

# HORACIO MORENO MONTAÑES

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## EDUCATION

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### University of Michigan, Ann Arbor

May 2024

B.S. in Mathematical Sciences — GPA: 3.92

B.S. in Interdisciplinary Physics — GPA: 3.96

Overall GPA: 3.928

### 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

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I am interested in mathematical modeling of complex dynamical systems, particularly plasma and fluids, as well as the numerical methods used. I am also interested in exploring the application of neural networks and machine learning in general as approximators for physical systems, as well as data-driven modeling.

## RESEARCH AND ACADEMIC EXPERIENCE

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### REU at the University of Michigan

May 2023 - Present

*Modeling 1D Cold Electrostatic Plasma with a Lagrangian Particle Method*

*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

October 2020 - Present

*Empirical Modeling of Solar Wind*

*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

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### 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****SACNAS NDiSTEM Conference Travel Scholarship***August 2023***University of Michigan REU Funding***May 2023***James B. Angell Scholar***May 2022, May 2023***University Honors***August 2020 - Present***Funding for Undergraduate Research Opportunities Program (UROP)***August 2020***Four-year Ferrante Scholarship Fund Recipient***August 2020*

## TECHNICAL STRENGTHS

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### **Computer Languages Libraries**

Pyhon, MATLAB, C++, Mathematica  
Experience in NumPy, Matplotlib, SciPy