Cassandra Lochhaas

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NASA Hubble Fellow & Institute for Theory and Computation Fellow
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Smithsonian Astrophysical Observabory
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Education

PhD in Astronomy — July 2019
The Ohio State University — *Columbus, OH*

Master of Astronomy — December 2015
The Ohio State University — *Columbus, OH*

Bachelor of Science in Physics — June 2013
California Institute of Technology — *Pasandena, CA*

Research Interests and Experience

Analytic and computational theory of the circumgalactic medium and galaxy evolution

Hubble Fellow and Institute for Theory and Computation Fellow — August 2023 - present
Center for Astrophysics | Harvard & Smithsonian — *Cambridge, MA*
Developing new suite of cosmological galaxy evolution simulations focusing on the coevolution of galaxies and the circumgalactic medium

Postdoctoral Researcher — September 2019 - August 2023
Space Telescope Science Institute — *Baltimore, MD*
Led projects exploring circumgalactic medium structure in the FOGGIE group (PI Molly S. Peeples, Co-Is Jason Tumlinson & Brian W. O'Shea)

PhD Student — August 2013 - August 2019
The Ohio State University — *Columbus, OH*
Led several research projects on galactic winds, stellar feedback, the circumgalactic medium, and Lyα forest large scale structure with Todd A. Thompson, David H. Weinberg, and Smita Mathur

Kavli Summer Program in Astrophysics Student Fellow — June - August 2018
Center for Computational Astrophysics at the Flatiron Institute — *New York, NY*
Led research project on idealized simulations of circumgalactic medium with Greg Bryan

Highlights

- **Publications:** 8 first-author papers (179 total citations), 10 papers with substantial contributions (164 total citations), 7 papers with contributed observations (520 total citations)
- **Grants, Fellowships, and Awards:** NASA Hubble Fellow starting August 2023 ($397,000 over 3 years), PI of HST Theory grant (Cycle 28, $137,400), AAS Rodger Doxsey Travel Prize (2019), Graduate Student Fellow and Presidential Fellow (OSU 2013 and 2018)
- **Talks:** 21 invited talks (including 9 colloquia) and 6 contributed talks since 2019
- **Mentoring:** Primary mentor for three and secondary mentor for two undergraduate research students
- **Teaching/Outreach:** Ran The Ohio State University Planetarium for two years, gave 89 planetarium shows, developed one new show from scratch, and won the first installment of OSU's Ann S. Tuttle Citizenship, Engagement, and Outreach Prize

- **Service:** Won funding for and organized a CGM conference, refereed 10 papers, organized FOGGIE group meetings (2020-present), reviewed applications for summer undergraduate research program, served as panel support for JWST Cycle 1 review panel, served on NASA and NSF grants review panels, served on ITC fellowship admissions committee

Successful Proposals and Grants

- **NASA Hubble Fellowship** August 2023 - present
  Smithsonian Astrophysical Observatory *Cambridge, MA*
  "Non-Equilibrium Galaxy Evolution Driven by the CGM"
  Developing new suite of cosmological galaxy evolution simulations focusing on the coevolution of galaxies and the circumgalactic medium
  $397,000, 3 years, 7 million CPU-hours on NASA Pleiades computer ($55,000)
  Faculty contact: Alexey Vikhlinin
- **Hubble Space Telescope Cycle 28 Archive Research Theory** January 2021 - December 2022
  *PI: **Cassandra Lochhaas***
  "What Holds Up the CGM?"
  $137,400, 2 years, 8.75 million CPU-hours on NASA Pleiades computer ($146,875)
  Co-Is: Molly S. Peeples, Jason Tumlinson, Brian W. O'Shea, Yong Zheng
- **Hubble Space Telescope Cycle 31 Archive Research Theory Grant** January 2024
  PI: Anna Wright
  "Predicting Dwarf Galaxy Evolution in Resolved Milky Way Halos"
  Co-Is: Molly S. Peeples, Jason Tumlinson, Brian W. O'Shea, **Cassandra Lochhaas**, Raymond Simons, Erik Tollerud, Gregory Snyder
- **Hubble Space Telescope Cycle 28 Archive Research Theory Grant** January 2021
  PI: Raymond Simons
  "On The Rapid Evolution of Galaxy Metallicity Gradients: A Bridge Between Theory and Observations"
  Co-Is: Molly S. Peeples, Jason Tumlinson, Brian W. O'Shea, Gregory Snyder, Ivelina Momcheva, **Cassandra Lochhaas**, Ramona Augustin, Casey Papovich, Jasleen Matharu

