C. MICHAEL HAYNES

Doctoral Candidate, Georgia Institute of Technology
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POSITIONS HELD

Georgia Institute of Technology, School of Earth and Atmospheric Sciences Atlanta, GA
Graduate Research Assistant, Center for Relativistic Astrophysics *August 2022 - Present*

- Developed a modular, scalable, and highly distributed computational model to study energetic ion precipitation onto icy moons' atmospheres and their production of Energetic Neutral Atoms (ENAs)
- Implemented this model at Callisto, Ganymede and Europa to investigate the intensity and morphology of the emitted ENA population in preparation for the (en route) JUICE mission
- Determined the imprint on the ENA emission pattern at a moon from changes in: the magnetospheric field configuration, the plasma interaction, the atmosphere, and the energetic ion spectrum
- Utilized the same framework to constrain the observability of plumes at Europa in ENA data
- Applied a hybrid plasma simulation tool to model both the interaction of Jupiter's magnetosphere with the persistent oxygen and water vapor exospheres of Europa as well as the induced magnetosphere of Pluto due to its atmosphere's interaction with impinging solar wind

Georgia Institute of Technology, School of Earth and Atmospheric Sciences Atlanta, GA
Undergraduate Research Assistant, Center for Relativistic Astrophysics *Jan 2022-July 2022*

- Studied computational space plasma physics in the Jovian magnetospheric environment with Dr. Sven Simon (Magnetospheres of the Outer Solar System group)
- Developed a charged particle tracing tool to model the process of charge exchange between energetic magnetospheric ions and cold neutral gas in Europa's and Callisto's atmospheres
- This work resulted in a first-authored conference presentation at the 2022 MOP meeting

Georgia Institute of Technology, School of Physics Atlanta, GA
Undergraduate Research Assistant, Center for Nonlinear Sciences *May 2021-February 2022*

- Analytically and numerically modeled continuum dynamics for the purpose of Direct Air Capture (DAC) technology development with Dr. Roman Grigoriev (Pattern Formation and Control Lab)
- Performed control volume analysis of the evaporative cooling stage to construct a system of transport PDEs that describe the evolution of temperature and concentration
- Formulated Mathematica scripts to generate series solutions using the Rayleigh-Ritz technique
- Responsible for weekly presentation of results to the Private Entity as well as quarterly technical progress reports delivered to the Department of Energy

Georgia Institute of Technology, School of Mathematics Atlanta, GA
Undergraduate Research Assistant, Dynamical Systems REU *May 2020-December 2020*

- Investigated the analytical properties of certain hyperbolic dynamical systems (Arnold's cat maps) using perturbation theory working with Dr. Federico Bonetto in an REU
- Derived a convergent perturbative expansion for the Lyupanov spectrum and the expression for the invariant manifold up to several orders, visualized with a computational MATLAB model
- Responsible for delivery of a seminar talk describing methods and highlighting results to GT Math

Georgia Institute of Technology, School of Physics Atlanta, GA
Undergraduate Research Assistant, Center for Nonlinear Sciences *May 2019-December 2019*

- Worked with Dr. Mike Schatz and Logan Kageorge in the Pattern Formation and Control Lab

- Utilized the Hall Effect to systematically measure and document the highly variable magnetic field of an experimental setup used to induce quasi-2D turbulent Kolmogorov flow
- Repurposed a machine mill to act as a high-precision spatial positioning system to control the measurement with implementation of system machine code (G-code) interfaced through MATLAB
- Constructed a circuit to operate the high-precision Hall Effect sensor, fabricated and soldered sensitive measurement components

EDUCATION

Georgia Institute of Technology — *August 2022 - Present*
Doctor of Philosophy (Ph.D.), Planetary Science — Expected Graduation: December 2026
Minor, Physics
Advisor: Sven Simon — GPA: 4.0

Georgia Institute of Technology — *August 2018 - May 2022*
B.S., Physics, Concentration: Astrophysics — High Honors
Minor, Mathematics

PUBLICATIONS

3 First-Authored Publications (5 Total). Citations: 21 (Google Scholar). H-index: 2

(*) *Indicates that all authors contributed equally to this study.*

Emission of Energetic Neutral Atoms From Ganymede's Magnetosphere-Atmosphere Interaction
C. Michael Haynes, Sven Simon, Lucas Liuzzo, *J.Geophys. Res. (Space Physics)*, 130(10), e2025JA034469, doi: 10.1029/e2025JA034469, 2025b

Dynamics of Energetic Heliospheric Ions in Pluto's Induced Magnetosphere
Randall Ruch, Sven Simon, **C. Michael Haynes**, *J.Geophys. Res. (Space Physics)*, 130(1), e2024JA033548, doi: 10.1029/2024JA033548, 2025

Constraints on the Observability of Energetic Neutral Atoms from the Magnetosphere-Atmosphere Interactions at Callisto and Europa
C. Michael Haynes, Tyler Tippens, Sven Simon, Lucas Liuzzo, *J.Geophys. Res. (Space Physics)*, 130(1), e2024JA033391, doi: 10.1029/2024JA033391, 2025
This article was selected as the cover story of the JGR issue (January 2025: Volume 130, Issue 1); **C. Michael Haynes** is accredited with the cover figure.

