

# Paul Masih Das | CV

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## Education

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### Ph.D. in Physics

*University of Pennsylvania*

2020

GPA: 3.89/4.0, Advisor: Prof. Marija Drndic

### M.S. in Physics

*University of Pennsylvania*

2016

GPA: 3.72/4.0

### B.S. in Materials Science

*Johns Hopkins University*

2014

GPA: 3.86/4.0, Advisor: Prof. Timothy Weihs

## Research Interests

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Biosensing, Micro/Nanofabrication, Nanopore Sensing, Nanocharacterization, Micro/Nanostructured Materials, Optoelectronic Spectroscopy, 2D Materials, Nanophotonics, Nanoelectronics, Transmission Electron Microscopy.

## Work Experience

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### Ph.D. Candidate

*University of Pennsylvania, Drndic Lab*

2014–2020

- Fabricated low-dimensional nanostructures in 2D materials and performing physical/optoelectronic characterization.
- Investigated the electronic, ionic, and gas transport properties of 2D nanopores and nanoporous membranes.
- Developed methods for engineering atomic defects in 2D materials through chemical etching and ion/electron irradiation.
- Published 21 articles in peer-reviewed journals and presented 18 talks/posters at scientific conferences.

### Industrial Research Scientist

*Goepfert LLC*

(Aug–Dec) 2018

- Tested techniques for growing and processing 2D semiconductors with high throughput.

### Undergraduate Research Assistant

*Johns Hopkins University, Weihs Lab*

2013–2014

- Performed photolithographic patterning and time-resolved thermal testing of reactive nanofolios.

### Visiting Research Fellow

*University of Pennsylvania, Drndic Lab*

(Jun–Sep) 2013

- Investigated chemical vapor deposition methods for the growth of monolayer graphene.

### Undergraduate Research Assistant

*Johns Hopkins University, Bevan Lab*

(May–Aug) 2012

- Probed the interactions of ferroelectric nanoparticles in dynamic electric fields.

### Visiting Research Fellow

*SRI International, Molecular Physics Lab*

(May–Aug) 2011

- Performed mass spectrometry on the thermal decomposition products of ablator resins.

### Visiting Research Fellow

*Stony Brook University, Rafailovich Lab*

(May–Aug) 2010

- Developed a chemical synthesis for graphene and graphene oxide in organic polymer solar cells.

### In Review

- [21]: J.P. Thiruraman, **P. Masih Das**, M. Drndic. *Stochastic Ionic Transport in Single Atomic Zero-Dimensional MoS<sub>2</sub> Pores*. In Review.
- [20]: J.P. Thiruraman, S.A. Dar, **P. Masih Das**, A. Keethi, M. Drndic, R. Boya. *Gas Flow through Single Atom Apertures*. In Review.
- [19]: M. Zhao, D. Zhang, **P. Masih Das**, Q. Zhang, S. Mandyam, C. Wen, M. Drndic, A.T.C. Johnson. *Fast Growth of Monolayer MoSe<sub>2</sub> Films for Large-Area Electronics*. In Review.
- [18]: Q. Zhang, S. Wang, Z. Gao, S.H. Parra, J. Berry, Z. Addison, **P. Masih Das**, W.M. Parkin, M. Drndic, J.M. Kikkawa, F. Wang, E.J. Mele, Z. Luo, A. T. C. Johnson. *Electrically Tunable Coupling of Quantum Valley Hall Edge States between CVD Bilayer Graphene Layer Stacking Domain Walls*. In Review.