Teaching and Mentoring Experience

- **Mentor for Northeastern University Co-op Internship student** January - July 2025
  Harvard & Smithsonian Center for Astrophysics *Cambridge, MA*
  - Developed a project for an undergraduate student to measure velocity structure functions of turbulence in the CGM in cosmological zoom-in simulations
  - Mentored student through project with once to twice weekly meetings to teach advanced python, plot development and analysis, and the physics of turbulence
  - Coached student through writing a journal article that will be submitted to ApJ
- **Mentor for Maria Mitchell Observatory's REU Program** June - August 2024
  Maria Mitchell Observatory *Nantucket, MA*
  - Developed a project for an undergraduate student to investigate the ability of absorption observations to accurately measure CGM turbulence using synthetic spectra of the CGM in cosmological zoom-in simulations
  - Mentored student through project with virtual meetings and a one week visit for intensive in-person mentoring, including background on the field, how to read in and analyze simulation data, produce and interpret scientific plots
  - Coached student through writing a report and giving a presentation on the main results

- Continuing to work with student through school year and now writing a journal article that will be submitted to ApJ

- **Co-mentor for Space Astronomy Summer Program** June - August 2022, 2023
  Space Telescope Science Institute *Baltimore, MD*
  - Was designated point-of-contact when primary mentor was unavailable
  - Helped undergraduate students with interpretation and presentation of results

- **Mentor for Space Astronomy Summer Program** June - August 2021
  Space Telescope Science Institute *Baltimore, MD*
  - Developed a project for an undergraduate student to investigate the spread of CGM metallicity and inward and outward metal mass fluxes through the CGM using cosmological zoom-in simulations
  - Mentored student through project with minimum twice-weekly meetings, including background on the field, how to read in and analyze simulation data, produce and interpret scientific plots
  - Coached student through final presentation and interpreting main results: hotter CGM gas has higher average and spread of metallicity, and metal mass primarily flows through and out of CGM without being retained

- **Planetarium TA** May 2015 - May 2017
  The Ohio State University *Columbus, OH*
  - Scheduled planetarium shows, trained volunteers, produced software documention and show scripts
  - Presented a total of 89 shows for the public, private field trip groups, and college classes
  - Attended the Spitz Summer Institute workshop in 2015 to learn how to produce effective planetarium shows
  - Developed new content, including an all-new full-length production, "Pluto: The Distant, Icy World"

- **TA for Introductory Astronomy courses** Spring Semester 2015
  The Ohio State University *Columbus, OH*
  - Developed problems for homework sets, generated exams, quizzes, and study guides, graded all student work, held review sessions and office hours

Invited Colloquia and Seminars

- **"Galactic Accretion through the Dynamic Circumgalactic Medium"** February 3, 2025
  Theoretical Astrophysics Center Seminar
  UC Berkeley, Berkeley, CA
- **"The Non-Equilibrium Circumgalactic Medium"** May 21, 2024
  Astronomy Colloquium
  NRC Herzberg Centre, Victoria, Canada (virtual)
- **"The Non-Equilibrium Circumgalactic Medium"** April 4, 2024
  Astronomy Seminar
  UC Davis, Davis, CA (virtual)
- **"The Non-Equilibrium Circumgalactic Medium"** December 1, 2023
  Astronomy Colloquium
  New Mexico State University, Las Cruces, NM
- **"The Non-Equilibrium Circumgalactic Medium"** June 22, 2023
  Diffuse Gas in Cosmic Ecosystems Special Interest Group
  NASA Cosmic Origins Program Analysis Group (virtual)

