

Aaron L. Sharpe

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Education

Stanford University

Ph.D in Applied Physics, Thesis: Correlations in moiré heterostructures

2014–2020

Rice University

Bachelor of Science in Physics, Magna Cum Laude with Distinction in Research

2010–2014

Research

Jarillo-Herrero Group, Massachusetts Institute of Technology

Visiting Scientist

2023– Present

Performed low temperature transport measurements exploring the effect of the relative twist angle between layers on the electronic properties in twisted trilayer graphene and twisted bilayer graphene hexagonal boron nitride heterostructures. Principle achievements include the discovery of superconductivity and orbital ferromagnetism in previously unstudied twisted trilayer graphene heterostructures.

Sandia National Laboratory, Livermore, CA

Truman Fellow

2020– 2023

Applying microwave resonance in conjunction with transport measurements to characterize strongly correlated states in twisted bilayer graphene and ABC-trilayer graphene boron nitride moiré superlattices. Developed new techniques for stacking 2D materials and initiated collaborations with Tony Heinz, Takashi Taniguchi, Kenji Watanabe, Wei Pan, and Arthur Barnard.

Goldhaber-Gordon Group, Stanford University

Graduate Student

2014–2020

Performed low temperature transport measurements of correlated electronic phases in twisted bilayer graphene and ABC-trilayer graphene boron nitride moiré superlattices. Principle achievements include discovery of a novel ferromagnetic state in these graphene heterostructures and superconducting-like behavior in the trilayer heterostructure. To perform these experiments, developed specialized microscope equipped with an array of micromanipulators that enabled the fabrication of atomically clean van der Waals heterostructures. Fabricated graphene heterostructures with precise rotational alignment between layers.

Developed Monte Carlo simulation capable of modeling ballistic electron transport of ultra-clean materials for an arbitrarily shaped Fermi surface. Compared simulations to transport measurements of graphene-based superlattices and PdCoO₂.

Mittleman Group, Rice University

Research Assistant

2012–2014

Simulated and developed multi-plate parallel-plate waveguides used for guiding terahertz radiation.

Microdevices Laboratory, NASA's Jet Propulsion Laboratory

Summer Undergraduate Research Fellowship (SURF)

Summer 2013

Characterized quantum cascade laser developed for next-generation hazardous gas spectrometers.

Jin Group, The University of Colorado at Boulder

National Science Foundation Research Experience for Undergraduates (REU) Summer 2012

Assisted in simulation, design, and construction of magnetic coil transfer system for ^{40}K experiment.

Hulet Group, Rice University

Research Assistant 2011–2012

Designed and assisted in fabrication of parts for an ultracold ^6Li experiment.

Nagel Group, The University of Chicago

National Science Foundation Research Experience for Undergraduates (REU) Summer 2011

Used laser interference to image the geometry of the vapor layer beneath a water Leidenfrost drop.

Honors and Awards

William McMillan Award 2024

Highest accolade for an early-career condensed matter physics experimentalist or theorist

Achievement Rewards for College Scientists Foundation, Inc. Fellow 2019–2020

National Science Foundation Graduate Research Fellow 2015–2018

Ford Foundation Fellow 2016–2019

Stanford EDGE (Enhancing Diversity in Graduate Education) Doctoral Fellow 2014–2017

Barry Goldwater Scholar 2014

Phi Beta Kappa Honor Society 2014

Mellon Mays Undergraduate Fellow 2013–2014

Master's Special Service Award, Rice University, Wiess College 2014

President's Honor Roll, Rice University (4 Semesters) 2010–2014

American Physical Society Minority Scholarship 2012–2014

Tom Bonner Book Prize, Rice University 2011

Most Outstanding Sophomore Physics Student

Incentive Program Award, Seminole Nation of Oklahoma Judgment Fund 2010–2014

Burlington Northern Santa Fe Foundation Award 2010

Oklahoma Indian Student Honor Society 2010

San Manuel Band of Mission Indians Mainstream Tribal Scholars Program Scholarship 2010

