

Jonathan Sullivan-Wood, M. S. Physics, Dual B. S. Physics & Computational Physics, B. S. Mathematics

Physics PhD Student and Teaching Assistant at Purdue University, CRLA Level 1 Certified Physics Tutor, Science Communicator, and YouTube Video Creator

Professional Websites: <https://jons-woodphysics.webnode.com/>

Creative Website: <http://heroic-science.webnode.com/>

Education, Degrees, and Certifications

- Fall 2022-Present
 - Currently PhD Student in Physics at Purdue University
- Summer 2022
 - Awarded M. S. in Physics from University of Iowa
 - Thesis: [“Cosmological Calculation Conundrum: Computational Methods to Constrain the Cosmological Constant”](#)
- Spring 2021
 - Awarded Teaching Certification by Iowa Mentored Community College Teaching Practicum in community college physics instruction at Kirkwood Community College.
- Spring 2020:
 - Awarded dual B. S. in Physics & Computational Physics from Illinois State University
 - Awarded B. S. in Mathematics from Illinois State University
- Summer 2019
 - Attended the Joint Institute for Nuclear Astrophysics-Center for the Evolution of the Elements (JINA-CEE) First Frontier Summer School hosted at Michigan State University on current developments and advancements in astrophysics and nuclear physics.
- Spring 2018
 - Certified as a Level 1 CRLA tutor
- Spring 2017
 - High School Diploma from Oak Forest High School

Awards, Scholarships, & Fellowships

- Summer 2021:
 - Andrew Nelson 1st Year Graduate Student Summer Research Fellowship, UIOWA Physics
- Spring 2020:
 - ISU Physics Outstanding Graduating Senior Award
 - ISU Physics Outstanding Service Award
 - 1st Place Skadron Computational Physics Competition
- Spring 2019:
 - Michael F. Canney Scholarship
 - Recognizes hard work, motivation, and an entrepreneurial spirit in physics
 - ISU Physics Outstanding Teaching Assistant
 - ISU Honors Spring 2019 Scholarship
 - Inducted as a member of Sigma Pi Sigma
 - Elected ISU Physics Club and SPS Chapter President for Fall 2019 and Spring 2020 semesters
- Spring 2018:
 - ISU Physics Outstanding Service
 - ISU Honors Spring 2018 Scholarship

- Fall 2017 and Prior
 - ISU Physics Freshman Merit Scholarship, Robert D. Young Physics Scholar Award
 - ISU Redbird Scholar 4-year renewable
 - ISU Presidential Scholarship Semifinalists

Employment

- July 2023
 - STEM Instructor, GER²I Summer Camp, Purdue University
 - Develop curriculum and instruct STEM summer classes. Classes met for 3 hours a day for 2 weeks.
 - Developed and instructed introductory coding and astrophysics course for high schoolers. Course title: “Launching Codes” Course Description: Modern physics depends on the use of powerful computers to solve problems that cannot be solved by hand, but these programs must be written by someone. Join us for an out-of-this-world exploration of coding and how it translates to astrophysics. Challenge your coding skills by writing a numerical simulation of planets orbiting around a star.
 - Developed and instructed science communication course for 7-8th graders. Course title: “Let’s Talk Science” Course Description: In an increasingly technological world, scientists need to know both the science of their specialty and how to effectively communicate their work to fellow scientists and the public. Our audience determines how we “talk science.” In this course, you will be introduced to digital media research skills and empathy building experiences to create informative presentations that your listeners will understand and enjoy.
- August 2022-Present
 - Teaching Assistant, Purdue University
 - Write Solutions for and grade upper division physics courses and work in a walk-in help center for university level introductory calculus-based physics.
- July 2022-August 2022
 - Research Scientist, Illinois State University
 - Adapting a serial self-consistent model of magnetic field reversal across the mid-plane of Earth’s Magnetotail to a parallel model with MPI in Fortran.
- Fall 2021
 - Physics and Math Tutor, University of Iowa Department of Athletics
 - Lead weekly tutoring sessions for UIOWA student athletes in college algebra, calculus 1, conceptual Physics, college physics 1, and introductory physics 1. Worked with small groups and individual students, employed active learning techniques and student lead discussion.
- Summer 2021-July 2022
 - Playologist, Iowa Children’s Museum
 - Provided primary staff interaction with families attending the museum and museum events. Worked at admission desk handling purchases, answer guest questions. Worked on museum floor sanitizing, resetting exhibit, interact with children, model learning through play. Also assisted with museum opening and closing procedures.
- May 2021-August 2022
 - Research Assistant at University of Iowa