- **"Circumgalactic Medium Dynamics are Crucial to Galaxy Evolution"** February 14, 2023
  Astronomy Colloquium
  University of Virginia, Charlottesville, VA
- **"Circumgalactic Medium Dynamics are Crucial to Galaxy Evolution"** February 1, 2023
  Physics Colloquium
  North Carolina State University, Raleigh, NC
- **"How Circumgalactic Medium Dynamics Impact Galaxy Evolution"** November 3, 2022
  Astronomy Colloquium
  University of Wisconsin Madison, Madison, WI
- **"Structure of the Circumgalactic Medium in High-Resolution Cosmological Simulations"**
  Astronomy Seminar December 10, 2021
  University of Pittsburgh/Carnegie Mellon University, Pittsburgh, PA
- **"Structure of the Circumgalactic Medium in High-Resolution Cosmological Simulations"**
  Astronomy Seminar December 8, 2021
  Michigan State University, East Lansing, MI
- **"Using Simulations to Understand the Structure of the Circumgalactic Medium"**
  Astrophysics Seminar October 13, 2020
  University of Notre Dame, Notre Dame, IN

Invited Conference Talks

- **"Accretion through the Dynamic, Non-Equilibrium CGM"** January 8, 2025
  Remembering Ed Jenkins: The Baryon Cycle
  Princeton, New Jersey
- **"Accretion Streams through the CGM in the FOGGIE Simulations"** June 18, 2024
  What Matter(s) Around Galaxies conference 2024
  Varenna, Italy
- **"Accretion Streams through the CGM in the FOGGIE Simulations"** March 26, 2024
  Arthur M. Wolfe Symposium 2024
  UC San Diego, San Diego, CA
- **"The Non-equilibrium and Dynamic Circumgalactic Medium"** September 4, 2023
  CGM at Notre Dame conference
  Kylemore Abbey, Ireland
- **"How well do equilibrium theories characterize the CGM?"** February 21, 2023
  Oases in the Cosmic Desert conference
  Arizona State University, Tempe, AZ
- **"Gas Kinematics Change the Temperature and Pressure of the CGM"** December 6, 2022
  Aspera Science Workshop
  University of Arizona, Tucson, AZ
- **"Tracking the Fuel for Galaxy Growth"** November 14-17, 2022
  Supercomputing 2022 conference, NASA Exhibit
  Dallas, TX
- **"How CGM Kinematics Affect More Than You Think"** March 22, 2022
  Arthur M. Wolfe Symposium 2022
  University of Santa Cruz, Santa Cruz, CA
- **"Impact of Galactic Winds on Circumgalactic Medium Structure"** August 20, 2021
  Baltimore Winds Workshop
  Johns Hopkins University, Baltimore, MD

- **"Thermal and Kinetic Properties of the Simulated Circumgalactic Medium"** June 24, 2020
  The Circumgalactic Medium Around Galaxies Conference
  Institut d'Astrophysique de Paris, Paris, France
- **"Multiphase CGM: Fast Winds, Slow Shells"** November 7, 2019
  Cosmic Turbulence and Magnetic Fields Conference
  Institut d'Etudes Scientifiques de Cargèse, Corsica, France

Contributed Conference Talks

- **Led two discussion sessions on CGM turbulence** August 26 - September 6, 2024
  Toward a Holistic Understanding of the Multi-scale, Multiphase Circumgalactic Medium
  Aspen Center for Physics, Aspen, CO
- **"Properties of Accretion in the FOGGIE Simulations"** August 1, 2023
  The Evolution of Gas in and Around Galaxies
  Stanley, Idaho
- **"Outflow-driven CGM dynamics disrupt galactic accretion"** July 19, 2023
  New Views on Feedback & the Baryon Cycle in Galaxies
  Melbourne, Australia
- **"Impact of CGM Kinematics on Hot and Cold Mode Accretion"** September 15, 2022
  What Matter(s) Around Galaxies conference 2022
  Champoluc, Italy

