**CHRISTOPHER EVAN MALEC**

**CONTACT INFORMATION**

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 **GIt:** [**https://github.com/cemalec**](https://github.com/cemalec/Data-Science-Porfolio)

 **Website:** [**https://cemalec.github.io/main/**](https://cemalec.github.io/main/)

**EDUCATION**

**PhD Physics:** Georgia Institute of Technology

Thesis: *Transport in Graphene Tunnel Junctions*

Advisor: Dragomir Davidovic

 **B.S. Physics:** University of Wisconsin-Madison

[**Data Science Specialization:**](https://www.coursera.org/account/accomplishments/specialization/RY2799CBRHZT) Coursera (Johns Hopkins)

**Springboard:** Data Science Career Track (in progress)

**SKILLS**

**Programming and Analysis**:

* Python / Visual Python
* Jupyter
* R
* Shiny
* ggplot2
* Office/Excel
* SQL
* Matlab/Octave
* Pandas
* SciKit-Learn
* Matplotlib
* Numpy/Scipy
* Data Visualization
* html
* Unix shell scripting
* Git/Github
* Supervised Machine Learning
* Signal Processing
* Dimensionality Reduction
* Labview
* LaTeX
* Design of Experiments (DOE)

**Communication:**

* Curriculum Writing
* Lesson writing/Lesson planning
* Microsoft Office Powerpoint
* Latex Beamer

**WORK EXPERIENCE**

**Science Writer**: Journal of Visualized Experiments (JoVE) - Remote (2018-present)

Create engaging scripts and storyboards to explain introductory college laboratories.

 **ACTIVITIES**

* Created scripts and storyboards to be turned into video instructions for physics labs.
* Modeled activities and created error analysis workflows to be followed by students.

**Physics Faculty**: Bard High School Early College - Baltimore (2015-2018)

As one of the founding faculty at BHSEC - Baltimore, I taught High School and College level physics to students in the Baltimore City Public School system.

 **ACTIVITIES**

* Created curriculum, lessons and delivered the following classes:
	+ College Physics: Mechanics
	+ Freshman Physics: Motion and Waves
	+ College Physics: Modern Physics
	+ Chinese Society and Technology
	+ Geometry (long term substitute)
* Planned, organized, and built lab equipment to meet the needs of Physics classes
* Advised the following extracurricular activities:
	+ Green Club
	+ Schoolwide recycling program
	+ Anime Club
* Maintained contact with parents and students regarding behavior and academic progress.
* Facilitated daily Advisory period that guided students through academic skills, interpersonal relationship building, and ways to improve emotional well being.
* Wrote and enacted a yearly Student Learning Objective in order to assess whether or not students had met certain learning targets by the end of a course. Plans were evaluated by administration for high standards and accurate assessment.
* Pursued and obtained a Standard Professional Certificate in secondary teaching
	+ Reading Course I & II
	+ Pedagogy courses
	+ Passing scores on the Praxis I, Praxis II: Practices of Teaching and Learning, and Praxis II: Physics Content
	+ Mentoring with experienced teachers
	+ Teaching Porfolio, including complete lesson plans, samples of student work, feedback and reflection on student work and lessons
* Obtained chromebooks for classroom through donorschoose.org
* Co-wrote and obtained a grant for Green Projects through Baltimore City
* Wrote middle school science curriculum for the Baltimore City school district. Created Next Generation Science Standards (NGSS) aligned lessons, worksheets, quizzes, and detailed activities to teach and assess concepts of Heat and Energy to eighth grade science students.

**Engineering Instructor:** Johns Hopkins - Frederick, MD (Summer of 2017, 2018

Delivered the Engineering Innovation class, Johns Hopkins' introductory engineering course to talented high school students at the Hood College Campus.

 **ACTIVITIES**

* Lead engineering activities that emphasized creative problem solving and analytical thinking
* Lead students through academic content related to Mechanical, Chemical, and Electrical Engineering. Topics taught also included finance and ethics as it relates to the engineering disciplines.
* Guided students through a final project building bridges from spaghetti to support the largest possible load.

**Post-doctoral Researcher:** Naval Research Laboratory - Washington, D.C. (2012 - 2015)

Researched fabrication techniques, measurement methods, and analysis of novel Domain Wall based memory devices. Obtained Public Trust Clearance.