- Under supervision of Professor Craig Pryor, have modified and develop a python code to fit fermion and boson mass spectrums towards satisfying Pauli's mass balance conditions to constrain the zero-point energy density to zero.
- Fall 2020-Present
 - Graduate TA at University of Iowa
 - TA virtual and in person Introductory Physics II labs and discussions at the University of Iowa. Made introductory lab lectures, discussion worksheets on electricity, magnetism, and optics for undergraduate engineering majors. Use active learning techniques in discussions. Also graded labs.
- Summer 2020
 - Physics Lab Video Developer, Illinois State University Department of Physics
 - Developed, co-wrote, directed, and video edited lab videos for conceptual physics general education course for virtual physics labs.
 - Argonne National Labs, Student Research Participation Program in the Systems Assessment Group of the Energy Systems Division
 - Work as coder in Excel VBA to help analyze data from EIA's annual Energy Outlook to update the GREET software managed by Argonne. Assistant to Dr. Uisung Lee.
- Fall 2017-Spring 2020
 - PHY 108, 105 and 102 Content Tutor at the University College Visor Center
 - Tutor groups of 1-7 Students in weekly sessions reviewing gen-ed level physics classes. Write practice tests and review sheets for students I tutor.
 - Tutor 2-6 sessions a semester.
 - At semester ends give 2-hour long Final Reviews for PHY 108, 105 and 102
 - Topics were conceptual physics, and college physics 1.
 - Have substitute for Tutors for CHE 102, 110, 140, and MAT 146
 - Physics 102, 105, 108, 109 Drop-in Tutor at the ISU Athletics Study Center.
 - Tutor for any athlete at ISU who requires walk-in physics assistance. Tutor there once a week for 2 hours.
- Spring 2018 -Fall 2020
 - Undergraduate TA for the ISU Department of Physics
 - Spring 2018: TA PHY 102 & 112 labs
 - Fall 2018: TA PHY 108 lab (two lab sections)
 - Spring 2019: TA PHY 108 & 109 labs
 - Fall 2019: TA PHY 102, 108, & 112 Labs
 - Spring 2020: TA PHY 102, 108, & 110 Labs
 - 102: Monitored and graded general education level physics laboratories.
 - 108: Instructed and graded algebra-based physics mechanics labs for STEM majors.
 - 109: Instructed and graded algebra-based physics E&M and optics labs for STEM majors.
 - 110: Instructed and Graded Calculus based Physics Mechanics Labs for STEM and physics majors
 - 112: Taught computational techniques and numerical methods to sophomore physics majors in their 3rd semester of introductory physics. Used Mathematica
- Summer 2018-Summer 2020

- Undergraduate Research assistant
 - Assistant to Dr. Dan Holland, Chair and Professor of physics, Illinois State University
 - Assist with development and analysis of data from a numerical simulation. Use Fortran code to model B-Field reversal in the midplane of Earth's Magnetotail and diamagnetic effects on B-Field equilibrium.
- Summer 2019
 - Intern for Northern Illinois University REU program
 - Undergraduate research assistant to Professor Roland Winker on computational solid-state physics.
 - Debugged and modified a Fortran code to self-consistently calculate eigenstates for electrons in an varying effective mass quantum well to model heterostructures, such as those created in GaAs ALAs.

List of Publications

- August 2021
 - J. Sullivan-Wood and D. Holland, *Test Particle Calculation of Plasma Equilibria*, Journal of Undergraduate Reports in Physics, Volume XXX, issue 1

List of Research Presentations

Talks

Spring 2020

- April 25th: Illinois State University Research Symposium Department of Physics Oral Presentations
 - *Effects of Diamagnetism on Magnetotail Current Sheet Equilibrium*
 - Abstract: A commonly used analytic model for magnetic field reversals is the Harris equilibrium. In this model, the particle motion is completely integrable, and is characterized by a strongly peaked (in z) density profile that asymptotically approaches zero, and a magnetic field that varies in z , but points in the x direction. When we allow for normal component to the current sheet of the magnetic field, the particle dynamics are nonintegrable, and frequently chaotic.

We have developed a test-particle simulation method for calculating the self-consistent equilibrium of the earth's magnetotail that fully incorporates the nonlinear/chaotic charged particle dynamics of the ions. The equilibrium of the magnetic field is qualitatively similar to the Harris model, but the density is asymptotically constant and the current is created by a completely different mechanism. We show that the current density can be broken into a free current density and a bound current density. The free current is formed by the meandering motion of ions in the vicinity of the field reversal, and the bound current is caused by plasma diamagnetism. Furthermore, the more field aligned the ion sources are in the asymptotic region, the thinner the current sheet, the more peaked the density profile, and the smaller the effects of diamagnetism.
- April 24th: Spring 2020 Meeting of the Illinois Section of the American Association of Physics Teachers
 - *Effects of Diamagnetism on Current Sheet Equilibrium*
 - Abstract: Earth's magnetosphere is very complicated nonlinear system with many regions interacting with each other. Here, we work to model magnetic reversal in the plasma sheet of Earth's magnetotail. Using the Modified Harris Model we self-consistently calculate B-Field reversals accounting for both bound current density from diamagnetism and for a free current

in the midplane. We also show transient, chaotic, and integral ion orbits and a simulation of separatrix crossing.