Publications

First Author Publications

A. L. Sharpe, "Stacks on stacks on stacks," *Nature Materials* **21**, 842-843 (2022)

M. D. Bachmann,* **A. L. Sharpe**,* A. W. Barnard, C. Putzke, T. Scaffidi, N. Nandi, S. Khim, M. König, D. Goldhaber-Gordon, A. P. Mackenzie, and P. J. W. Moll, "Directional ballistic transport in the two-dimensional metal PdCoO₂," *Nature Physics* **18**, 819-824 (2022)

A. L. Sharpe, E. J. Fox, A. W. Barnard, J. Finney, K. Watanabe, T. Taniguchi, M. A. Kastner, D. Goldhaber-Gordon, "Evidence of Orbital Ferromagnetism in Twisted Bilayer Graphene Aligned to Hexagonal Boron Nitride," *Nano Letters* **21**, 4299-4304 (2021)

G. Chen*, **A. L. Sharpe***, E. J. Fox*, S. Wang, B. Lyu, L. Jiang, H. Li, K. Watanabe, T. Taniguchi, M. F. Crommie, M. A. Kastner, Z. Shi, D. Goldhaber-Gordon, Y. Zhang, F. Wang, "Tunable ferromagnetism at non-integer filling of a moiré superlattice," *Nano Letters* **22**, 238-245 (2022)

A. L. Sharpe,* E. J. Fox,* A. W. Barnard, J. Finney, K. Watanabe, T. Taniguchi, M. A. Kastner, D. Goldhaber-Gordon, "Emergent ferromagnetism near three-quarters filling in twisted bilayer graphene," *Science* **365**, 605-608 (2019)

G. Chen,* **A. L. Sharpe**,* P. Gallagher, I. T. Rosen, E. Fox, L. Jiang, B. Lyu, H. Li, K. Watanabe, T. Taniguchi, J. Jung, Z. Shi, D. Goldhaber-Gordon, Y. Zhang, F. Wang, "Signatures of Gate-Tunable Superconductivity in Trilayer Graphene Boron Nitride Moiré Superlattice," *Nature* **572**, 215-219 (2019)

M. D. Bachmann,* **A. L. Sharpe**,* A. W. Barnard, C. Putzke, M. König, S. Khim, D. Goldhaber-Gordon, A. P. Mackenzie, and P. J. W. Moll, "Super-geometric electron focusing on the hexagonal Fermi surface of PdCoO₂," *Nature Communications* **10**, 5081 (2019)

Contributing Author Publications

L.-Q. Xia, S. C. de la Barrera, A. Uri, **A. L. Sharpe**, Y. H. Kwan, Z. Zhu, K. Watanabe, T. Taniguchi, D. Goldhaber-Gordon, L. Fu, T. Devakul, P. Jarillo-Herrero, "Helical trilayer graphene: a moiré platform for strongly-interacting topological bands," *arXiv:2310.12204* (2023)

M. Pendharkar, S. J. Tran, G. Zaborski Jr., J. Finney, **A. L. Sharpe**, R. V. Kamat, S. S. Kalantre, M. Hocking, N. J. Bittner, K. Watanabe, T. Taniguchi, B. Pittenger, C. J. Newcomb, M. A. Kastner, A. J. Mannix, D. Goldhaber-Gordon, "Torsional Force Microscopy of Van der Waals Moirés and Atomic Lattices," *PNAS* (2024)

G. Chen, Y.-H. Zhang, **A. L. Sharpe**, Z. Zheng, S. Wang, L. Jiang, B. Lyu, H. Li, K. Watanabe, T. Taniguchi, Z. Shi, D. Goldhaber-Gordon, Y. Zhang, F. Wang, "Magnetic Field-Stabilized Wigner Crystal States in a Graphene Moiré Superlattice," *Nano Letters* **23**, 7023-7028 (2023)