 **ACTIVITIES**

* Analyzed data using a variety of software packages to create publication quality figures.
* Developed scripts to simulate physical quantities measured in experiments
* Developed step detection techniques to identify sudden increases/decreases in noisy data
* Created software to control the scientific instruments involved in experiments, so that data could be collected autonomously
* Designed, executed, and published on experiments relating to spin-based electronics
* Helped maintain, troubleshoot, and develop recipes for a variety of lab equipment in the Nano Science Institute (NSI) cleanroom, including the Scanning Electron Microscope
* Designed and built novel lab equipment for experiments

**SELECTED PROJECTS**

* **Spin transport in 2D semiconductors**: In conjunction with several groups at the Naval Research Lab, we investigated how electron spins moved in a class of semiconductors known as 2DEG's (Two Dimensional Electron Gas). In particular, a 2DEG known as InAs, a crystal that was grown by another research group. My task was to fabricate a device from the InAs material to investigate spin transport. The devices required sophisticated processing, using both Ultra Violet and electron-beam lithography. Ion milling was used to remove material, Atomic Layer Deposition was used to apply thin insulating coatings, sputtering deposition was used to apply thick insulating layers, and metal film evaporation was used to deposit magnetic and metallic electrodes. Rapid Thermal Annealing processes removed damage to the starting material. The samples were characterized using conductive probes at room temperature, and promising samples were tested down to a temperature of 4K using two perpendicular magnets. Measurements were again taken using electronic instruments automated via LabView. The research was presented at several talks and conferences.
* **Transport of Magnetic Domains detected with semiconductor devices**: This project required using a property of semiconductors known as the Hall Effect. This effect is used to detect magnetic fields. The goal of the experiment was to detect the transition of one magnetic state to the other via the Hall effect. To this end, magnetic wires were fabricated on top of InAs semiconducting detectors. I machined an aluminum enclosure to hold the electronic devices inside, and that would allow current sources, voltage sensors, and a high speed electronic pulse generator to be attached. The instruments, including a pair of perpendicular magnets, were automated via LabView. The data was analyzed using various routines written in MatLab and Python.

There was a random component to the magnetic field at which the magnetic wire changed its magnetization direction, so I wrote a stepfinder algorithm which found steps with fairly high precision if the user clicked on a point near the step. The results were compared with a computer modeling program (Oommf - Object Oriented Magnetic Modeling Framework) written by colleagues at NIST that made use of the parallel processing of graphics cards to improve performance. The Oommf software calculated the ideal magnetic field generated by my magnetic wires, which I fed into a MatLab program I wrote to analyze the Hall effect of a given magnetic field. The computer models demonstrated good agreement with the data. The results were published in the Journal of Applied Physics and the presented at several talks and conferences. This research also resulted in a patent to use the device in conjunction with a magnetic data storage technique known as racetrack memory.

**Graduate Teaching/Research Assistant:** Georgia Institute of Technology - Atlanta, GA (2005 - 2011)

Conducted research into graphene devices as well as single nano particle based tunneling devices. Oversaw labs, graded and proctored exams.

 **ACTIVITIES**

* Analyzed data using a variety of software packages to create publication quality figures and insights
* Helped students work through Excel and Python based numerical lab assignments
* Developed scripts to automatically perform common data manipulations and create graphs from raw data
* Designed, executed, and published on experiments relating to mesoscopic electronics
* Maintained SEM used by condensed matter department including troubleshooting and interfacing with company technicians
* Designed and built novel lab equipment for experiments
* Supervising/troubleshooting introductory lab sections
* Grading/proctoring exams

 **SELECTED PROJECTS**

* **Aluminum and Copper in tunneling contact with graphene**: A tunneling contact requires an extremely thin insulating layer between the metal and graphene so that the metal and graphene only weakly interact. Creating this thin insulating barrier was challenging, since many known methods of creating oxide insulating barriers are ineffective on graphene. Eventually, we found that by depositing pure aluminum or copper metal onto graphene and exposing it to an oxygen rich environment or acid, we could create an oxide insulating barrier. The electric current through these contacts was studied at low temperatures, down to 4 Kelvin. I found that the major effect of the metal was to shift the number of electrons present in the graphene, making it more or less conductive. To explain my results, I created a model that replicated the behavior of the data I collected, using MatLab and Igor scripts. Other researchers in this area made use of my model to explain their own data. This research resulted in a paper in the Journal of Applied Physics, and several talks.
* **Magnetic oscillations in graphene nano-constrictions**: In this project, I created constrictions through graphene that were only 100 nm wide or less. By lowering the graphene to low temperatures and exposing it to fields as high as 12 Tesla (the average MRI only generates 3 Teslas of magnetic field), we found that the magnetic oscillations normally seen in the resistance of a semiconducting sample developed "beats," or a low frequency oscillation in amplitude in addition to the normal oscillation. By combining a sample that had both constricted, and unconstricted regions from the same piece of graphene, I was able to show that the constrictions caused the novel behavior.
* **Electron spins in metallic nanoparticles**: Several studies were undertaken to find how electron spins behaved when confined in a small metallic nanoparticle. We created a mechanism by which we could perform several fabrication steps without taking our sample out of vacuum. The result was a 10 nm aluminum particle that had a weak connection to two ferromagnetic electrodes. In these devices, we could measure electrons traveling from one ferromagnet to the other through the nanoparticle "one at a time." In order to observe these phenomenon, we needed to cool the samples down to 30 mK so that temperature fluctuations didn't dominate the data. This research resulted in the publication of two papers, one for the experiment and one for the model, in Physical Review B.