- February 29th: Honors Council of the Illinois Region Spring 2020 Student Symposium
 - *Effects of Diamagnetism on Current Sheet Equilibrium:*
 - Abstract: A commonly used analytic model for magnetic field reversals is the Harris equilibrium. In this model, the particle motion is completely integrable, and is characterized by a strongly peaked (in z) density profile that asymptotically approaches zero, and a magnetic field that varies in z , but points in the x direction. When we allow for a normal (to the current sheet) component of the magnetic field, the particle dynamics are nonintegrable, and frequently chaotic. We have developed a test-particle simulation method for calculating the self-consistent equilibrium of the earth's magnetotail that fully incorporates the nonlinear/chaotic charged particle dynamics of the ions. The equilibrium magnetic field is qualitatively similar to the Harris model, but the density is asymptotically constant and the current is created by a completely different mechanism. We show that the current density can be broken into a free current density and a bound current density. The free current is formed by the meandering motion of ions in the vicinity of the field reversal, and the bound current is caused by plasma diamagnetism. Furthermore, the more field aligned the ion sources are in the asymptotic region, the thinner the current sheet, the more peaked the density profile, and the smaller the effects of diamagnetism.

Fall 2019

- November 11th: Fall 2019 Meeting of the Illinois Section of the American Association of Physics Teachers
 - *Kinetic Calculation of the Magnetotail Equilibrium*
 - Abstract: We present a technique for calculating the equilibrium structure of a magnetic field reversal, including the full nonlinear/chaotic charged particle dynamics. Specific examples of the Earth's magnetotail current sheet are shown that demonstrate the impact of the ion source distribution. Furthermore, we discuss the effects of various electron models.

Spring 2019

- April 5th: Illinois State University Research Symposium Department of Physics Oral Presentations
 - *Self-Consistent Equilibria in the Earth's Magnetotail Current Sheet*
 - Abstract: Due to the non-linear/chaotic dynamics of charged particles in the Earth's magnetotail, the equilibria structure of the current sheet is notoriously difficult to calculate. Simple analytic models can reproduce qualitatively correct magnetic fields (B-field), but for completely incorrect reasons. Additionally, the simple models cannot determine realistic densities and pressures. In this presentation, we self-consistently determine the equilibrium structure of the current sheet including the full non-linear ion dynamics. Using a test particle simulation, an input source distribution of protons is pushed through a model B-field. As each particle moves through the B-field, its contributions to the overall particle density, current, and pressure are calculated. Appropriate weightings are then used to calculate the total density, current, and pressure. Updated magnetic fields are determined from the calculated currents and compared with the input B-field. The calculated and input B-fields are mixed to produce an updated input field. This process is iterated until the calculated and input fields converge. Once the fields are convergence, the solution exhibits pressure balance in both the diagonal and off-diagonal elements of the momentum equations. We will show several examples varying both the drift velocity and temperature of the source distribution. It is found that adding low

levels of noise into the system does not significantly alter the results. Finally, we allow for Boltzmann electrons, which results in an electric field near the center of the current sheet that acts to attract electrons and repel ions. This tends to increase the current sheet thickness.

- April 6th: Spring 2019 Meeting of the Illinois Section of the American Association of Physics Teachers
 - *Self-Consistent Equilibria in the Earth's Magnetotail Current Sheet*
 - Abstract: We describe a test-particle simulation method for calculating the self-consistent equilibrium of the earth's magnetotail. The method fully incorporates the nonlinear/chaotic charged particle dynamics of the ions. The effects of changes in drift velocity and temperature of the source particle distributions are discussed.

Poster Presentations

Fall 2020

- AGU Fall 2020 Meeting
 - *Self-Consistent Calculation of the Magnetic Field Reversal*
 - iPoster:: https://agu2020fallmeeting-agu.ipostersessions.com/default.aspx?s=23-92-9C-35-F4-5D-11-7F-D0-47-48-D9-B2-5C-C6-E9&fbclid=IwAR1K44HHS_OKGb-Rl8p3CKjiF9w6nK2cxXboOiBl0h0ZOSQtbGJcNhm5eA
 - Abstract: We present a test particle numerical method to self-consistently calculating equilibrium profiles for the magnetotail current sheet that incorporates the full nonlinear/chaotic charged particle dynamics of the plasma ions. The ions are modeled using a drifting Maxwellian source in the asymptotic region. The ions are then numerically pushed through a model magnetic field, all the while calculating their density, current and pressure. Initially, the electrons are taken to be a neutralizing background that does not contribute to the net current. Once all of the ions have been pushed through the field, a new magnetic field is calculated and compared to the input field. The process is iterated until the input and calculated field converge. The results are in agreement with other similar models. We have focused on the effects of bound vs free currents in the field reversal. We find that as the drift velocity becomes smaller (as compared to the thermal velocity) the current sheet becomes thicker and the field due to the bound current becomes much larger (and in the opposite direction) to the net magnetic field (due to the sum of the bound and the free currents). For very small drift velocities, the convergence begins to fail. We believe this is due to the bound current becoming sufficient large that the free current cannot contribute a sufficient amount to create the assumed field reversal.

