

# Trevor Arp

*Curriculum Vitae*

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## Professional Summary

I am fascinated by the ways that novel instrumentation can change how we can understand the exotic physics of nanoscale systems. In graduate school I developed a technique to efficiently study the ultrafast optoelectronics of two dimensional (2D) materials.<sup>6</sup> With it I revealed exciton-phonon coupling in interlayer excitons of a MoSe<sub>2</sub>-WSe<sub>2</sub> heterostructure,<sup>4</sup> hot carrier physics in graphene,<sup>2</sup> and an electron hole liquid phase in 2D MoTe<sub>2</sub>, published in *Nature Photonics*.<sup>7</sup> I have modeled biological systems, particularly focusing on the importance of quantum structure in reducing harmful noise in photosynthesis, published in *Science*.<sup>5</sup> In my postdoc, I learned the nanoSQUID on Tip (nSOT) magnetometry technique and combined it with thermodynamic compressibility measurements to explore ferromagnetism, intervalley coherence, and spin-orbit coupling in the symmetry broken phases of rhombohedral trilayer graphene, published in *Nature Physics*.<sup>3</sup> Most recently, I applied this approach to shine light on the nature of unconventional superconductivity in rhombohedral graphene.<sup>1</sup>

## Education

2020	Ph.D in Physics	University of California, Riverside
2014	M.S. in Physics	University of California, Riverside
2013	B.S. in Physics	University of Washington

## Research Experience:

**Postdoctoral Research, University of California, Santa Barbara** **2020 – Present**  
 PI: Andrea Young

**Rhombohedral Trilayer Graphene:** nSOT magnetometry on rhombohedral trilayer graphene, measuring spin and valley magnetism. Discovered intervalley coherence and the effect of intrinsic and extrinsic spin-orbit coupling on magnetism and superconductivity in rhombohedral graphene.<sup>1,3</sup>

**NanoSQUID on Tip Microscopy:** Designed and built custom nSOT instrumentation and software, including commissioning and optimizing a 300 mK system for nSOT experiments.

**Graduate Research, University of California, Riverside** **2014 - 2020**  
 PI: Nathaniel Gabor

**Optoelectronic Dynamics of 2D Materials:** Investigated optoelectronic properties in graphene and TMD heterostructures. Discovered a room-temperature electron-hole liquid in MoTe<sub>2</sub>,<sup>7</sup> vibronic exciton-phonon states in WSe<sub>2</sub>-MoSe<sub>2</sub>,<sup>4</sup> and studied hot carrier thermal physics in graphene.<sup>2</sup>

**Biophysics of Photosynthesis:** Explored statistical mechanics of photoexcitation in a noisy environment, resulting in a predictive model for photosynthetic pigments in real organisms.<sup>5,8</sup>

**Novel Optoelectronics Instrumentation:** Developed an efficient imaging technique for spatially and temporally resolved photocurrent and reflectance measurements with ultrafast pulsed lasers.<sup>6</sup>

**Undergraduate Research, University of Washington** **2011 - 2013**  
 Advisor: Jens Gundlach, Eöt-Wash Group

**Precision Instrumentation:** Designed, constructed, and optimized a new kind of autocollimator.<sup>9</sup>

## First Author Publications:

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\* Contributed Equally

1. Superconductivity and spin canting in spin-orbit proximitized rhombohedral trilayer graphene. Caitlin L. Patterson\*, Owen I. Sheekey\*, **Trevor B. Arp\***, Ludwig F. W. Holleis\*, et al. In review at *Nature* as of 10/2024. [arXiv:2408.10190](https://arxiv.org/abs/2408.10190)
2. Dirac excited state quenching in graphene. Jacky C. Wan\*, **Trevor B. Arp\***, Nathaniel M. Gabor. In review as of 10/2024. [arXiv:2409.03058](https://arxiv.org/abs/2409.03058)
3. Intervalley coherence and intrinsic spin orbit coupling in rhombohedral trilayer graphene. **Trevor Arp\***, Owen Sheekey\* et al. *Nature Physics* **20**, 1413–1420 (2024).
4. Vibronic Exciton–Phonon States in Stack-Engineered van der Waals Heterojunction Photodiodes. Fatemeh Barati\*, **Trevor B. Arp\***, et al. *Nano Letters* **22** (14) 5751–5758 (2022).
5. Quieting a noisy antenna reproduces photosynthetic light harvesting spectra. **Trevor B. Arp**, Jed Kistner-Morris, Vivek Aji, Richard Cogdell, Rienk van Grondelle, Nathaniel M. Gabor, *Science* **368**, 1490–1495 (2020).
6. Multiple Parameter Dynamic Photoresponse Microscopy for data-intensive optoelectronic measurements of van der Waals heterostructures. **Trevor B. Arp**, Nathaniel M. Gabor, *Review of Scientific Instruments* **90**, 023702 (2019).
7. Electron-hole liquid in a van der Waals heterostructure photocell at room temperature. **Trevor B. Arp\***, Dennis Pleskot\*, Vivek Aji, Nathaniel M. Gabor, *Nature Photonics* **13**, 245–250 (2019).
8. Natural Regulation of Energy Flow in a Green Quantum Photocell. **Trevor B. Arp**, Yafis Barlas, Vivek Aji, and Nathaniel M. Gabor, *Nano Letters* **16** (12) 7461–7466 (2016).
9. A reference-beam autocollimator with nanoradian sensitivity from mHz to kHz and dynamic range of  $10^7$ . **Trevor B. Arp**, Charles A. Hagedorn, Stephan Schlamminger, and Jens H. Gundlach, *Review of Scientific Instruments*, **84**, 095007 (2013).