Since the number of electrons and electron spins on the nano-particle significantly affects the voltage of the nano-particle, we created a computer model to explicitly calculate the rate of electron transfer (which translates into current) that brought the system into balance.

* **Graduate teaching**: As an experimental physicist, the bulk of my teaching was overseeing introductory lab sections. I also proctored tests and occasionally filled in for my advisor's quantum mechanics class. During my time as a teaching assistant, we introduced a new introductory physics course that emphasized virtual labs written in VPython and Python in addition to more traditional labs.

**Mad Scientist**: Mad Science of Atlanta - Atlanta, GA (2004 - 2005)

Brought engaging and fun science experiments to elementary and middle school students. Built and maintained stock of demonstration equipment for fellow Mad Scientists.

**ACTIVITIES**

* As a Mad Scientist:
	+ I traveled to mostly elementary schools to deliver interactive and engaging science activities.
	+ I returned activity kits in reasonable shape with permanent resources intact and unused consumables clearly marked.
* As equipment manager:
	+ I Took in kits from Mad Scientists to reload consumables and repair/replace other issues
	+ I trained Mad Science instructors on new activity kits and summer camps.
	+ I managed the inventory and procured needed supplies to insure that Mad Scientists always had the materials they needed to deliver classes
	+ I created a new system of Mad Science kits, meaning that I constructed 16 kits following the Mad Science guidelines to franchises to expand our course offerings

**Research Assistant**: University of Wisconsin - Madison (2001 - 2004)

Researched and built a tuning fork based probe to fit on the end of an Atomic Force Microscope.

 **ACTIVITIES**

* Electronic tuning fork modification as an alternative sensing probe for atomic force microscopy (AFM). I modified the quartz tuning fork found in most digital watches to work as an atomic force microscope/conductivity tester. I invented methods to remove the fork from its canister, attach a conductive wire, and connect control electronics. I also fashioned a sample holder that interfaced with the existing AFM. I designed and created digital logic control electronics as well as a feedback loop that adjusted the sensitivity of the probe. I successfully carried out several tests that confirmed the ability of the probe to both create an image and sense electric voltage.
* Electronic testing platform. I machined a flat platform to allow for the testing of electronic devices.
* Drybox gas installation. I installed a flow control and gas hookup to an existing dry box to reduce moisture to sensitive samples.
* Water purification system. I installed a three part, water purification system with filtration, reverse-osmosis, and storage to supply pure water to several groups in condensed matter and chemical physics.
* Measured the interaction with light of several members of a family of compounds known as conductive polymers.

**VOLUNTEER AND OUTREACH**

**Science Demonstrations with National Air and Space Museum** (2013 - 2018)

* Shared knowledge of air flight, space flight, and celestial mechanics with visitors to the air and space museum
* Built and repaired several pieces of equipment for the air and space museum.
* Designed new curriculum to improve the ability of other volunteers (sometimes High School students) to deliver content to visitors.
* Modified existing content to create easy to read directions and streamline the interaction with visitors.

**Postdoctoral Colloquium organizer** (2014 - 2015)

The Naval Research Lab employs a number of post-doctoral researchers. In order to promote ideas across the disciplines, and awareness of the larger post-doctoral community, I helped organize a post-doctoral colloquium where a researcher would share their work once a month.

**Graduate student colloquium** (2009-2010)

I participated and organized several opportunities for graduate students to share their work with the other graduate students in the department. This promoted conversations across specializations and helped new graduate students find research they would like to be involved with.

