

Ryan Muzzio

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EDUCATION

BA: Physics

Kenyon College | Gambier, Ohio

08/2014 – 05/2018

Ph.D. Physics (pursuing)

Carnegie Mellon University | Pittsburgh PA

09/2018-Present

RESEARCH INTEREST

I seek to investigate the electronic properties of novel materials and devices in the 2D regime by utilizing nano-scaled angle resolved photoemission spectroscopy (nanoARPES) and mesoscopic device fabrication. This union will give immediate insight on how electric properties change as the device is in operation, thus birthing *in-operando ARPES*.

RESEARCH EXPERIENCE

Graduate Research

Advisor: Dr. Jyoti Katoch

Probing electronic structure of 2D materials-based devices using nano-scaled ARPES

- Fabrication and measurement of graphene-based field-effect transistors to electronically tune the many body effects which are monitored through nanoARPES. NanoARPES was performed at the 7.0.2 beamline within the Advanced Light Source, Lawrence Berkeley National Labs.
- Incorporation of CVD grown 2D materials for device application such as twisted bilayer graphene, twisted transition metal dichalcogenides. Resulted in measurement of spatially-resolved electronic structure of gate- and current- controlled twisted bilayer graphene. NanoARPES measurements were performed at the I05 beamline at the DIAMOND light source at the Harwell Science and Innovation Campus in Oxfordshire.
- Fabrication of twisted bilayer graphene devices with target angles through semi-encapsulation and heterostructure flipping.

Magneto transport of WTe₂ based devices

- Fabrication of WTe₂ based devices in a glovebox environment.
- Measurement of Fe₃GeTe₂ magnetization switching via spin-orbit torque imposed by spin currents in WTe₂ flakes in the 2D regime.

Construction of the lab at Carnegie Mellon University

- Building and maintenance of two custom 2D material heterostructure transfer tools.
- Design and maintenance of transfer tool inside the glovebox.
- Construction of custom-built molecular beam epitaxy system.

Undergraduate Research

Advisor: Dr. Frank Peiris

Probing the zero-momentum electronic properties of double perovskite Sr₂CrReO₆

- Temperature dependent ellipsometry of wave numbers between 250 and 50,000 to understand the optical properties of materials. Other materials properties were probed via X-ray diffraction and reflectivity, absorption spectroscopy, AFM, and Raman Spectroscopy of materials

Advisor: Dr. Lisa Prato

Inspecting the properties of young stars in binary systems

- Data collection by operating the Discovery Channel Telescope using a near-infrared spectrometer
- Data reduction and analysis to extract parameters of hundreds of stars such as temperature, velocities, pair separation, surface gravity, and circumstellar disk properties.

PUBLICATIONS

Published

[3] Alfred J. H. Jones*, **Ryan Muzzio***, Paulina Majchrzak*, Sahar Pakdel, Davide Curcio, Klara Volckaert, Deepnarayan Biswas, Jacob Gobbo, Simranjeet Singh, Jeremy T. Robinson, Kenji Watanabe, Takashi Taniguchi, Timur K. Kim, Cephise Cacho, Nicola Lanata, Jill A. Miwa, Philip Hofmann, Jyoti Katoch, Søren Ulstrup, “Observation of Electrically Tunable van Hove Singularities in Twisted Bilayer Graphene from nanoARPES” Accepted for publication in *Advanced Materials* (2020); ArXiv:2006.00791. * represents equal authorship.

[2] **Ryan Muzzio***, Alfred J. H. Jones*, Davide Curcio, Deepnarayan Biswas, Jill A. Miwa, Philip Hofmann, Kenji Watanabe, Takashi Taniguchi, Simranjeet Singh, Chris Jozwiak, Eli Rotenberg, Aaron Bostwick, Roland J. Koch, Søren Ulstrup, Jyoti Katoch, “Momentum-resolved view of highly tunable many-body effects in a graphene/hBN field-effect device” *Physical Review B*, 101, 201409(R) (2020). * represents equal authorship.