Awards and Honors

- **American Astronomical Society Rodger Doxsey Travel Prize** January 2019
  American Astronomical Society 233rd Meeting *Seattle, WA*
  - Travel funds awarded to 10 graduating PhD students to present dissertation work at AAS winter meeting
- **Ann S. Tuttle Citizenship, Engagement, and Outreach Prize** December 2018
  The Ohio State University Department of Astronomy *Columbus, OH*
  - Awarded the first installment of this prize for exceptional outreach work
- **Presidential Fellow** August 2018 - July 2019
  The Ohio State University Department of Astronomy *Columbus, OH*
  - Awarded to final-year graduate students for especially promising research in any field
- **Student Fellow, Kavli Summer Program in Astrophysics** June 2018 - August 2018
  Center for Computational Astrophysics, Flatiron Institute *New York, NY*
  - 16 students invited to 6-week intensive summer program in galaxy evolution
- **Graduate Student Fellow** September 2013 - August 2014
  The Ohio State University *Columbus, OH*
  - Awarded to especially promising incoming graduate students in any field
- **Robert L. Blinkenburg Summer Undergraduate Research Fellow** Summers 2011, 2012
  California Institute of Technology *Pasadena, CA*
  - Summer research funding awarded to undergraduate researchers with interesting projects

Service

- Served on Harvard's Institute for Theory and Computation Fellowship admissions committee
- Won funding for and organized a local conference at the CfA: "Multiphase Madness: Resolving the CGM in Theory and Observations", August 21-23, 2024
- Refereed 10 papers
- Organized FOGGIE research group meetings 2020-present: scheduled agenda items for discussion
- Helped organize and lead several discussion sessions in two FOGGIE collaboration retreats, May 2024 and March 2025
- Panel Support "Leveler" for JWST Cycle 1: listened to all panel discussions and ensured process remained fully anonymous
- Reviewed student applications for STScI Space Astronomy Summer Program, springs 2020-2022
- Served on NASA Astrophysics Theory Program Review Panel
- Served on NSF Astronomy & Astrophysics Grants Review Panel
- Organized the Institute for Theory and Computation Discussion series, Center for Astrophysics, August 2023 to present

Cassandra Lochhaas - Publication List

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First Author Publications

1. **Cassandra Lochhaas**, Jason Tumlinson, Molly S. Peeples, Brian W. O'Shea, et al., "Figuring Out Gas & Galaxies In Enzo (FOGGIE) VI: The Circumgalactic Medium of $L^\star$ Galaxies is Supported in an Emergent, Non-Hydrostatic Equilibrium", 2023, ApJ, 948, 43
2. **Cassandra Lochhaas**, Jason Tumlinson, Brian W. O'Shea, Molly S. Peeples, et al., "Figuring Out Gas & Galaxies In Enzo (FOGGIE) V: The Virial Temperature Does Not Describe Gas in a Virialized Galaxy Halo", 2021, ApJ, 922, 121
3. **Cassandra Lochhaas**, Todd A. Thompson, & Evan E. Schneider, "The Characteristic Momentum of Radiatively Cooling Energy-Driven Galactic Winds", 2021, MNRAS, 504, 3412
4. **Cassandra Lochhaas**, Greg L. Bryan, Yuan Li, et al., "Properties of the Simulated Circumgalactic Medium." 2020, MNRAS 493, 1461
5. **Cassandra Lochhaas**, Smita Mathur, Stephan Frank, et al., "A High Signal-to-Noise HST Spectrum Toward J1009+0713: Precise Absorption Measurements and the Origin of O VI." 2019, MNRAS 489, 78
6. **Cassandra Lochhaas**, Todd A. Thompson, Eliot Quataert, et al., "Fast Winds Drive Slow Shells: A Model for the CGM as Galactic Wind-Driven Shells." 2018, MNRAS, 481, 1873
7. **Cassandra Lochhaas** & Todd A. Thompson, "Second Generation Stars in Globular Clusters from Rapid Radiative Cooling of Pre-Supernova Massive Star Winds." 2017, MNRAS, 470, 977
8. **Cassandra Lochhaas**, David H. Weinberg, Sébastien Peirani, et al. "Modeling Lyman-α Forest Cross-Correlations with LyMAS." 2016, MNRAS, 461, 4353