Summer 2020

- Argonne National Labs Learning on The Lawn Student Research Presentations:
 - *Using Excel VBA and Mathematica to Analyze EIA AEO and Greet USER Data: Using Coding Languages to do Calculations*
 - Abstract For Project 1 (EIA AEO): The U. S. Energy Information Administration (EIA) releases Annual Energy Outlook (AEO) reports. These governmental reports share energy data in the form of Excel spreadsheets. The spreadsheets list the total electricity “Generation by Fuel Type” for both nonrenewable fuel sources (e. g. coal, petroleum, Natural gas, ...) and renewable fuel sources (e.g. hydroelectric, geothermal, solar photovoltaic, ...) in units of billion kilowatt-hours. In addition to providing the energy generation from the past and current year, each sheet has predictions in 5-year intervals (2025, 2030, 2035, ...) of how much energy the US will produce from each fuel source. Furthermore, EIA divides the USA into energy regions and subregions. The Argonne run software GREET uses EIA data to make

energy predictions, however, the input data needs to be in the form of percentages. Excel VBA is used to convert EIA data into percentages.

- Abstract for Project 2 (Greet User Data): When a user downloads GREET from Argonne's website for the first-time, they input geographic and demographic information. EGS wants to have visual representation of their user by country and institution type. Here, Mathematica was used to create pie charts and maps to visually show the diversity of GREET users.
- 236th AAS Meeting
 - *Effects of Diamagnetism on Magnetotail Current Sheet Equilibrium*
 - iPoster: <https://aas236-aas.ipostersessions.com/default.aspx?s=BD-16-CF-4D-16-12-E3-4B-86-1F-C1-D9-40-9A-73-91&guestview=true&fbclid=IwAR2aX6XuWxP1X2D15sab7bV8vYtSBeziZRyOVRLZlhqo5-l-Qg8xJhho6Eg>
 - Abstract: Magnetic fields are ubiquitous in nature, with currents sheets found on numerous stellar bodies. Here, we model plasma diamagnetism's affects in the current sheet in a Earth-like magnetotail. A commonly used analytic model for magnetic field reversals is the Harris equilibrium. In this model, the particle motion is completely integrable, and is characterized by a strongly peaked (in z) density profile that asymptotically approaches zero, and a magnetic field that varies in z , but points in the x direction. When we allow for normal component to the current sheet of the magnetic field, the particle dynamics are nonintegrable, and frequently chaotic. We have developed a test-particle simulation method for calculating the self-consistent equilibrium of the earth's magnetotail that fully incorporates the nonlinear/chaotic charged particle dynamics of the ions. The equilibrium of the magnetic field is qualitatively similar to the Harris model, but the density is asymptotically constant and the current is created by a completely different mechanism. We show that the current density can be broken into a free current density and a bound current density. The free current is formed by the meandering motion of ions in the vicinity of the field reversal, and the bound current is caused by plasma diamagnetism. Furthermore, the more field aligned the ion sources are in the asymptotic region, the thinner the current sheet, the more peaked the density profile, and the smaller the effects of diamagnetism.

Fall 2019

- October 22nd AGU Virtual Poster Showcase Fall 2019
 - *Self-Consistent Equilibria in The Earth's Magnetotail Current Sheet*
 - <https://youtu.be/ar1-c8ddCms>
 - *Abstract:* Due to the non-linear/chaotic dynamics of charged particles in the Earth's magnetotail, the equilibrium structure of the current sheet is notoriously difficult to calculate. Simple analytic models can reproduce qualitatively correct magnetic fields (B-field), but for completely incorrect reasons, i.e. diamagnetic current produces the field as opposed to particles streaming across the current sheet. Additionally, the simple models cannot determine realistic densities and pressures. In this presentation, we self-consistently determine the equilibrium structure of the current sheet including the full non-linear ion dynamics. Using a test particle simulation, an input source distribution of protons is pushed through a model B-field. As each particle moves through the B-field, its contributions to the overall particle density, current, and pressure are calculated. Appropriate weightings are then used to calculate the total density, current, and pressure. Initially electrons are treated as a simple neutralizing background. Updated magnetic fields are determined from the calculated currents and

compared with the input B-field. The calculated and input B-fields are mixed to produce an updated input field. This process is iterated until the calculated and input fields converge. Once the fields are convergence, the solution exhibits pressure balance in both the diagonal and off-diagonal elements of the momentum equations. Typical results are in good agreement with other models and satellite data. We also calculate the dependence of the current sheet thickness on the incoming drift velocity and temperature of the ion distribution. It is found that adding low levels of noise into the system does not significantly alter the results. Finally, we allow for Boltzmann electrons, which results in an electric field near the center of the current sheet that acts to attract electrons and repel ions. This tends to increase the current sheet thickness.

Summer 2019

- August 9th Northern Illinois University's Summer Research Symposium
 - *Self-Consistent Eigenstates in Symmetric Quantum Wells*
 - Abstract: A textbook example of quantum mechanical phenomenon is a finite potential well. A potential well occurs when a particle cannot leave a fixed region because the area around that region requires an energy greater than the particle possesses to enter. Classically, a particle would be trapped in the fixed region. However, due to the wave nature of quantum particles, there is a nonzero probability that quantum particles can leave the well. This is referred to as tunneling into the barrier. The probability of a particle tunneling through a well can be found by solving for the wave function in Schrodinger's Equation. Artificial materials are built layer by layer at the atomic level. An example is creating semiconductors made of layers of different molecules, for example GaAs and AlAs, with atomically sharp interfaces. This creates a potential well between GaAs and the sheets of AlAs the GaAs is sandwiched between. The goal of the project is to write a code that generates self-consistent calculations for the potentials and wave functions in a quantum well. To generate accurate solutions, the code must be self-consistent sense the electrons have coulomb repulsion between each other. This results in an additional effective potential felt by each electron due to the presence of the other electrons. A main addition to the model in the computation is that an electron in a solid behaves like a free electron with an effective mass different from its actual mass depending on the material the electron is in.

