

HORACIO MORENO MONTAÑES

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EDUCATION

University of Michigan, Ann Arbor

Ph.D in Applied and Interdisciplinary Mathematics and Scientific Computing

August 2024-Present

University of Michigan, Ann Arbor

B.S. in Mathematical Sciences — GPA: 3.92

B.S. in Interdisciplinary Physics — GPA: 3.96

Overall GPA: 3.928

May 2024

Relevant Coursework:

- **Mathematics:** Numerical Linear Algebra, Intro to Numerical Methods, Mathematical Modeling, Ordinary/Partial & BV/Nonlinear Differential Equations, Applied Complex Analysis, Single and Multivariable Real Analysis, Explorations in Mathematics Research
- **Physics:** Mechanics, E & M, Computational Physics, Mathematical Methods in Physics, Topics in Modern Physics, Intro to Optics/Thermodynamics/Relativity
- **Other:** Intro to Plasmas and Fusion, Elementary Programming Concepts, Data Structures and Algorithms

RESEARCH INTERESTS

I am interested in exploring mathematical patterns embedded in physical phenomena and using them to solve real-world problems. My current interests are the mathematical modeling and both the design and implementation of numerical methods for problems in fluid and plasma dynamics. I am also interested in exploring the application of machine learning and neural networks to physics problems.

RESEARCH AND ACADEMIC EXPERIENCE

REU at the University of Michigan

Modeling 1D Cold Electrostatic Plasma with a Lagrangian Particle Method

May 2023 - Present

Advisor: Robert Krasny

- Developed a Lagrangian Particle method in Python to simulate the evolution of a one-dimensional cold, collisionless plasma, using the Vlasov-Poisson equations.
- Implemented regularization of the discontinuities in the electric field and resolve convergence, as well as a particle insertion scheme to ensure the plasma is well-defined without increased computational cost of a finer spatial discretization on all of the plasma.
- Analyzed the method's convergence to a solution as timestep size, spatial discretization, and regularization parameters were varied.
- Investigated possible applications to other fields where the Vlasov-Poisson equations are used, such as the evolution of perturbations of dark matter at cosmological scales.
- Presented findings in a 30-minute talk during the weekly REU seminars to other participating students and faculty.

UROP at the Climate and Space Sciences Department, University of Michigan

Empirical Modeling of Solar Wind

October 2020 - Present

Advisor: Enrico Landi

- Wrote Python program to find suitable parametrized equations for the evolution of velocity, density, and temperature of the solar wind using Markov Chain Monte Carlo methods.
- Analyzed and evaluated resulting models with empirical data across different stages of the solar cycle.
- Proposed and implemented alternative parametrizations to ensure the developed models fit physical constraints.
- Produced, collected, and organized results and data for 6 different stages of the solar cycle for further analysis.

· Presented results in the annual UROP Symposium.

Introduction to Mathematical Modeling Course

January 2023 - April 2023

- Studied different mathematical modeling techniques used in different fields, from Mathematical Physics to Biology, Epidemiology, and Economics.
- Worked on two research projects along the semester in groups of three students, one in Discrete Modeling of Dune-Obstacle Interactions and Dynamics, as well as the Propagation of Stadium Waves.
- Wrote simulations in Matlab and Python and analyzed the results to assess their applicability, accuracy to real-world systems, and shortcomings and areas of improvement.
- Compiled results into two research papers, as well as presenting them to the rest of the class on brief, 10 minute presentations.

Explorations in Mathematics Research Course

January 2022 - April 2022

- Collaborated with other undergraduate students to work on two Mathematics research projects throughout the semester, one in Dynamical Systems and one in Probability.
- Implemented key aspects of Mathematical research, such as posing well-formed questions, formulating definitions, exploring examples, and making conclusions and conjectures.
- Explored, analyzed problems at hand through discussion and computer simulations to gain a further understanding.
- Presented results both in two written reports and two hour-long presentations to the rest of the class.

Directed Reading Program at the University of Michigan

January 2021 - April 2021

The Hartman-Grobman Theorem: Approximating Nonlinear Dynamical Systems

Graduate Mentor: Saibal De

- Participated in an individualized exploration of introductory ideas in Differential Equations and Dynamics.
- Gained solid theoretical understanding on the topic through independent study and exercises.
- Met with graduate student advisor in regular weekly meetings to discuss progress, clarify concepts, and receive guidance on further study. Discussed insights, questions, and potential directions for further research.
- Presented the *Hartman-Grobman Theorem* along with all necessary background to fellow students participating in the DRP in an end-of-semester seminar.