X. Wang, J. Finney, **A. L. Sharpe**, L. K. Rodenbach, C. L. Hsueh, K. Watanabe, T. Taniguchi, M. A. Kastner, O. Vafek, D. Goldhaber-Gordon, "Unusual magnetotransport in twisted bilayer graphene from strain-induced open Fermi surfaces," *PNAS* **120**, 34 (2023)

J. Finney, **A. L. Sharpe**, E. J. Fox, C. L. Hsueh, D. E. Parker, M. Yankowitz, S. Chen, K. Watanabe,

T. Taniguchi, C. R. Dean, A. Vishwanath, M. A. Kastner, D. Goldhaber-Gordon, "Unusual magnetotransport in twisted bilayer graphene," *PNAS* **119**, 16 (2022)

G. Chen, **A. L. Sharpe**, E. J. Fox, Y.-H. Zhang, S. Wang, L. Jiang, B. Lyu, H. Li, K. Watanabe, T. Taniguchi, Z. Shi, T. Senthil, D. Goldhaber-Gordon, Y. Zhang, F. Wang, "Tunable correlated Chern insulator and ferromagnetism in a moiré superlattice," *Nature* **579**, 56-61 (2020)

A. W. Barnard, A. Hughes, **A. L. Sharpe**, K. Watanabe, T. Taniguchi, and D. Goldhaber-Gordon, "Absorptive pinhole collimators for ballistic Dirac fermions in graphene," *Nature Communications* **8**, 15418 (2017)

J. C. Burton, **A. L. Sharpe**, R. C. A. van der Veen, A. Franco, and S. R. Nagel, "Geometry of the Vapor Layer Under A Leidenfrost Drop," *Physical Review Letters* **109**, 074301 (2012)

A. M. Bautista-Chavez, A. N. Garza, S. M. Herkes, K. J. Kienast, N. W. McClendon, **A. L. Sharpe**, and B. C. Houchens, 2012 Motivations of Volunteer DREAM Mentors, ASEE Paper AC 2012-3355, Proceedings of the 2012 ASEE Annual Conference & Exposition, San Antonio, TX

Presentations

Invited Presentations

"Magnetism at $3/4$ filling in twisted bilayer graphene," *Invited speaker*, Caltech Young Investigators Lecture Series, Pasadena, CA (Feb. 2020)

"Magnetism at $3/4$ filling in twisted bilayer graphene," *Invited speaker*, Moiré in Paris, Paris, France (Jun. 2019)

"Magnetism at $3/4$ filling in twisted bilayer graphene," *Invited speaker*, Quantum Mesoscopic Physics session of the Rencontres de Moriond, La Thuile, Italy (Mar. 2019)

"Magnetism at $3/4$ filling in twisted bilayer graphene," *Invited speaker*, Stanford Quantum Initiative, Stanford, CA (Feb. 2019)

"Monte Carlo simulation of ballistic electron transport," *Invited speaker*, Gear Up For Research Computing Conference, Stanford, CA (Feb. 2019)

Contributed Presentations

"Magnetism in moiré heterostructures," *Contributed talk*, Moore Foundation EPiQS Postdoctoral Symposium 2024, Alta, UT

"Field-stabilized Chern insulator in magic-angle helical trilayer graphene" *Contributed talk*, American Physical Society March Meeting 2024, Minneapolis, MN

"Systematically Aligning Graphene and Hexagonal Boron Nitride," *Contributed talk*, American Physical Society March Meeting 2023, Las Vegas, NV

"Magnetic anisotropy in twisted bilayer graphene and ABC-trilayer graphene aligned with hexagonal boron nitride," *Contributed talk*, American Physical Society March Meeting 2022, Chicago, IL

“Transport measurements of correlated insulating states in twisted bilayer graphene,” *Contributed talk*, American Physical Society March Meeting 2019, Boston, MA