**Graphene Journal Club organizer** (2008-2010)

I organized a weekly journal club where a peer-reviewed article was selected and then discussed with the other active graphene researchers in the department.

**Undergraduate talks** (2003-2004)

I found undergraduates doing research within the physics department, and organized times for them to share their work with others.

**PATENTS**

* [No. 8497499 - A method to modify the conductivity of graphene](http://patft.uspto.gov/netacgi/nph-Parser?Sect2=PTO1&Sect2=HITOFF&p=1&u=/netahtml/PTO/search-bool.html&r=1&f=G&l=50&d=PALL&RefSrch=yes&Query=PN/8497499)

Inventors: Dragomir Davidovic, Walter A. de Heer, Christopher E. Malec

* [No. 9276197 - A method of detecting Domain Walls in a nano magnet](http://patft.uspto.gov/netacgi/nph-Parser?Sect2=PTO1&Sect2=HITOFF&p=1&u=/netahtml/PTO/search-bool.html&r=1&f=G&l=50&d=PALL&RefSrch=yes&Query=PN/9276197)

Inventors: Mark B. Johnson, Christopher E. Malec

**PUBLICATIONS**

* [Anisotropic Magnetoresistance Dominant in a Three Terminal Hanle Measurement](http://scitation.aip.org/content/aip/journal/apl/108/7/10.1063/1.4942007)

February 2016, *Applied Physics Letters*, **C. E. Malec**, Michael M. Miller, Mark B. Johnson

A metallic spin valve is made with oxidized aluminum leads to investigate the whether or not the three terminal Hanle technique can be used to measure the spin lifetime in metals.

* [Detection of Domain Wall Pinning and Depinning with a Semiconductor Device](http://scitation.aip.org/content/aip/journal/jap/118/23/10.1063/1.4936783)

December 2015, *Journal of Applied Physics*, **C. E. Malec**, Brian R. Bennett, Mark B. Johnson

A device made from an InAs SQW is used to detect the motion of a single Domain Wall in a patterned ferromagnet.

* [Transport in Graphene Tunnel Junctions](https://aip.scitation.org/doi/pdf/10.1063/1.3554480)

January 2011, *Journal of Applied Physics*, **C. E. Malec**, Dragomir Davidovic

Fabrication, low temperature measurement, and modeling of solid state tunneling junctions fabricated from graphene and Al or Cu.

* [Electrical Properties of Au-graphene Contacts](http://prb.aps.org/abstract/PRB/v84/i3/e033407)

 July 2011, *Physical Review B*, **C. E. Malec**, Dragomir Davidovic

A novel fabrication method is used to study the effects of a clean Au-graphene interface.

* [Evidence for incompressible states in a metal-graphene tunnel junction in high magnetic field](http://prb.aps.org/abstract/PRB/v84/i12/e121408)

September 2011, *Physical Review B*, **C. E. Malec**, Dragomir Davidovic

We observed the formation of Landau levels in low-doped Cu/graphene tunnel junctions.

* [Vacuum-annealed Cu contacts for graphene electronics](http://www.sciencedirect.com/science/article/pii/S0038109811004479)

August 2011, *Solid State Communications*, **C. E. Malec**, B. Elkus, D. Davidovic

We demonstrate a method of annealing Cu contacts to greatly reduce the resistance to graphene, quantified by a TLM analysis.

* [Saturation of spin-polarized current in nanometer scale aluminum grains](http://prb.aps.org/abstract/PRB/v76/i19/e195327)

October 2007, *Physical Reivew B*, Y. G. Wei, **C. E. Malec**, D. Davidovic

We create a double tunnel junction between two Py leads and a 10nm Al nano particle. The spin current through the nano-particle at mK temperatures is found to saturate to a maximum value.

* [Modeling electron-spin accumulation in a metallic nanoparticle](http://prb.aps.org/abstract/PRB/v78/i3/e035435)

February 2008, *Physical Review B*, Y. G. Wei, **C. E. Malec**, D. Davidovic

We present a model of spin accumulation in a nano-particle to explain our earlier observation in this system.

* [Spin-polarized electron tunneling through an aluminum particle in a noncollinear magnetic field](http://prb.aps.org/abstract/PRB/v79/i24/e245425)

June 2009, *Physical Review B*, F. T. Birk, **C. E. Malec**, D. Davidovic

We perform measurements of the spin-polarized current through an Al nano-particle in a noncollinear magnetic field. In contrast to the bulk system, we find that the Hanle effect is suppressed in a nano-particle

REFERENCES

**Francesca Gamber** (supervisor)

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