PROFESSIONAL EXPERIENCE

Honors Multivariable Calculus

August 2023 - Present

Course Assistant

Ann Arbor, MI

- Attended Inquiry-Based Learning (IBL) lectures of 30 students, providing direction to groups of students working on select problems chosen to construct knowledge through investigation and discovery.
- Provided visualizations, alternative interpretations, and examples to help solidify student understanding of topics in Multivariable Calculus and Linear Algebra.
- Graded and provided useful, personalized feedback on weekly homework assignments.

Explorations in Mathematics Research

January 2023 - April 2023

Course Assistant

Ann Arbor, MI

- Mentored and guided two groups of three to four undergraduate students working on small mathematical research projects in dynamical systems and graph theory.
- Oversaw research progress and checked in with groups of students on one-on-one meetings once a week to discuss any issues they have encountered, as well as assessing the validity of their research findings.
- Aided students on developing communication strategies to effectively discuss mathematical research with peers during weekly meetings.
- Provided critical feedback in eight different presentation dry-runs and four research paper drafts to ensure clear and concise exposition of mathematical ideas.
- Lectured a class of 16 students on useful tools for mathematical research and exploration like Mathematica and Python.

University of Michigan Math Lab

September 2021 - December 2022

*Mathematics Tutor**Ann Arbor, MI*

- Tutored dozens of students enrolled in introductory Precalculus, Calculus, Differential Equations, and Linear Algebra courses for 8 hours a week.
- Reviewed new topics in brief 10-15 minute lectures to solidify understanding.
- Performed several administrative tasks such as ensuring both tutors and tutees registered time spent in the Math Lab and assigned students to tutors.
- Provided alternative explanations and perspectives with the aid of custom computer visualizations to illustrate hard-to-grasp topics when applicable.

M-STEM Summer Program

June 2021 - August 2021

*Academic Facilitator**Ann Arbor, MI*

- Assisted a graduate instructor in summer Math lectures to a class of 15 incoming freshmen to prepare them for advanced Calculus classes in the fall.
- Held hour-long office hours and supplemental instruction sessions twice a week, assigning practice problems and answering homework or class questions.
- Learned and applied several learning techniques both in lectures and in supplemental instruction sessions.
- Graded weekly and biweekly homework, providing valuable and insightful feedback to students. d

LEADERSHIP AND OUTREACH**Society For Advancing Chicanos/Hispanics & Native Americans in Science**

July - Present

*Undergraduate Representative**Ann Arbor, MI*

- Collaborated with fellow graduate and undergraduate students to organize various community-building, outreach, social, and professional development events throughout the summer and into the fall semester to increase participation in STEM for underrepresented minorities.
- Advertised the student organization to the undergraduate population in several university-wide outreach events.
- Participated in fund-raising campaigns to secure necessary resources for events, as well as funding SACNAS members to attend the annual nDiSTEM Conference to present research results.

TALKS AND PRESENTATIONS*Modeling 1D Cold Electrostatic Plasma with a Lagrangian Particle Method* - NDiSTEM Conference *October 2023**Modeling 1D Cold Electrostatic Plasma with a Lagrangian Particle Method* - REU Seminar *June 2023**Differentiating and Integrating with Matrices* - St. Joseph High School *December 2022**Empirical Modeling of Solar Wind* - UROP Seminar *April 2021**The Hartman-Grobman Theorem: Approximating Nonlinear Dynamical Systems* - DRP Presentation *April 2021***MAJOR ACHIEVEMENTS, SCHOLARSHIPS, AND AWARDS****Wilfred Kaplan Award in Applied Mathematics** *May 2024***MICDE Fellowship** *March 2024***SACNAS NDiSTEM Conference Travel Scholarship** *August 2023***James B. Angell Scholar** *May 2022, May 2023***University Honors** *August 2020 - Present***Four-year Ferrante Scholarship Fund Recipient** *August 2020*

TECHNICAL STRENGTHS

Computer Languages
Libraries

Python, Julia, MATLAB, C++, Mathematica
Experience in NumPy, Matplotlib, SciPy