[1] T. S. Allen, L. Prato, N. Wright-Garba, G. Schaefer, L. I. Biddle, B. Skiff, I. Avilez, **R. Muzzio**, and M. Simon “Properties of the Closest Young Binaries. I. DF Tau’s Unequal Circumstellar Disk Evolution” *The Astrophysical Journal*, 845:161 (16pp), (2017).

Under Review

Davide Curcio, Alfred J. H. Jones, **Ryan Muzzio**, Klara Volckaert, Deepnarayan Biswas, Charlotte E. Sanders, Pavel Dudin, Cephise Cacho, Simranjeet Singh, Kenji Watanabe, Takashi Taniguchi, Jill A. Miwa, Jyoti Katoch, Søren Ulstrup, Philip Hofmann, "Accessing the spectral function in a current-carrying device", arXiv:2001.09891.

TRAINING AND SKILLS

Material Growth

- Mechanical exfoliation of 2D materials, and Van der Waals heterostructure fabrication.

Nanoscale Device Fabrication

- Electron beam lithography, plasma etcher, electron-beam deposition, X-ray diffraction and reflectivity, Raman spectroscopy, Ellipsometry, and wire bonder.

Material/Device Characterization

- Angle-resolved photoemission spectroscopy, x-ray photoemission spectroscopy, Scanning electron microscopy, semi-contact atomic force microscopy, and magneto transport.

Coding Languages

- C, Mathematica, Origin, and Igor Pro

Teaching

- Lead teaching assistant for three years during my undergraduate career. Teaching assistant for introduction to astronomy (Fall 2018) and Experimental physics (Spring 2019). I was responsible for in-class work as well as grading.

Management and Administration

- Co-founder of Kenyon College Radio and Optical Astronomy Research. Co-founder of Kenyon College's SACNAS chapter. Responsible for training in-coming graduate and undergraduate students who enter our lab and work with chemicals and 2D device fabrication.

PRESENTATIONS

- Pittsburgh Quantum Institute, 2020: *Momentum-Resolved View of Highly Tunable Many-Body Effects in a Graphene/hBN Field-Effect Device.*
- Pittsburgh Quantum Institute, 2019: *Towards in-operando nanoARPES of Quantum Devices.*
- Alleghany Observatory, 2019: *Young Stellar Objects: The opening chapter in the life of a Star.*
- Kenyon College 2017: *Investigating the Optical Properties of a Particular Double Perovskite Thin Film.*
- American Astronomical Society, 2017: *Effective Temperatures for Young Stars in Binaries.*
- American Astronomical Society, 2016: *Component Properties of T Tauri Star Binaries.*

AWARDS

- Spring 2020: Pittsburgh Quantum Institute poster presentation award.
- Spring 2019: Pittsburgh Quantum Institute poster presentation award.

COMMUNITY SERVICE

- Carnegie Mellon Summer 2020: I am one of two student volunteers who are on the *Equity, Diversity, and Inclusion Committee*. We meet to discuss and put in action plans for increasing the department's equity diversity and inclusion.
- Carnegie Mellon Spring 2020: I assisted in hosting the Conference for Undergraduate Women in Physics by giving tours of my lab and serving on a panel about the inclusivity of minorities in physics.
- Young Scholars of Western PA summer 2020: Remotely held a question and answer session for middle schoolers during the historic Space-X launch.
- Carnegie Mellon Fall 2018: I ran a day-long scientific workshop for four groups of 20 middle schoolers, in partnership with *Breakthrough Pittsburgh*. Our goal was to inspire the newest generation of scientists.
- Kenyon College Fall 2017: I ran a public program for the Kenyon college community for Vera Rubin Day. This day is dedicated to scientists who did not receive credit for what they contributed to science.
- Kenyon College, 2015-2017: With *Head Start*, I raised money for, set up, and participated in a holiday party for underprivileged children of Knock County, Ohio.