meeting, Mar 2023
20. Experimental Fingerprints of Floquet Graphene Antidot Lattices, **A. Cupo** et al., Poster, Gordon Research Conference on Quantum Science (Stonehill College), July 2022
19. Electronic Transport and Photoemission Fingerprints of Floquet Graphene Antidot Lattices, **A. Cupo** et al., Talk, APS March Meeting, Mar 2022
18. Driving Quantum-Confined Massless Dirac Fermions: Floquet Graphene Antidot Lattices, **A. Cupo** et al., Poster, Princeton Summer School on Condensed Matter Physics, June 2021
17. Driving Quantum-Confined Massless Dirac Fermions: Floquet Graphene Antidot Lattices, **A. Cupo** et al., Talk, APS March Meeting, Mar 2021
16. Theoretical Analysis of Vibrational Lineshapes from Molecular Dynamics, **A. Cupo** et al., Talk, APS March Meeting, Mar 2020, Canceled due to COVID-19 - abstract and slides posted [here](#)
15. Signal Analysis for Material Vibrations, **A. Cupo** et al., Talk, Graduate Research Symposium (Rensselaer Polytechnic Institute), Apr 2019
14. Theoretical Analysis of Spectral Lineshapes from Molecular Dynamics, **A. Cupo** et al., Talk, Center for Materials, Devices, and Integrated Systems (cMDIS) Fall Symposium (Rensselaer Polytechnic Institute), Dec 2018
13. First-Principles Study of Phonon Anharmonicity in Atomically-Thin Black Phosphorus, **A. Cupo** et al., Talk, APS March Meeting, Mar 2018
12. First-Principles Study of Phonon Anharmonicity in Atomically-Thin Black Phosphorus, **A. Cupo** et al., Poster, Graphene for US (New York City, New York), Feb 2018
11. First-Principles Study of Phonon Anharmonicity in Atomically-Thin Black Phosphorus, **A. Cupo** et al., Poster, New York State Section of the American Physical Society, Nov 2017

10. Tunable Band Gap in Phosphorene Antidot Lattices, **A. Cupo** et al., Talk, Hudson Mohawk AVS Chapter Meeting, May 2017
9. Tunable Band Gap in Phosphorene Antidot Lattices, **A. Cupo** et al., Poster, Graphene and Beyond (Pennsylvania State University), May 2017
8. Tunable Band Gap in Phosphorene Antidot Lattices, **A. Cupo** et al., Talk, Graduate Research Symposium (Rensselaer Polytechnic Institute), Mar 2017
7. Tunable Band Gap in Phosphorene Antidot Lattices, **A. Cupo** et al., Talk, APS March Meeting, Mar 2017
6. Tunable Band Gap in Phosphorene Antidot Lattices, **A. Cupo** et al., Poster, New York State Section of the American Physical Society - 115th Topical Symposium - Physics of 2D Materials, Nov 2016
5. Phosphorene Nanoribbons and Nanopores, **A. Cupo** et al., Poster, Graduate Research Symposium (Rensselaer Polytechnic Institute), May 2016
4. Phosphorene Nanoribbons and Nanopores, **A. Cupo** et al., Poster, Graphene and Beyond (Pennsylvania State University), May 2016
3. Substrate Induced Antidot Superlattices in 2D Materials, **A. Cupo** et al., Poster, Innovation Expo (Stevens Institute of Technology), May 2015
2. Substrate Induced Antidot Superlattices in Graphene, **A. Cupo** et al., Poster, Scholars Research Symposium (Stevens Institute of Technology), Oct 2014
1. Substrate Induced Antidot Superlattices in Graphene, **A. Cupo** et al., Poster, Scholars Research Symposium (Stevens Institute of Technology), Oct 2013

Scientific Skills

- Density functional theory (VASP and Quantum ESPRESSO)
- GW many-body perturbation theory (VASP and WEST)
- Phonon calculations (phonopy - harmonic, phono3py - anharmonic)
- Floquet analysis for periodically driven quantum systems
- Linear response theory
- Python (including Matplotlib) and MATLAB
- Supercomputing systems (including Linux, Slurm, and TORQUE)
- \LaTeX and Overleaf
- Raman spectroscopy of 2D materials
- Scanning electron microscopy (SEM): imaging and energy dispersive spectroscopy (EDS)
- Focused ion beam (FIB): nanopatterning and metal deposition
- Mechanical exfoliation of 2D materials
- Transfer of chemical vapor deposited 2D materials

Teaching Experience

Lecturer, Dartmouth College, Fall 2022

- Taught the optics course (Physics 47) for upper-level physics majors
- Developed syllabus, lectures, homework assignments, exams, and term project
- Included four laboratories: (i) eight demonstrations in optics (ii) microwave optics (iii) interferometry (iv) Fourier optics

- Used Canvas course management system
- Textbook: Introduction to Optics 3rd Edition by Pedrotti, Pedrotti, and Pedrotti

Future Faculty Teaching Seminar, Dartmouth Center for the Advancement of Learning (DCAL), Dartmouth College, Spring 2022

- Attended a weekly seminar dedicated to training future faculty

Quantum Winter School, Dartmouth College, Dec 2020

- Held one of the workshops on qubits, quantum gates, and quantum programs (IBM's Qiskit) on the qBraid platform

Teaching Assistant (Volunteer), Rensselaer Polytechnic Institute, Fall 2018

- Upper-level undergraduate electromagnetism

Personal Physics Tutor, Stevens Institute of Technology, Spring 2014

Proctor for Introductory Mechanics Exams, Stevens Institute of Technology, Fall 2013 - Spring 2014

Review Instructor, Stevens Institute of Technology, Aug 2013 - May 2015

- Taught two-hour reviews for introductory mechanics (course run by Professor Vladimir Lukic) before all exams (seven per semester) and the final exam for four semesters
- Approximate attendance was 50 students in the fall and 100 students in the spring per session

Honors

- Hillard B. Huntington Award, Department of Physics, Applied Physics, and Astronomy at Rensselaer Polytechnic Institute, May 2019 "Awarded to an outstanding graduate student in physics"
- DOE Office of Science Graduate Student Research (SCGSR) Program Recipient, Aug 2018 (Notification)
- First Place Poster for Graduate Students, New York State Section of the American Physical Society at Union College, Nov 2017
- Edmond Brown Graduate Prize in Physics, Department of Physics, Applied Physics, and Astronomy at Rensselaer Polytechnic Institute, May 2017 "Presented to an outstanding graduate student in physics for research in theoretical condensed matter physics"
- Honorable Mention, NSF Graduate Research Fellowship Program (GRFP), Apr 2016
- Leadership Award, Department of Physics at Stevens Institute of Technology, May 2015 "In recognition for outstanding achievements in physics and engineering physics"
- Sigma Pi Sigma (Physics Honor Society), Apr 2014
- Carlos Alomar Protégé Award for Advanced Guitar Technique, Stevens Institute of Technology, May 2013
- Scholars Program (Summer Research Funding), Stevens Institute of Technology, 2012-2015
- Edwin A. Stevens Scholarship and Presidential Scholarship, Stevens Institute of Technology, 2011-2015

Additional Experience

Fingerstyle Guitarist, 2001 - Present

President of the Stevens Institute of Technology Chapter of the Society of Physics Students (SPS), Spring 2012 - Spring 2014