Significant Contribution Publications

1. Emily Silich, John ZuHone, Elena Bellomi, et al. (**Cassandra Lochhaas** 7th author of 9), "X-ray emission signatures of galactic feedback in the hot circumgalactic medium: predictions from cosmological hydrodynamical simulations", 2025, arXiv:2506.17440
2. Ramona Augustin, Jason Tumlinson, Molly S. Peeples, et al. (**Cassandra Lochhaas** 6th author of 14), "FOGGIE X: Characterizing the Small-Scale Structure of the CGM and its Imprint on Observables", 2025, arXiv:2501.06551
3. Raymond C. Simons, Molly S. Peeples, Jason Tumlinson, et al. (**Cassandra Lochhaas** 5th author of 13), "Figuring Out Gas & Galaxies in Enzo (FOGGIE). IX: The Angular Momentum Evolution of Milky Way-like Galaxies and their Circumgalactic Gas", 2024, arXiv:2409.17244
4. Alison L. Coil, Serena Perrotta, David S. N. Rupke, et al. (**Cassandra Lochhaas** 4th author of 12), "Detection of Spatially Extended Ionized Gas in an Odd Radio Circle", 2024, *Nature* 625, 459
5. Ayan Acharyya, Molly S. Peeples, Jason Tumlinson, et al. (**Cassandra Lochhaas** 5th author of 10), "Figuring Out Gas & Galaxies In Enzo (FOGGIE) VIII: Complex and Stochastic Metallicity Gradients at $z > 2$", 2025, ApJ 979, 129
6. Hyeonmin Lee, Ayan Acharyya, Anna C. Wright, et al. (**Cassandra Lochhaas** 5th author of 7), "Evolution of Galaxy Size in the FOGGIE Simulations", 2023, Research Notes of the AAS, 7, 202
7. Anna C. Wright, Jason Tumlinson, Molly S. Peeples, et al. (**Cassandra Lochhaas** 5th author of 10), "Figuring Out Gas & Galaxies In Enzo (FOGGIE) VII: The (Dis)Assembly of Stellar Halos", 2024, ApJ 970, 70

8. Raymond C. Simons, Molly S. Peeples, Jason Tumlinson, et al. (**Cassandra Lochhaas** 7th author of 12), "Figuring Out Gas & Galaxies In Enzo (FOGGIE). IV. The Stochasticity of Ram Pressure Stripping in Galactic Halos", 2020, ApJ 905, 167

9. Yong Zheng, Molly S. Peeples, Brian W. O'Shea, et al. (**Cassandra Lochhaas** 5th author of 9), "Figuring Out Gas & Galaxies In Enzo (FOGGIE). III. The Mocky Way: Investigating Biases in Observing the Milky Way's Circumgalactic Medium", 2020, ApJ 896, 143

10. Yuan Li, Marie-Lou Gendron-Marsolais, Irina Zhuravleva, et al. (**Cassandra Lochhaas** 7th author of 19), "Direct Detection of Black Hole-driven Turbulence in the Centers of Galaxy Clusters", 2020, ApJL 889, 1

Contributed Observations Publications

1. Keith Horne, G. De Rosa, B. M. Peterson, et al., "Space Telescope and Optical Reverberation Mapping Project. IX. Velocity-Delay Maps for Broad Emission Lines in NGC 5548", 2021, ApJ 907, 76

2. Williams, P. R., Pancoast, A., Treu, T., et al., "Space Telescope and Optical Reverberation Mapping Project. XII. Broad-Line Region Modeling of NGC 5548", 2020, ApJ 902, 74

3. G. A. Kriss, G. De Rosa, J. Ely, et al., "Space Telescope and Optical Reverberation Mapping Project. VIII. Time Variability of Emission and Absorption in NGC 5548 Based on Modeling the Ultraviolet Spectrum", 2019, ApJ 881, 153

4. G. De Rosa, M. M. Fausnaugh, C. J. Grier, et al., "Velocity-resolved Reverberation Mapping of Five Bright Seyfert 1 Galaxies." 2018, ApJ 866, 133

5. M. M. Fausnaugh, D. A. Starkey, Keith Horne, et al., "Continuum Reverberation Mapping of the Accretion Disks in Two Seyfert 1 Galaxies." 2018, ApJ, 854, 107

6. M. M. Fausnaugh, C. J. Grier, M. C. Bentz, et al., "Reverberation Mapping of Optical Emission Lines in Five Active Galaxies." 2017, ApJ, 840, 97

7. L. Pei, M. M. Fausnaugh, A. J. Barth, et al., "Space Telescope and Optical Reverberation Mapping Project. V. Optical Spectroscopic Campaign and Emission-line Analysis for NGC 5548." 2017, ApJ, 837, 131