Trevor Arp

Curriculum Vitae

University of California, Riverside
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Education

2013-Present, PhD in Physics, University of California Riverside, Riverside CA
In Progress

2014, M.S. in Physics, University of California Riverside, Riverside CA

2013, B.S. in Physics, University of Washington, Seattle WA
Physics Major, Applied Mathematics Minor with a focus in Scientific Computing

Awards and Honors

Dissertation Year Program Fellowship. UCR Graduate Division Award, funded for Fall Quarter 2018.

Fellowships and Internships in Extremely Large Data Sets (FIELDS) Graduate Student Fellowship. Funded from 3/29/2016 to 6/24/2018

2016 Al Staats Awards for Exceptional Skills in Designing and Building Physics Apparatus. UCR Physics Departmental Award

Research Interests

Optoelectronic probes of atomically thin materials provide a fertile testing ground for quantum mechanics. For the first time we can build materials where key measurable properties are determined by quantum confinement, leading to a large variety of strange behavior that runs contrary to human intuition. Understanding the behavior of these systems is no small challenge. Quantum optics, however, provides a rich set of tools for interacting with quantum systems. Quantum optoelectronics sits on an exciting boundary between quantum mechanics, materials science and optics. Making illuminating measurements requires data acquisition, processing and analysis on a large scale not seen in traditional condensed matter research, providing us with an exciting new challenge in experimental technology.

I am interested in pushing the state of the art in quantum optoelectronic experiments in both hardware and software. Our group has become proficient at making high-quality samples of atomically thin materials. But, determining their properties is difficult due to their quantum mechanical nature. My experiments excite a sample with femtosecond laser pulses and measure its response while controlling a large number of experimental parameters such as magnetic field, temperature, and wavelength. Using custom data acquisition and control software we can perform these measurements to map out the response of the sample spatially and temporally. With many such scans for different experimental parameters, we can construct a large and dense data set characterizing the response of a given nanodevice to external excitation. Analysis of these data sets will reveal insights into the physical processes and charge carrier dynamics of nanoscale systems.

Research Experience

March 2014 - Present, Quantum Materials Optoelectronics Laboratory, University of California, Riverside, CA 92521, USA.
Advisor: Nathaniel Gabor

- **Development of Custom Software for Data Acquisition and Experimental Control**
  Designed and implemented software to rapidly acquire, process and display data. Software simultaneously controls multiple pieces of hardware that continuously vary experimental conditions. Software was designed to be extensible and portable, able to be used for different experimental setups and to easily incorporate new measurements that require different control routines.

- **Development of Software for Data Analysis and Simulation**
  Wrote various analysis software to analyze and visualize large sets of data gathered in the course of many experimental runs. Developed a standardized "toolbox" of data analysis code for use across many measurements. Applications have included rapid fitting, image processing, and filtering noise out of experimental data. Simulated Quantum Heat Engines to test ideas about regulation in quantum systems and guide future experiments in quantum photocells.

- **Developing Novel Instrumentation and Techniques for Optoelectronics Experiments**
  Designed, prototyped and built a custom experimental setup that utilizes a femtosecond pulsed near-infrared laser to probe the properties of nanoscale materials by measuring spatially and temporally resolved photocurrent and reflectance. The setup is capable of applying voltages and magnetic fields (up to 3 T) to the sample while controlling for temperature (from 4 K to 420 K), pump-probe time delay as well as laser power, wavelength and polarization.

- **Optoelectronic Probes of Nanodevice Properties**
  Using the custom experimental setup to probe the response of Transition Metal Dichalcogenide heterostructures and Graphene samples to optical excitation under a variety of controlled conditions.

March 2011 - August 2013, Eöt-Wash Gravitational Physics Group, Center for Experimental Nuclear Physics and Astrophysics (CENPA), Seattle WA
Advisor: Jens Gundlach

- **Developing a Precise Autocollimator for Gravitational Experiments**
  Designed, constructed and optimized an new kind of autocollimator for measuring angles to sub-nanoradian precision at low frequencies for use in gravitational experiments. Applications include: LIGO ground tilt sensor, torsion balance experiments.

- **Development of Data Acquisition Software** Wrote custom data acquisition and analysis software for the autocollimator. In the process developed a customized fitting routine to allow for efficient high speed processing of complex optical data.

- **Environmental Sensor Network**
  Designed, constructed and maintained a wireless network of temperature and humidity sensors to continuously monitor environmental conditions in an experimental laboratory containing sensitive equipment. Analyzed the resulting data to determine environmental fluctuations and worked to improve the stability of the lab environment.

Teaching Experience

Teaching Assistant, University of California Riverside, Department of Physics and Astronomy, 2014-2016

Teaching weekly laboratory and discussion sections for the following courses: Physics 40B and 40C, General Physics for engineering students, and Physics 2B, General Physics for life science students.

Other Skills

Computational Experience

I have long been interested in programming and it's application to science. I have spent a lot of time learning scientific programming both formally, satisfying my undergraduate off-major course requirements with programming and scientific computing classes, and informally through experience coding in the lab. I have become proficient in the use of multiple programming languages and in efficient and extensible program design.

- **Programming Languages:** Python, C, C++, Matlab/Octave, C#, Java, JavaScript
- **Operating Systems:** Linux, Windows
- **Other Software:** SolidWorks, Autodesk 3DS MAX, LaTeX, NI-DAQ, LabVIEW

Fabrication

I have spent much of my research career building novel instruments and pushing the cutting edge of experimental technology. Along the way I have gained experience in engineering and fabrication.

- **Nanofabrication:** Mechanical exfoliation of atomically thin films, dry transfer techniques, and wirebonding to nanodevices.
- **Prototyping:** Building of custom electrical circuitry and optical systems.
- **Machining:** Proficient in the operation of a mill, lathe, drill press and other common machine shop equipment.

Publications

Refereed Publications

- *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).
- *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).
- *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).