Winter 2019

- January 2019
 - D. L. Holland, P. Kovarik and J. Sullivan-Wood, *The effects of collisions on observational signatures of nonlinear charged particle dynamics in the magnetotail*, Dynamics Days Paper A15, Evanston, IL, January 4-6, 2019

Invited Public Talks

- Oct 10th 2023
 - 3rd Annual Oak Forest High School Science Speaker Symposium
 - Guest Speaker and Organizer with High School Physics Teacher Mr. Stephen Hogan
 - As speaker, spoke to honors physics, honors chemistry, honors biology, AP Physics 1, and AP Chemistry students about my research career as well as advice about going into STEM Fields
 - As organizer, contacted scientists and science students to virtually visit each class period in addition to myself. Also introduced them and proctored their presentations.

- June 2023
 - Astronomy on Tap, West Lafayette Section, The Spot Tavern
 - 30-minute presentation to general public interested in learning astronomy related research and engaging with professional scientists.
 - Title: The Stuff that Space is Made of
 - Abstract: The Universe is getting bigger at an ever-increasing rate. Where does the energy driving the expansion come from? This energy, commonly called “dark energy”, might just come from space itself, but exactly what is space? Let’s dive into how astronomers found the universe is growing and talk about why that might be.
 - Recording of Talk: <https://youtu.be/ekS74XRk0bQ>
- October 14th 2022
 - ISU Physics Department Alumni Speaker
 - 15 minutes about career post-ISU and advice for current undergraduates.
 - Title: Life, Post-ISU: On Grad School Life, Adaptability, Advice and Outreach Activities
- Oct 11th 2022
 - 2nd Annual Oak Forest High School Science Speaker Symposium
 - Guest Speaker and Organizer with High School Physics Teacher Mr. Stephen Hogan
 - As speaker, spoke to honors physics, honors chemistry, honors biology, AP Physics 1, and AP Chemistry students about my research career as well as advice about going into STEM Fields
 - As organizer, contacted scientists and science students to virtually visit each class period in addition to myself. Also introduced them and proctored their presentations.
- March 18th 2022
 - 1st Annual Oak Forest High School Science Speaker Symposium
 - Guest Speaker and Organizer with High School Physics Teacher Mr. Stephen Hogan
 - As speaker, spoke to honors physics and AP Physics classes about my research career as well as advice about going into STEM Fields
 - As organizer, contacted scientists and science students to virtually visit each class period in addition to myself. Also introduced them and proctored their presentations.

Volunteer and Science Outreach

- Fall 2020-Spring 2021
 - Video Cameraman and editor for physics demonstration performed by Dale Stille for Iowa Physics UCapture videos.
- Fall 2018-Spring 2020
 - Physics on the Road
 - Assist with physics demonstrations for kids in elementary school to middle school age.
 - Have presented with Dr. Ansher at the Children’s Discovery Museum for monthly physics days. 2-hour long events where children come up to see physics demonstrations
 - August 30, 2018, Presented the Physics Day at the Children’s Discovery Museum at “Science at the Amusement Park” with only

assistance from Museum Staff, Dr. Ansher was unable to attend that event after setting up.

- Physics Tutor
 - Tutor through ISU Physics Club, in physics tutor room, 3 hours a week. Any student taking a physics class can drop in to ask for assistance.

Physics Research Experience

- May 2023-Present
 - Physics Education Graduate Research Assistant, Purdue University Department of Physics and Astronomy
 - Assistant to Dr. Sanjay Rebell, develop new introductory electromagnetism curriculum to emphasize concepts of fields and interdependence of electro and magnetic phenomena.
- July 2022-August 2022
 - Research Scientist, Illinois State University Department of Physics
 - Adapt previously written serial self-consistent model of magnetic field reversal across the midplane of Earth's magnetotail to a parallel code in MPI with Fortran.
- Summer 2021-Present
 - Computational Mathematical Physics Graduate Research Assistant
 - Under supervision of UIowa Associate Professor Craig Pryor, have modified and develop a python code to fit fermion and boson mass spectrums towards satisfying Pauli's mass balance conditions to constrain the zero-point energy density to zero. (Work continued for a year after leaving UIowa).
- Summer 2018-Summer 2020
 - Research Assistant to ISU Physics Department Chair, Dr. Daniel Holland. Writing a computational model in Fortran to solve for self-consistent solutions for Electric and Magnetic fields for ions moving through the plasma sphere in the magnetotail of the Earth.
- Summer 2019
 - Intern for Northern Illinois University REU program
 - Undergraduate research assistant to Professor Roland Winker on computational solid-state physics. Work to debug and edit a Fortran code to self-consistently calculate eigenstates for electrons entering quantum wells with varying effective mass in order to model heterostructures (such as those created in GaAs AlAs)

