Trevor Arp

Curriculum Vitae

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Professional Summary

I am fascinated by the ways that improvements in instrumentation can change how we can understand the exotic physics of nanoscale systems. In my graduate studies I utilized ultrafast optics and data-intensive imaging[5] to study the optoelectronics of two dimensional (2D) materials. Revealing, among other things, exciton-photon coupling in interlayer excitons of a $MoSe_2$-WSe_2 heterostructure[8], and a 2D electron hole liquid phase that emerges out of interacting excitons in photoexcited 2D $MoTe_2$, published in *Nature Photonics*.[4] In addition, I have worked to apply concepts from quantum optoelectronics to biological systems, particularly focusing on the importance of quantum structure in reducing harmful noise in photosynthesis, published in *Science*.[3,6] In my postdoc I expanded my skill set to include scanned probe nanoSQUID magnetometry combined with thermodynamic measurements to explore the symmetry broken phases of crystalline graphene multilayers, particularly Rhombohedral trilayer graphene.[9] Along the way I have acquired a varied set of technical skills in building instrumentation, optics, cryogenics, and electronics as well as expertise in experimental automation, data acquisition, and the application of data science to image analysis in practical settings.

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

Imaging Ferromagnetic Phases of ABC Trilayer Graphene. Performed scanned probe magnetometry experiments using the nanoSQUID on Tip (nSOT) technique to explore Rhombohedral trilayer graphene. Measured spin and valley magnetism in different electronic phases to uncovered evidence of an intervalley coherence and the effect of intrinsic spin-orbit coupling on the competition of symmetry broken magnetic phases.[9]

NanoSQUID Instrumentation. Designed, built, and iterated custom instrumentation and software to support the nanoSQUID technique. Installed and commissioned a customized 300 mK cryostat to preform nanoSQUID experiments at ultra-low temperatures.

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

Optoelectronic Dynamics of 2D Material Heterostructures. Studied the optoelectronic physics of graphene and TMD heterostructures to uncover dynamics of excitons formed from photoexcitation. Discovered the formation of a correlated electron-hole liquid phase in $MoTe_2$ that persists at room temperature.[4] Explored dynamics of vibronic exciton phonon states in WSe_2-

$MoSe_2$ heterojuctions.[7] Probed graphene-hBN-graphene stacked heterostructures to reveal the thermal physics of hot carriers in graphene.

Energy Flow in Noisy Biological Systems. Simulated energy flow in noisy quantum systems, revealing how regulation can naturally emerge from quantum structure in molecular systems.[3] Adapted this concept to the photosynthesis in multiple biological systems, developed a model that can predict ideal photosynthetic structure from light conditions that accurately predicts the structure of photosynthetic pigments of multiple model organisms based on their light enviroment.[6]

Novel Instrumentation for Optoelectronic Experiments. Designed and built a custom experimental setup using near-infrared ultrafast pulsed lasers to probe nanoscale materials by measuring spatially and temporally resolved photocurrent and reflectance. Designed and implemented software to rapidly acquire, process and visualize data from automated multi-variable experiments, for efficient acquisition and analysis of photoresponse imaging datasets.[5]

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

Precision Instrumentation Designed, constructed, optimized, and published a new kind of autocollimator for measuring angles to nanoradian precision for use in gravity experiments.[1,2]

Teaching Experience:

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

FIELDS 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^{th} through 6^{th} grade students.

Awards and Fellowships:

- *Robert T. Poe Memorial Scholarship* (2020)
  - UCR physics department award for best 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
- *Al Saats Award, UCR Physics Department* (2016)
  - UCR physics department award for experimental physics
- *Chancellor's Distinguished Fellowship* (2013-2014)

Publications:

9. “Intervalley coherence and intrinsic spin orbit coupling in rhombohedral trilayer graphene” **Trevor Arp***, Owen Sheekey* et al. In review at *Nature*. arXiv:2310.03781

8. “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).

7. “Vibronic Exciton–Phonon States in Stack-Engineered van der Waals Heterojunction Photodiodes” Fatemeh Barati*, **Trevor B. Arp***, et al. *Nano Letters* **22** (14) pp. 5751-5758 (2022).

6. “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).

5. “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).

4. “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).

3. “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) pp. 7461-7466 (2016).

2. “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).

1. “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).

* Contributed Equally