## Other Publications:

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10. Direct magnetic imaging of fractional Chern insulators in twisted MoTe<sub>2</sub> with a superconducting sensor. Evgeny Redekop, Canxun Zhang, Heonjoon Park, Jiaqi Cai, Eric Anderson, Owen Sheekey, **Trevor Arp**, Grigory Babikyan, Samuel Salters, Kenji Watanabe, Takashi Taniguchi, Xiaodong Xu, Andrea F. Young. In press at *Nature*. [arXiv:2405.10269](https://arxiv.org/abs/2405.10269)
11. Optical Imaging of Flavor Order in Flat Band Graphene. Tian Xie, Tobias M. Wolf, Siyuan Xu, Zhiyuan Cui, Richen Xiong, Yunbo Ou, Patrick Hays, Ludwig F Holleis, Yi Guo, Owen I Sheekey, Caitlin Patterson, **Trevor Arp**, Kenji Watanabe, Takashi Taniguchi, Seth Ariel Tongay, Andrea F Young, Allan H. MacDonald, Chenhao Jin. [arXiv:2405.08074](https://arxiv.org/abs/2405.08074)
12. Electric-field tunable Type-I to Type-II band alignment transition in MoSe<sub>2</sub>/WS<sub>2</sub> heterobilayers. Jed Kistner-Morris, Ao Shi, Erfu Liu, **Trevor Arp**, Farima Farahmand, Takashi Taniguchi, Kenji Watanabe, Vivek Aji, Chun Hung Lui, Nathaniel Gabor. *Nat Commun* **15**, 4075 (2024).
13. Intrinsic spin Hall torque in a moire Chern magnet. C. L. Tschirhart, Evgeny Redekop, Lizhong Li, Tingxin Li, Shengwei Jiang, **T. Arp**, O. Sheekey, Takashi Taniguchi, Kenji Watanabe, Kin Fai Mak, Jie Shan, A. F. Young. *Nature Physics* **19**, 807–813 (2023).
14. A high-precision mechanical absolute-rotation sensor. Krishna Venkateswara, Charles A. Hagedorn, Matthew D. Turner, **Trevor Arp**, and Jens H. Gundlach, *Review of Scientific Instruments*, **85**, 015005 (2014).

## Teaching Experience:

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**Teaching Assistant**, University of California Riverside **2014-2016**

Teaching weekly laboratory and discussion sections for the following courses:

- Physics 40B, General Physics for Engineering Students II
- Physics 40C, General Physics for Engineering Students III
- Physics 2B, General Physics for Life Science Students II

**Elementary School Outreach**, University of California Riverside **2016-2018**

Designed and implemented an online educational activity on the science of wildfires (gridfire.ucr.edu). Participated in presentations at local schools, reaching hundreds of 4<sup>th</sup> through 6<sup>th</sup> grade students.

## Invited Conference Talks:

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1. “Ferromagnetism, Intervalley Coherence, and Spin-Orbit Coupling in Rhombohedral Trilayer Graphene.” EPQHS-9 Workshop, Nanyang Technological University, Singapore, Jan 3<sup>rd</sup> 2024.

## Awards and Fellowships:

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- *Robert T. Poe Memorial Scholarship* (2020)
  - Physics department award for best PhD dissertation
- *Dissertation Year Program Fellowship* (2018)
  - UCR graduate division award
- *Fellowships and Internships in Extremely Large Data Sets (FIELDS) Fellow* (2016-2018)
  - An interdisciplinary data science program in partnership with NASA/JPL and UCR for applications of data science across disciplines and in unconventional areas.
- *Al Saats Award for Experimental Physics* (2016)
  - Physics department award for “exceptional skills in designing and building physics apparatus.”
- *Chancellor’s Distinguished Fellowship* (2013-2014)

## References:

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Letters of reference can be obtained from the following individuals:

Professor Andrea Young  
[andrea@physics.ucsb.edu](mailto:andrea@physics.ucsb.edu)  
(646) 420-6120  
University of California Santa Barbara  
Relationship: Postdoc PI

Professor Nathaniel Gabor  
[nathaniel.m.gabor@gmail.com](mailto:nathaniel.m.gabor@gmail.com)  
(951) 850-8387  
University of California Riverside  
Relationship: Graduate Advisor

Professor Vivek Aji  
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(951) 827-7302  
University of California Riverside  
Relationship: Frequent Collaborator