Computer Languages

- Fortran
 - Proficient. As research assistant to Dr. Dan Holland I have learned and used Fortran to make computational models of ions in the plasma in the magnetotail of the Earth. Also used at summer REU at Northern Illinois University as research assistant to Dr. Roland Winkler on computational solid-state physics for debugging and editing a code to solve for self-consistent eigenstates for electron wave functions in a heterostructures (mainly GaAs and AlAs)
 - Have experience with using MPI and Open MP in Fortran for Parallel coding
- Python

- Proficient. Have developed and edited python code as research assistant at UIOWA on a fermion and boson mass spectrum minimization scheme. The code makes uses of numerical techniques and multiprocessing threads.
- C++
 - Intermediate: Used C++ computer codes in PHY 380A80 on computation homework assignments modeling neuron action potentials. Also edited and ran prewritten code in PHY 380A03 for modeling nonlinear systems.
- Mathematica
 - Intermediate: Taken and taught introduction Computational physics laboratory that use Mathematica.
- Excel VBA
 - Intermediate: Worked as research assistant at Argonne National Labs in Summer 2020 to develop a code in Excel VBA to automatically take data from EIA AEO reports and organize it by percentages and years in Excel
- Java
 - Introductory: Taken and passed introductory coding class that uses Java.

Videography and Photography

- May 2023-Present
 - Cinematographer and Video Editor, Purdue University Saturday Morning Astrophysics
 - Help record and edit videos written by Dr. David Sederberg for astrophysics education and outreach.
 - Measuring Earth: <https://www.youtube.com/watch?v=s6nOhnDJCow>
 - Scaling a Solar Eclipse: <https://youtu.be/0IYCoQkMZAe?si=qARJmgnQBp2Tfvrk>
- September 23rd 2023
 - Purdue University Quantum Open House
 - Photographer and Videographer of the event, going from opening lecture to classroom and lab demos taking photography and video of the event.
 - Published photographs https://new.express.adobe.com/webpage/nPe97GwHgtVx4?_ga=2.170138528.165107826.1703460356-1580588439.1680980976
- June 2022-August 2022
 - Video Scriptor, Director, and Editor, University of Iowa, Department of Physics and Astronomy
 - Developed videos on the research activities and graduate student research opportunities in space physics research under UIowa Professors Jasper Halekas and Allison Jaynes.
 - Dr. Halekas: <https://youtu.be/NUgesJttuto>
 - Dr. Jaynes: <https://youtu.be/DP09Hz745Uw>

Physics Education Videos

Heroic Science

- Created YouTube Channel to communicate science and physics concepts with both creative conceptual videos and white board review videos. Also post original short films.
 - *Time Dilation for my Niece*
 - Discussion of the history of the discovery and conceptual meaning of “time dilation”. Intended for my niece (who was 8 at the time) and wider general audience. Wrote, Shot (Except for 1 scene), Directed, Hosted, and Video Edited Video: <https://youtu.be/1TfDL9wj-0k>
 - *A very Fermi Christmas*
 - Example Fermi Estimation. Walk through the process of fermi estimating how many Christmas presents are in a neighborhood. Wrote, Directed, acted in, and video edited video. <https://youtu.be/qzZMzNN15k>
 - *Recoil (In Space!)*
 - Algebra based physics derivation and explanation of recoil. Wrote, presented, directed, and video edited video. https://youtu.be/JdeBIUotk_0
 - *Math Toolkit for Physics*
 - Mathematical methods videos on vector algebra aim at freshmen and sophomore year physics majors. I write, present, and video edit each video.
 - Ep. 1 “Position and Unit Vectors” <https://youtu.be/58tnRJhbNbA>
 - Ep. 2 “Dot Product and Example Application” <https://youtu.be/H7X2W1ivb4E>
 - Ep. 3 “Cross Product and Example Application” <https://youtu.be/gp7PFKMRu0E>
 - Ep. 4 “Polar Coordinates and Example Application” (To be released)
 - *Ask the Physics Majors:*
 - Algebraic Physics Problem Solving Example. Apply momentum and energy conservation to calculating how fast Thor from Marvel Comics needs to spin his hammer to liftoff from ground. I co-written and video edited the video. https://youtu.be/If0jr_QotAE
 - *How to be a Good Remote Learner*
 - Written by and starring high school Math teacher Megan March. Directed and video edited by me. Goes through advice on how to be a successful remote learner. <https://youtu.be/QjzJA30JvTo>
 - *PHY 105 Lab Videos:*
https://youtube.com/playlist?list=PL71cyeHiZaIn_cpklvvgK79CWwKkLtSc7
 - Videos used for virtual labs for conceptual physics labs for PHY 105 at Illinois State University. I co-wrote, directed, and video edited all videos.
 - Lab 1. “The Giant Disk Lab” on measuring the diameters and circumference of circles to find a relationship,
 - Lab 2. “Addition of Forces Lab” On using a force table to balance multiple weights at different angles.
 - Lab 3. “Measuring g” On measuring the acceleration due to gravity.
 - Lab 4. “Newton’s 2nd Law” on using carts on a ramp to test validity of $F=ma$.
 - Lab 5. “Centripetal Force” On using strings and weights to confirm the centripetal force equation.
 - Lab 6. “Simple Harmonic Motion” On using pendulums and springs to demonstrate SHM.
 - Lab 7 “Velocity of a Projectile” On momentum and energy conservation.
 - Lab 8. “Measurement of Specific Heat” On measuring the specific heat of metals.
 - Lab 9. “Latent Heat of Fusion” On the latent heat of fusion of Ice.