Magnetic Signatures of the Interaction Between Europa and Jupiter's Magnetosphere During the Juno Flyby
(*) Peter Addison, **C. Michael Haynes**, Aaron Stahl, Lucas Liuzzo, Sven Simon, *Geophys. Res. Lett.*, 57(1), e2023GL106810, doi: 10.1029/2023GL106810, 2024
This article was selected as the cover story of the GRL issue (January 2024: Volume 51, Issue 2); **C. Michael Haynes** is accredited with the cover figure.

Emission of Energetic Neutral Atoms from the Magnetosphere-Atmosphere Interactions at Callisto and Europa
C. Michael Haynes, Tyler Tippens, Peter Addison, Lucas Liuzzo, Andrew R. Poppe, Sven Simon, *J.Geophys. Res. (Space Physics)*, 128(10), e2023JA031931, doi: 10.1029/2023JA031931, 2023

PRESENTATIONS

(†) *Indicates an oral presentation.*

C. M. Haynes, T. Tippens, S. Simon, and L. Liuzzo. **Observability of Energetic Neutral Atom Emissions at Europa and Callisto: Predictions for the JUICE Mission**. *AGU Fall Meeting*, Washington D.C., USA, 09-13 December, 2024.

C. M. Haynes, T. Tippens, S. Simon, and L. Liuzzo. **Global Morphology and Detectability of ENA Emissions from the Magnetosphere-Atmosphere Interactions at Callisto and Europa**. *AGU Fall Meeting*, Washington D.C., USA, 09-13 December, 2024.

† **C. M. Haynes**, T. Tippens, S. Simon, and L. Liuzzo. **Observability of ENA Emissions at Europa and Callisto: Predictions for the JUICE Mission**. *EuroPlanet Science Congress*, Berlin, Germany, 08-13 September, 2024.

C. M. Haynes, T. Tippens, P. Addison, L. Liuzzo, A. R. Poppe, and S. Simon. **Global Morphology of ENA Emissions from the Atmosphere-Magnetosphere Interactions at Callisto and Europa**. *EuroPlanet Science Congress*, Berlin, Germany, 08-13 September, 2024.

C. M. Haynes, Peter Addison, Aaron Stahl, Lucas Liuzzo, and Sven Simon. **Magnetic Signatures of the Interaction Between Europa and Jupiter's Magnetosphere During the Juno Flyby.** *EuroPlanet Science Congress*, Berlin, Germany, 08-13 September, 2024.

† **C. M. Haynes**, T. Tippens, P. Addison, L. Liuzzo, A. R. Poppe, and S. Simon. **Global Morphology of ENA Emissions from the Atmosphere-Magnetosphere Interactions at Callisto and Europa**. *Magnetospheres of the Outer Planets Meeting*, Minneapolis, USA, 07-12 July, 2024.

C. M. Haynes, T. Tippens, P. Addison, L. Liuzzo, A. R. Poppe, and S. Simon. **Observability of ENA Emissions at Europa and Callisto: Predictions for the JUICE Mission**. *Magnetospheres of the Outer Planets Meeting*, Minneapolis, USA, 07-12 July, 2024.

C. M. Haynes, T. Tippens, P. Addison, L. Liuzzo, A. R. Poppe, and S. Simon. **Modeling the Detection of Energetic Neutral Atoms at Europa and Callisto: a Tool to Characterize Moon-Magnetosphere Interactions on a Global Scale**. *AGU Fall Meeting*, San Francisco, USA, 11-15 December, 2023.

† **C. M. Haynes**, T. Tippens, P. Addison, L. Liuzzo, A. R. Poppe, and S. Simon. **Emission of Energetic Neutral Atoms from the Magnetosphere-Atmosphere Interactions at Callisto and Europa**. *AGU Fall Meeting*, San Francisco, USA, 11-15 December, 2023.

C. M. Haynes, T. Tippens, P. Addison, L. Liuzzo, A. R. Poppe, and S. Simon. **Emission of Energetic Neutral Atoms at Callisto and Europa**. *AGU Fall Meeting*, Chicago, USA, 12-16 December, 2022.

