

# Theodore Broeren

PHD STUDENT · APPLIED MATHEMATICS

University of Arizona: Tucson AZ, USA

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## Education

### The University of Arizona

Tucson AZ, USA

PHD & MS IN APPLIED MATHEMATICS (EXPECTED GRADUATION: SPRING 2024)

2019 - Current

- Focus in mathematical modeling, data analysis, and space plasma physics

### Northwestern University

Evanston IL, USA

BS IN ENGINEERING SCIENCES & APPLIED MATHEMATICS

2015 - 2018

- Focus in mathematical modeling, numerical simulations, and mechanical engineering

## Experience

### NASA HelioSwarm Mission

Tucson AZ, USA

THE UNIVERSITY OF ARIZONA (SUPERVISED BY DR. KRISTOPHER KLEIN)

2020 - Current

- Created new mathematical models to maximize the accuracy of magnetic field reconstructions from a known configuration of spacecraft.
- Used Bayesian Inferencing to learn equations that quantify the uncertainty of the wavevectors reconstructed in space plasmas using multi-spacecraft in-situ data.
- Utilized high performance computing resources to perform calculations on large data-sets.

### Sandia National Laboratory

Albuquerque NM, USA

URA GRADUATE RESEARCH FELLOWSHIP (SUPERVISED BY DR. WILLIAM LEWIS)

Summer 2022

- Worked in the Radiation Electrical & High Energy Density Science Research Foundation where I programmed fluid simulations of the 2D Rayleigh-Taylor Instability.
- Using the weakly non-linear theory as a guide, I learned equations of evolution for the surface perturbation from the RT instability simulations.
- I then generalized these equations to be applicable at arbitrary Atwood numbers (i.e. density ratios).

### Undergraduate Research

Evanston IL, USA

NORTHWESTERN UNIVERSITY (SUPERVISED BY DR. DANIEL ABRAMS)

2017 - 2018

- Assessed the validity of applying the Kuramoto Model of Synchronization to the early behavior of matter near Saturn, to study how it aggregated into the planet's rings and moons.
- Created numerical models in Matlab, and used Mathematica and Maple to solve generalized mathematical systems.

### SpacICE CubeSat Team

Evanston IL, USA

NORTHWESTERN UNIVERSITY (SUPERVISED BY DR. DAVID DUNAND)

2017 - 2018

- Designed a CubeSat payload to explore the viability of freeze-casting in the temperatures and pressures of space.
- Analyzed satellite structure to determine its integrity in reaction to loads, vibrations, and thermal gradients.
- Machined and assembled components and mounts for optical and thermal sensors.

### Formula SAE Suspension Team

Evanston IL, USA

NORTHWESTERN FORMULA RACING

2015 - 2018

- Programmed and documented a dynamic vehicle model in Matlab to simulate brake thermal characteristics utilizing vehicle speed data.
- Used Solidworks to design mechanical components and analyzed them using hand calculations, numerical analysis, and Finite Element Analysis.
- Manufactured racecar components using mills, lathes, saws, and other tools.

## Skills

<b>Programming</b>	Python, Matlab, LaTeX
<b>Software</b>	SolidWorks, Excel, Autodesk Inventor
<b>Manufacturing</b>	Manual and CNC mill, lathe, saw, laser cutter, router

# Honors

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## FELLOWSHIPS

2022 **URA Summer Graduate Fellowship**, Summer research experience at Sandia National Laboratories

## AWARDS

2018 **Best Oral Presentation**, Undergraduate Research Expo: 'Advancements in Science & Engineering' Panel

## GRANTS

2018 **Summer Undergraduate Research Grant** McCormick School of Engineering and Applied Sciences

2017 **Undergraduate Research Assistant Program Grant** Northwestern University

## SCHOLARSHIPS

Current **Graduate College Dean's Tuition Award** The University of Arizona

Current **Graduate College Merit Fellowship** The University of Arizona

2015 **Great Lakes National Scholarship** Great Lakes Educational Loan Services, Inc

2015 **Bennett Scholarship** Wisconsin Society of Professional Engineers

2015 **Arlie McNeill Scholar** Dolphin Scholarship Foundation

2015 **Bay Sesquicentennial Scholarship** Greater Green Bay Community Foundation

2015 **Resch Scholarship** Greater Green Bay Community Foundation

2015 **P&G Scholarship** The Procter & Gamble Company

# Conferences & Presentations

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## ISSI International Team: Cross-scale Energy Transfer in Space Plasmas

Bern, CH

STARTED OPEN COLLABORATION WITH INTERNATIONAL PLASMA PHYSICISTS STUDYING TURBULENCE

Feb. 2023

- Presented research on multi-spacecraft analysis techniques and their application to the study of space plasma turbulence

## AGU Fall Meeting (American Geophysical Union)

Chicago IL, USA

POSTER SESSION: REVEALING MULTISCALE PLASMA DYNAMICS AND PROPERTIES OF TURBULENCE IN THREE DIMENSIONS

Dec. 2022

- Presented graduate research *Minimizing Error in the Classification of Space Plasma Waves using the Wave-Telescope Technique on HelioSwarm*

## HelioSwarm Science Team Meeting

Chicago IL, USA

INVITED TALK AT THE PHASE B SCIENCE TEAM MEETING

Dec. 2022

- Presented uncertainty quantification research of the wave telescope technique and its application to HelioSwarm.

## Machine Learning in Heliophysics

Boulder CO, USA

COMPLETED TUTORIAL USING THE PYTHON MACHINE LEARNING TOOL *scikit-learn*

Mar. 2022

## AGU Fall Meeting (American Geophysical Union)

New Orleans LA, USA

POSTER SESSION: REVEALING MULTISCALE PLASMA DYNAMICS AND PROPERTIES OF TURBULENCE IN THREE DIMENSIONS

Dec. 2021

- Presented graduate research *Reconstruction of Turbulent Magnetic Fields from a Multi-Point, Multi-Scale Spacecraft Observatory*

## Publications

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### **Data-Driven Uncertainty Quantification of the Wave-Telescope Technique: General Equations and Application to HelioSwarm**

T. BROEREN AND K G KLEIN  
• preprint arXiv:2303.12907

*Astrophys. J., Suppl. Ser.*

Mar. 2023

### **Magnetic Field Reconstruction for a Realistic Multi-Point, Multi-Scale Spacecraft Observatory**

T. BROEREN, K G KLEIN, J M TENBARGE, IVAN DORS, O W ROBERTS AND DANIEL VERSCHAREN  
• doi: 10.3389/fspas.2021.727076

*Front. Astron. Space Sci.*

Sept. 2021