- Lab 10. “Ohm’s Law” On parallel and series circuits.
- To Solve a Physics Problem
 - An outline on the steps a student should go through when solving physics problems. Written, directed, filmed, and video edited by myself. <https://youtu.be/1v1Dg3I-raw>
- Heroic Physics
 - Show explains basic physics concepts in a comedic way using superheroes. The following are the Released Episodes
 - Ep. 1: “Flash Physics” First episode written by me with assistance of History Education major Matt Donley, presented and edited by myself with advisement of ISU associate professor Dr. Allison Harris at Illinois State University. Explained 1-D motion using the Flash. <https://youtu.be/bh1BLctUmt4>
 - Ep. 2: “The Green Projectile” Second episode written by me with assistance of Matt Donley, presented and edited by myself with advisement of Dr. Harris. Explained 2-D motion concepts using the Green Arrow. <https://youtu.be/7d-6-pICaM>
 - Ep.3: “Physics in a Flashback” Third Episode written, directed, presented and video edited by me and script edited by Physics and Computational Physics double major Alex Plumadore. Episode demonstrated the constant acceleration in the vertical direction and the constant zero acceleration horizontally for objects in free fall. <https://youtu.be/vQzB-JJGk2M>
 - Ep. 3.5 “Arrow and Company” Written, directed, presented, and video edited by me. Describes the path of a projectile being a parabola and not a straight line. <https://youtu.be/aZdulnwUBBM>
 - Ep. 4: “Forces of the Knight”. Fourth episode written, presented, directed, and video edited by me. Script edited by Physics Techer Education Major Amber Sammons. Showcase seven different types of Forces and their definitions using Batman. <https://youtu.be/DVLpFG9lgWE>
 - “An Experiment in Holiday Specials (with negative results)” Episode co-written by myself and Matthew Donley. Directed and video-edited by myself. Gave very brief overview of Isaac Newton’s Life, and the importance of history for science focusing on the importance of being aware of multiple subjects. <https://youtu.be/qbJcWhhR5c>
 - Ep. 5: “Even Superheroes Accelerate due to Gravity” Written, directed, presented, and video edited by me and script edited by Amber Sammons. Episode demonstrated how to experimentally measure the acceleration due to gravity with household objects with the character of Green Lantern. <https://youtu.be/A96f6bKb6yE>
 - “It’s the Holiday Season ...Already?” 2019 Holiday Special, part of the Heroic Physics video series, but not an educational video, just a short comedic holiday special on the stress of being an undergrad student around the holidays. Written primarily by myself, directed and videos edited by me. <https://youtu.be/aICNRALpMc>
 - Ep. 6 “Newton and the Flash” Written with Matt Donley, script edited by Tori Edelman, directed and video edited by myself. Goes through Newton’s 3 Laws of Motion with the Flash. <https://youtu.be/ycUYH1vPT6g>

- Ep. 7 “Nightfall” Written, directed, presented, and video edited by me. Episode explained the physics concepts of air resistance, drag and terminal velocity opposite the character of Nightwing. <https://youtu.be/OYYEQ6SKzE>
- “Holiday Time Enough, alas” 2020 Holiday Special, no physics concepts, just a comedic look at what different characters are doing during a shelter in place Christmas. <https://youtu.be/sAGf1sm8pNg>
- Ep. 7.5 “Raindrops and Auditions”. Written, directed, acted in, and video edited by me. No Physics concepts, just continuing narrative threads from episode 7 to episode 8. https://youtu.be/EVMYBn5_aWk
- “Scarlet Night” Writer, Director, Actor, and video editor. No physics concepts, the Flash learns the meaning of Christmas and how to be a better roommate and friend to those in his life. https://youtu.be/EVMYBn5_aWk