C. M. Haynes, T. Tippens, P. Addison, L. Liuzzo, A. R. Poppe, and S. Simon. **Emission of Energetic Neutral Atoms at Callisto and Europa**. *Magnetospheres of the Outer Planets Meeting*, Liége, Belgium, 11-15 July, 2022.

ADVISING

Troy Stephens (co-advised) — Georgia Institute of Technology
Undergraduate Student — August 2023 - January 2025

Project: Using SPICE kernels to determine spacecraft position, bearing, altitude and orientation across pertinent satellite flybys during the Juno extended mission

Work selected for PURA undergraduate research funding upon submission of a PURA proposal

Jeremiah Tunis (co-advised) — Georgia Institute of Technology
Undergraduate Student — May 2024 - August 2024

REU Project: Tracing energetic test particles in Io's perturbed electromagnetic environment

REU students are responsible for delivering written and oral research presentations at regular intervals

Brendan McCluskey Georgia Institute of Technology
Undergraduate Student December 2022 - May 2023

Project: Tracing the emission of hydrogen energetic neutral atoms from test particles at Europa

TEACHING

Advanced Space Plasma Physics Atlanta, GA
Graduate Teaching Assistant *January 2023 - May 2023*

- Grading, office hours, and teaching support for the graduate course elaborating upon the theoretical framework of advanced plasma-physical techniques in the context of the solar system
- Topics include kinetic plasma theory, multi-fluid and magnetohydrodynamic treatments, cold plasma waves, shocks and discontinuities, planetary plasma interactions, and magnetospheric topology

Lecturer *March 2025*

- Full-time lecturer for a week of class sessions; taught an overview of nonlinear MHD phenomena

Introductory Physics I Atlanta, GA
Undergraduate Teaching Assistant *February 2020 - January 2022*

- Large undergraduate course on introductory mechanics, involving the supervision of weekly labs and the delivery of experimental and theoretical treatment in recitation-style lectures

HONORS AND AWARDS

Research Excellence Award April 2025
Awarded annually by the GT School of Earth and Atmospheric Sciences "for excellence in research, as judged primarily on the basis of the creativity and independence exhibited by the student in conduct of the research."

Best Paper Award April 2024
Awarded annually by the GT School of Earth and Atmospheric Sciences "for the best refereed paper or series of refereed papers, published by the time of selection, for which the student is the first author."

Outstanding Student Presenter Award (OSPA), AGU Fall 2023 December 2023
Awarded at the American Geophysical Union (AGU) meeting for the talk: "Emission of Energetic Neutral Atoms from the Magnetosphere-Atmosphere Interactions at Callisto and Europa". The award is given to the top 2%-5% of early career presenters, determined by senior scientists in the field.

Georgia Tech Presidential Fellowship August 2022 - Present
Awarded annually to the top 5% of the incoming class of graduate students at Georgia Tech. Fellowship includes an additional $5500 salary award and annual recognition at the Presidential Banquet.

UPC Silver Medal (contestant no. 434) November 2021
Awarded to the top 20% of contestants in the international University Physics Competition

Presidential Undergraduate Early Research Award (PURA): July 2018
Awarded to competitive research prospects within their first two years as undergraduates at Georgia Tech. Includes a $1500 salary award to fund a semester of original research.

Dean's List: Fall 2018 - May 2022
Awarded to any undergraduate student with a GPA greater than 3.0. Recognition provided in local newspapers.

Highest Honors: Fall 2018 - December 2022
Awarded to undergraduate students with a GPA greater than 3.55.

High Honors: December 2022 - May 2022
Awarded to undergraduate students with a GPA greater than 3.35.

PROFESSIONAL INVOLVEMENT

Oral Session Chair, Convener 2024
American Geophysical Union Fall Meeting (Washington D.C.)
Moon-Plasma Interactions Throughout the Solar System

Poster Session Chair 2023
American Geophysical Union Fall Meeting (San Francisco)
Moon-Plasma Interactions Throughout the Solar System

American Geophysical Union November 2021 - Present
Member

PROFESSIONAL REFERENCES

Sven Simon, Professor Ph.D. Advisor
School of Earth and Atmospheric Sciences, Georgia Institute of Technology
Email: sven.simon@eas.gatech.edu
Phone: (404) 385-1509
Website: https://svensimon.gatech.edu/

Lucas Liuzzo, Research Scientist Collaborator
Space Sciences Laboratory, University of California, Berkeley
Email: liuzzo@berkeley.edu
Website: https://lukeliuzzo.github.io/

Mike Schatz, Professor Undergraduate Research Advisor
School of Physics, Georgia Institute of Technology
Email: mike.schatz@physics.gatech.edu
Website: https://schatzlab.gatech.edu/