“Collimated Ballistic Quasiparticle Transport in a Graphene/hBN Superlattice,” *Contributed talk*, American Physical Society March Meeting 2018, Los Angeles, CA

“Exploring Proximity-Induced Ferromagnetism in Graphene/Cr₂Ge₂Te₆ Heterostructures,” *Contributed talk*, American Physical Society March Meeting 2017, New Orleans, LA

“Magnetotransport measurements in graphene/ferromagnetic insulator heterostructures,” *Contributed talk*, American Physical Society March Meeting 2016, Baltimore, MD

“Characterization of Quantum Cascade Laser Wafers,” *Contributed talk*, Mellon Mays Undergraduate Fellowship Southeastern Regional Conference, Atlanta, GA (Nov. 2013)

Best Undergraduate Research Poster, Rice University Society of Physics and Astronomy Students’ Annual Summer Undergraduate Research Poster Session (Sept. 2013)

“Characterization of Quantum Cascade Laser Wafers,” presentation of research done during SURF program, Jet Propulsion Laboratory, Pasadena, CA (Aug. 2013)

“Life Underneath a Leidenfrost Drop,” *Contributed talk*, American Physical Society March Meeting 2012, Boston, MA

“Magnetic Coil Transfer System,” presentation of research done during REU program, University of Colorado at Boulder, Boulder, CO (Aug. 2012)

“Looking Under Leidenfrost Drops,” presentation of research done during REU program, University of Chicago, Chicago, IL (Aug. 2011)

Grants

“Emergent Quantum Magnetism and Cryogenic Spin-Memory in Twisted Bilayer Graphene” Sandia National Laboratories Laboratory Directed Research and Development, Principal Investigator: Aaron Sharpe (2020–2023)

Teaching Experience

Practical Lab Skills

2021–2022

Lecture series I developed to familiarize young graduate students with tools and hardware they might encounter in the laboratory.

Volunteering and Mentoring Experience

Research Mentor in Goldhaber-Gordon group

2015 – Present

Served as a peer mentor for Wenmin Yang, Eli Fox, Joe Finney, Rupini Kamat, and Chaitrali Duse. After graduating, I have continued working with students in the group. This includes hiring Rupini Kamat as a year-round intern to continue collaborating while working at Sandia.

Applied Physics Student Advisor, Stanford University 2015 – 2020

Hosted twelve students during departmental visit weekends. Upon enrolling, served as peer mentor for Ilan Rose, John Roberts, Brandon Benson, and Nicholas Rommelfanger during their first years.

Enhancing Diversity in Graduate Education (EDGE) Mentor, Stanford University 2016 – 2018

Mentored Connie Mousatov and Dayshon Mathis during their transition to graduate school.

Physics 108: Advanced Physics Laboratory Project Mentor, Stanford University 2016 and 2018

Mentored two separate teams in project-based lab class. In the work with undergraduate students, Hava Schwartz, Sungyeon Yang, and Anthony Chen, devices were fabricated that led to two publications.

Future Advancers of Science and Technology (FAST) Mentor, Stanford University 2016 – 2017

FAST pairs local high school students with Stanford graduate student mentors who advised the students on their upperclass science fair projects. Worked with students to study the affects of the color of light on plant growth.

DREAM Mentor, Rice University 2010 – 2014

The DREAM program provides weekly meetings between Rice University students and local-area Houston high-school students to help promote their interest in STEM and attending college. As a head mentor (2011 – 2014), I helped run the program, working with other head mentors to recruit Rice students, plan projects, and coordinate the visits to schools. During my time as a head mentor, the program expanded to three additional schools in Houston.

Rice University Native American Student Association (RNASA) 2010 – 2014

In addition to other smaller events, RNASA hosts an annual pow wow for the Rice community. As president (2013 – 2014), I coordianted with local tribes to organize the pow wow and advertized it within the Rice community.