### Published

- [17]: X. Zheng, A. Calo, T. Cao, X. Liu, Z. Huang, **P. Masih Das**, C. Aruta, E. Albisetti, F. Lavini, T.D. Li, V. Narang, W.P. King, J.W. Harrold, M. Drndic, M. Vittadello, D. Shahrjerhi, E. Riedo, *Spatial Defects Nanoengineering for Bipolar Conductivity in MoS<sub>2</sub>*. Nat. Comm. (2020) In Press.
- [16]: **P. Masih Das**, M. Drndic. *In Situ 2D MoS<sub>2</sub> Field Effect Transistors with an Electron Beam Gate*. ACS Nano (2020) 14:6.
- [15]: Y.C. Chou, **P. Masih Das**, D. Monos, M. Drndic. *Lifetime and Stability of Silicon Nitride Nanopores and Nanopore Arrays for Ionic Measurements*. ACS Nano (2020) 14:6.
- [14]: J.P. Thiruraman, **P. Masih Das**, M. Drndic. *Ions and Water Dancing through Atom-Scale Holes: A Perspective toward 'Size-Zero'*. ACS Nano (2020) 14:4.
- [13]: K. Figueroa, N. Pinto, S. Mandyam, M. Zhao, C. Wen, **P. Masih Das**, Z. Gao, M. Drndic, A.T.C. Johnson. *Controlled Doping of Graphene by Impurity Charge Compensation via a Polarized Ferroelectric Polymer*. J. App. Phys. (2020) 127:125503.
- [12]: **P. Masih Das**, J.P. Thiruraman, M. Zhao, S. Mandyam, A.T.C. Johnson, M. Drndic. *Atomic-Scale Patterning in Two-Dimensional van der Waals Superlattices*. Nanotechnology (2020) 31:105302.
- [11]: S. Mandyam, M. Zhao, **P. Masih Das**, Q. Zhang, C. Price, Z. Gao, M. Drndic, V. Shenoy, A.T.C. Johnson. *Controllable Growth of Large-Area Tungsten Diselenides with Lateral pn Junctions*. ACS Nano (2019) 13:8.
- [10]: J.P. Thiruraman, **P. Masih Das**, M. Drndic. *Irradiation of Transition Metal Dichalcogenides using a Focused Ion Beam: Controlled Single-Atom Defect Creation*. Adv. Func. Mats. (2019) 30:1904668.
- [9]: **P. Masih Das**, J.P. Thiruraman, Y.C. Chou, G. Danda, M. Drndic. *Centimeter-Scale Nanoporous 2D Membranes and Ion Transport: Porous MoS<sub>2</sub> Monolayers in a Few-Layer Matrix*. Nano Lett. (2019) 19:1.
- [8]: G. Danda, **P. Masih Das**, M. Drndic. *Laser-Induced Fabrication of Nanoporous Monolayer WS<sub>2</sub> Membranes*. 2D Mats. (2018) 5:035011.
- [7]: J.P. Thiruraman, K. Fujisawa, G. Danda, **P. Masih Das**, T. Zhang, A. Bolotsky, N. Perea-Lopez, A. Nicolai, P. Senet, M. Terrones, M. Drndic. *Angstrom-Size Defect Creation and Ionic Transport through Pores in Single-Layer MoS<sub>2</sub>*. Nano Lett. (2018) 18:3.
- [6]: A. Cupo, **P. Masih Das**, C.C. Chien, G. Danda, N. Kharche, D. Tristant, M. Drndic, V. Meunier. *Periodic Arrays of Phosphorene Nanopores as Antidot Lattices with Tunable Properties*. ACS Nano (2017) 11:7.
- [5]: G. Danda, **P. Masih Das**, Y.C. Chou, J.T. Mlack, W. Parkin, C. Naylor, K. Fujisawa, T. Zhang, L.B. Fulton, M. Terrones, A.T.C. Johnson, M. Drndic. *Monolayer WS<sub>2</sub> Nanopores for DNA Translocation with Light-Enabled Size Control*. ACS Nano (2017) 11:2.
- [4]: J.T. Mlack, **P. Masih Das**, G. Danda, Y.C. Chou, C. Naylor, Z. Lin, T. Zhang, N. Perea-Lopez, M. Terrones, A.T.C. Johnson, M. Drndic. *Transfer of Monolayer TMD WS<sub>2</sub> and Raman Study of Substrate Effects*. Sci. Rep. (2017) 7:43037.
- [3]: **P. Masih Das**, G. Danda, A. Cupo, W. Parkin, L. Liang, N. Kharche, X. Ling, S. Huang, M. Dresselhaus, V. Meunier, M. Drndic. *Controlled Sculpture of Black Phosphorus Nanoribbons*. ACS Nano (2016) 10:6.