Flipping Physics

- Have written English Transcripts for Algebra Based Physics videos made by the YouTube channel Flipping Physics. As of December 22nd, 2019 I have transcribed 54,416 words. Videos I have written transcripts for are
 - Ep. 264 “Simple Harmonic Motion- Graphs of Mechanical Energies”
 - Ep. 268 “Center of Mass Introduction”
 - Ep. 270 “Center of Mass of an Irregular Object”
 - Ep. 271 “Center of Mass of an Object with a Hole”
 - Ep. 272 “Throwing a Ball in a Boat-Demonstrating Center of Mass”
 - Ep. 273 “Moment of Inertia Introduction and Rotational Kinetic Energy Derivation”
 - Ep. 274 “Introductory Moment of Inertia and Rotational Kinetic Energy Problem”
 - Ep. 275 “Eggs in a Carton Moment of Inertia Problem”
 - Ep. 276 “Moments of Inertia of Rigid Objects with Shape”
 - Ep. 278 “Torque Introduction”
 - Ep. 279 “The Right Hand Rule for Torque”
 - Ep. 280 “An Introductory Torque Wrench Problem”
 - Ep. 281 “Net Torque on a Door Problem”
 - Ep. 282 “Rotational Form of Newton’s Second Law – Introduction”
 - Ep. 283 “Demonstrating Rotational Inertia (of Moment of Inertia)”
 - Ep. 284 “Introductory Rotational Form of Newton’s Second Law Problem”
 - Ep. 285 “Measuring the Rotational Inertia of a Bike Wheel Part 1”
 - Ep. 286 “Measuring the Rotational Inertia of a Bike Wheel Part 2”
 - Ep. 287 “Rotational Equilibrium Introduction (and Static Equilibrium too!!)”
 - Ep. 288 “Introductory Rotational Equilibrium Problem”
 - Ep. 289 “Placing the Fulcrum on a Seesaw”
 - Ep. 290 “Painter on a Scaffold - Don't Fall Off!!”
 - Ep. 293 “Graphing the Rotational Inertia of an Irregular Shape”
 - Ep. 294 “How the Force of Tension on a Pulley Changes with Acceleration”
 - Ep. 295 “Using Integrals to Derive Rotational Inertia of a Long, Thin Rod with Demonstration”
 - Ep. 296 “2 Masses on a Pulley - Torque Demonstration”
 - Ep. 297 “2 Masses on a Pulley - Conservation of Energy Demonstration”
 - Ep. 298 “Torque - Mass on Plank with String”
 - Ep. 299 “Rolling Without Slipping Introduction and Demonstrations”

- Ep. 300 “Rolling Acceleration Down an Incline”
- Ep. 301 “Which Will Be First? (Rolling Down an Incline)”¹
- Ep. 303 “Angular Momentum of a Rigid Object with Shape Introduction”
- Ep. 304 “Conservation of Angular Momentum Introduction and Demonstrations”
- Ep. 305 “Wheel Conservation of Angular Momentum Demonstration and Solution”
- Ep. 306 “Merry-Go-Round - Conservation of Angular Momentum Problem”
- Ep. 307 “Which Direction will the Wheel Accelerate?”
- Ep. 308 “(Torque Solution) Acceleration of a Wheel Descending on a Rope”
- Ep. 309 “(Energy Solution) Acceleration of a Wheel Descending on a Rope”
- Ep. 310 “Angular Momentum of Particles Introduction”
- Ep. 311 “Common Point Particle Angular Momentum Triangle”
- Ep. 312 “What are the Equations for Kinetic Energy and Angular Momentum of a Point Particle?”
- Ep. 313 “Are Linear and Angular Momentum Conserved for a Satellite?”
- Ep. 314 “Are Linear and Angular Momentum Conserved during this Collision?”
- Ep. 316 “Dart with Thin Rod Collision-Conservation of Angular Momentum Demonstration and Problem”
- Ep. 317 “Thank You Flipping Physics!”
- Ep. 321 “Wave Superposition Introduction”

Narrative Short Films:

- *That Good Night* (45 min)
 - Sequel to *The Ides of March* in the same style. It's the weeks before finals, and when Josh and Donna get invited to CERN, they leave Charlie and Will having to cover for them. Meanwhile, Toby has made quite the mess for CJ to clean up when he goes on a rant telling kids Santa Claus is not real. It's all in a week's work at the Oakview State University Department of Physics. Writer, Director, Actor, and Video Editor. <https://youtu.be/96RDgoKGmHg>
- *The Ides of March* (12 min)
 - A homage to “The West Wing” if the show was about physics professors instead of politicians. Meet physics professors Josh, Donna, and Will as they race against the clock (and Josh's bad time management) to write and submit a grant for a dark matter detector by the end of business day. Time's running out and someone dropped a minus sign, just a day in the life at the Oakview State University Department of Physics. Writer, Director, Actor, and Video Editor. <https://youtu.be/zvuY8Nc44qo>
- *Sign* (15 min)
 - A horror satire that reflects on the graduate student experience. Film follows the journey of physics graduate student Alexis as she encounters visual manifestations of the stressors and anxiety introduced by a grad school life, catalyzed by a Jackson E&M assignment. She ultimately succumbs to the existential threat of being buried alive by one's own work. Writer, director, and Video Editor. <https://youtu.be/-aigf6nIDwY>
- *Trapped in the Physics Lounge* (23 min)
 - Short comedic film about 5 undergraduate physics majors trapped in their physics department lounge while monster over run the campus outside. Writer, director, co-lead, and video editor. <https://youtu.be/6nlccVcBUyk>

Miscellaneous

- Elected President of ISU Physics Club in Spring 2019 for the 2019-2020 School Year
- Entered College with 57 credit hours from AP Test Credit. Started in the Sophomore year of Physics and math major curriculums.
- Graduated Top 10 of Oak Forest High School Spring 2017
- Editor-in-Chief of Oak Forest High School Vidette Fall 2016-Spring 2017