- [2]: W. Parkin, A. Balan, L. Liang, **P. Masih Das**, M. Lamparski, C. Naylor, J.A. Rodriguez-Manzo, A.T.C. Johnson, V. Meunier, M. Drndic. *Raman Shifts in Electron-Irradiated Monolayer MoS<sub>2</sub>*. ACS Nano (2016) 10:3.
- [1]: X. Ling, S. Huang, E. Hasdeo, L. Liang, W. Parkin, Y. Tatsumi, A. Nugraha, A. Poretzky, **P. Masih Das**, B. Sumpter, D. Geohegan, J. Kong, R. Saito, M. Drndic, V. Meunier, M. Dresselhaus. *Anisotropic Electron-Photon and Electron-Phonon Interactions in Black Phosphorus*. Nano Lett. (2016) 16:4.

## Patents

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- 62/308,897 (Filed)**: Black-Phosphorus-Based Molecular Analysis Devices 2017
- 8728578 (Granted)**: Chemical Synthesis for Graphene Sheets >1 Micron in Length 2014

## Skills

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**Techniques**: Cleanroom-Based Fabrication (deposition, patterning, etching), Soft Lithography, Electron Beam Lithography, Nanopore Sensing, Biosensing, Photolithography, Raman Spectroscopy, Photoluminescence Spectroscopy, Chemical Vapor Deposition, Transmission Electron Microscopy, Ionic/Electronic Transport Measurements, 2D Materials Synthesis, Atomic Force Microscopy, Focused Ion Beam Irradiation, Nanofluidic Measurements.

**Software**: MATLAB, COMSOL, LabVIEW, Python, Adobe Illustrator, Adobe Photoshop, ImageJ, LaTeX, Abaqus, Xcode, Android Studio, Blender, Density Functional Theory Calculations.

## Funding

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### Doped TMDs for 2D Contact Engineering

NSF Paradim

2018–2019

- Use of the Cornell Nanoscale Science and Technology Facility for fabricating and characterizing doped transition metal dichalcogenides (TMDs) for 2D contact engineering.

## Awards

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- Dissertation Completion Fellowship**, University of Pennsylvania 2019
- President Gutmann Leadership Award**, University of Pennsylvania 2019
- Elias Burstein Prize**, University of Pennsylvania 2019
- Winner (Natural Sciences)**, University of Pennsylvania Ben Talks 2019
- Winner (Physics)**, University of Pennsylvania Pop Talks 2018
- Best PhD Student Poster Contribution**, Graphene 2017 2017
- Honorable Mention**, NSF Graduate Research Fellowship 2015–2016
- Semifinalist**, University of Pennsylvania AppltUp Challenge 2015
- Best Cloud-Based Mobile App**, University of Pennsylvania PennApps XIII 2015
- Baltimore Award for Community Impact**, Johns Hopkins University 2014
- Hodson Trust Merit Scholarship**, Johns Hopkins University 2010–2014
- Dean's List**, Johns Hopkins University 2010–2014
- Young Hall of Famer**, Long Island Technology Hall of Fame 2010
- Finalist**, Intel Science Talent Search 2010

## Academic Service

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**Carbon**, Reviewer

**Scientific Reports**, Reviewer

**Gotham-Metro Condensed Matter Meeting**, Organizer

## Presentations and Workshops

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\*Denotes invited talk

- \*Oak Ridge National Lab Seminar (Knoxville, TN):** (Feb) 2020  
*Nanostructure Engineering in 2D Materials Beyond Graphene*
- Materials Research Society Fall Meeting (Boston, MA):** (Dec) 2019  
*Defect Engineering in 2D Materials with Ion and Electron Beams*
- Gotham-Metro Condensed Matter Meeting (New York, NY):** (Oct) 2019  
*Low-Dimensional Phosphorene Nanostructures*
- Enabling Quantum Leap Workshop (Philadelphia, PA):** (Sep) 2019
- Graphene 2019 (Rome, Italy):** (Jun) 2019  
*Atomic Defect Engineering in Transition Metal Dichalcogenides*
- Graphene and Beyond: From Atoms to Applications (State College, PA):** (May) 2019  
*Nanotopography and Ion Transport in Centimeter-Scale MoS<sub>2</sub> Membranes*
- Biophysical Society Meeting (Baltimore, MD):** (Mar) 2019  
*Nanotopography and Ion Transport in Centimeter-Scale MoS<sub>2</sub> Membranes*
- \*University of Pennsylvania Ben Talks (Philadelphia, PA):** (Feb) 2019  
*2D Materials: Making Smartphones 'Cool' Again*
- Graphene for US (New York, NY):** (Feb) 2019  
*Nanotopography and Ion Transport in Centimeter-Scale MoS<sub>2</sub> Membranes*
- University of Pennsylvania Pop Talks (Philadelphia, PA):** (Nov) 2018  
*Novel Materials for Next Generation Electronics*
- Atom by Atom Fabrication (Oak Ridge, TN):** (Nov) 2018  
*Low-Dimensional Phosphorene Nanostructures*
- Singh Center for Nanotechnology Users Meeting (Philadelphia, PA):** (Oct) 2018  
*Low-Dimensional Phosphorene Nanostructures*
- NSF Summer School on Density Functional Theory for Experimentalists (Ithaca, NY):** (Jul) 2018
- Canadian-American-Mexican Graduate Student Conference (Washington, DC):** (Aug) 2017  
*Low-Dimensional Black Phosphorus Nanostructures*
- Graphene and Beyond: From Atoms to Applications (State College, PA):** (May) 2017  
*DNA Translocation Through WS<sub>2</sub> Nanopores*
- Graphene 2017 (Barcelona, Spain):** (Mar) 2017  
*Electronic Transport Properties of Few-Layer Black Phosphorus Nanoribbons*
- American Physical Society March Meeting (New Orleans, LA):** (Mar) 2017  
*Electronic Transport Properties of Suspended Few-nm Black Phosphorus Nanoribbons*
- \*Franklin Institute Early Access to Graduate Research Workshop (Philadelphia, PA):** (Dec) 2016  
*Exploring DNA in Two Dimensions*
- NSF Two-Dimensional Research and Engineering Meeting (San Francisco, CA):** (Dec) 2016  
*Two-Dimensional Nanopores for Next Generation Biotechnological Applications*
- Singh Center for Nanotechnology Nano Week (Philadelphia, PA):** (Oct) 2016  
*Controlled Sculpture of Black Phosphorus Nanoribbons*
- Graphene and Beyond: From Atoms to Applications (State College, PA):** (May) 2016  
*Controlled Sculpture of Black Phosphorus Nanoribbons*
- American Physical Society March Meeting (Baltimore, MD):** (Mar) 2016

*Fabrication of Suspended Few-Layer Black Phosphorus Nanopores and Nanoribbons*

**\*Moorman-Simon Seminar on STEM Education (Philadelphia, PA):** (Mar) 2016

*Physics Education in West Philadelphia Public Schools*

**Academically-Based Community Service Summit (Philadelphia, PA):** (Mar) 2016

**Graphene and Beyond: From Atoms to Applications (State College, PA):** (May) 2015

## Teaching and Outreach Experience

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### Research Mentor

*University of Pennsylvania* 2014–Present

- Assist, train, and supervise undergraduate and high school students (11 total) in performing research projects.

### Visiting Scientist

*Franklin Institute* 2016–2018

- Designed and participated in workshops for high school students with a focus on topics in academic research.

### Director

*Access Science Physics* 2014–2017

- Led a team of undergraduate students (25 total) in designing and performing weekly physics experiments in three West Philadelphia public high and middle schools.

### Educational App Developer

*Independent* 2014–2016

- Developed and published iOS apps and games to promote topics in academic research among K-12 students.

### Teaching Assistant

*University of Pennsylvania* 2014–2016

- Supervised undergraduate courses in General Physics (101-Mechanics, 150-Principles I, and 151-Principles II).

### Director

*Jail Tutorial Project* 2011–2014

- Led a team of undergraduate students (40 total) in tutoring inmates at the Baltimore City Detention Center in General Educational Development (GED) writing, mathematics, and computer skills.

### Teaching Assistant

*Barclay Middle School* 2011–2014

- Provided weekly mathematics extra-help sessions and assisted faculty with grading.

## Mobile Applications

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**KOH Etch Rate Calculator (iOS)** (Jul) 2015

**Master Sequencer (iOS)** (Feb) 2015

## References

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[1]: Prof. Marija Drndic, University of Pennsylvania, drndic@sas.upenn.edu.

[2]: Prof. Vincent Meunier, Rensselaer Polytechnic Institute, meuniv@rpi.edu.

[3]: Prof. Eric Stach, University of Pennsylvania, stach@seas.upenn.edu.