

Matthew Ho

POSTDOCTORAL RESEARCH FELLOW

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Academic Experience

Columbia University

New York City, NY

POSTDOCTORAL RESEARCH FELLOW

September 2024 - August 2026

Joint 2+2 year position within the Simons Collaboration on Learning the Universe developing accelerated emulators and inference models for cosmological analysis.

Advisor: Greg Bryan

Institut d'Astrophysique de Paris (IAP)

Paris, FR

POSTDOCTORAL RESEARCH FELLOW

September 2022 - August 2024

Joint 2+2 year position within the Simons Collaboration on Learning the Universe developing accelerated emulators and inference models for cosmological analysis.

Advisors: Benjamin Wandelt, Guilhem Lavaux

Education

Carnegie Mellon University

Pittsburgh, PA

PH.D., M.S. PHYSICS

August 2017 - August 2022

Thesis: Deep Learning for Dynamical Mass Estimation of Galaxy Clusters

Advisor: Hy Trac

GPA: 3.97

Carnegie Mellon University

Pittsburgh, PA

M.S. MACHINE LEARNING

August 2021 - May 2022

Research Interests: Deep Learning, Bayesian Modeling, Approximate Inference, Generative Models

GPA: 4.0

Shanghai Jiao Tong University

Shanghai, China

SUMMER STUDY

May 2017 - June 2017

Courses on Superconductivity Theory and Experiment

University of Illinois at Urbana-Champaign

Urbana, IL

B.S. ENGINEERING PHYSICS

August 2014 - May 2017

Minor in Mathematics

Research advisors: Lucas Wagner, Guy Garnett

Publications

* Highlighted works

PUBLISHED

Ricketts, B. J., Huppenkothen, D., ..., **Ho, M.**, et al. 2025, "RTFAST-Spectra: Emulation of X-ray reverberation mapping for active galactic nuclei" *MNRAS*, 538, 2

Bartlett, D., **Ho, M.**, and Wandelt, B. 2024, "Bye bye, LIMD bias: the statistics of the halo field are poorly determined by the local mass density" *The Astrophysical Journal Letters*, 977, 2

Modi, C., Pandey, M., **Ho, M.**, et al. 2023, "Sensitivity Analysis of Simulation-Based Inference for Galaxy Clustering" *MNRAS*, 536, 1

Bourdin, A., Legin, R., **Ho, M.** et al. 2024, "Inpainting Galaxy Counts onto N-Body Simulations over Multiple Cosmologies and Astrophysics" *ICML 2024 - AI4Science Workshop*

- Kim, C., Ostriker, E., ..., **Ho, M.** et al. 2024, “Metallicity Dependence of Pressure-regulated Feedback-modulated Star Formation in the TIGRESS-NCR Simulation Suite” *The Astrophysical Journal*, 972, 1
- ***Ho, M.**, Bartlett, D., Chartier, N. et al. 2024, “LtU-IL: An All-in-One Framework for Implicit Inference in Astrophysics and Cosmology” *Open Journal of Astrophysics*, 7
- Legin, R., **Ho, M.**, Lemos, P., et al. 2024, “Posterior sampling of the initial conditions of the universe from non-linear large scale structures using score-based generative models” *MNRAS*, 527, 1
- Ho, M.**, Soltis, J., Farahi, A., et al. 2023, “Benchmarks and Explanations for Deep Learning Estimates of X-ray Galaxy Cluster Masses” *MNRAS*, 524, 3
- Soltis, J., ..., **Ho, M.**, et al. 2022, “A Machine Learning Approach to Enhancing eROSITA Observations” *The Astrophysical Journal*, 940, 60S
- ***Ho, M.**, Ntampaka, M., Rau, M. M., et al. 2022, “The Dynamical Mass of the Coma Cluster from Deep Learning” *Nature Astronomy*, 6 (8), 936-941
- Aguena, M., Avestruz, C., ..., **Ho, M.**, et al. 2021, “CLMM: a LSST-DESC Cluster weak Lensing Mass Modeling library for cosmology” *MNRAS*, 508, 6092
- Ho, M.**, Farahi, A., Rau, M. M., Trac, H. 2021, “Approximate Bayesian Uncertainties on Deep Learning Dynamical Mass Estimates of Galaxy Clusters” *The Astrophysical Journal*, 908, 204H
- Farahi, A., **Ho, M.**, & Trac, H. 2020 “Aging Halos: Implications of the Magnitude Gap on Conditional Statistics of Stellar and Gas Properties of Massive Halos” *MNRAS*, 493, 1, 1361-1374
- Ho, M.**, Rau, M. M., Ntampaka, M., et al. 2019, “A Robust and Efficient Deep Learning Method for Dynamical Mass Measurements of Galaxy Clusters” *The Astrophysical Journal*, 887, 1

IN PRESS

- Lue, A., Genel, S., ..., **Ho, M.**, et al. 2025, “Cosmology with One Galaxy: Auto-Encoding the Galaxy Properties Manifold” Accepted in *The Astrophysical Journal*
- Sommovigo, L., Cochrane, R. K., ..., **Ho, M.**, et al. 2025, “Learning the Universe: physically-motivated priors for dust attenuation curves” Accepted in *The Astrophysical Journal*
- ***Ho, M.**, Zhao, X., and Wandelt, B. 2025, “Ordered Embeddings and Intrinsic Dimensionalities with Information-Ordered Bottlenecks” Accepted in *Machine Learning: Science and Technology*

IN REVIEW

- Lovell, C., Starkenburg, T., **Ho, M.**, et al. 2024, “Learning the Universe: Cosmological and Astrophysical Parameter Inference with Galaxy Luminosity Functions and Colours” Submitted to *MNRAS*
- Hsu, A., **Ho, M.**, Lin, J., et al. 2024, “Reconstructing Galaxy Cluster Mass Maps using Score-based Generative Modeling” Submitted to *The Astrophysical Journal*
- Pandey, S., Modi, C., ..., **Ho, M.** et al. 2024, “CHARM: Creating Halos with Auto-Regressive Multi-stage networks” Submitted to *MNRAS*
- Huppenkothen, D., Ntampaka, M., **Ho, M.**, et al. 2023, “Constructing impactful machine learning research for astronomy: Best practices for researchers and reviewers” Submitted to *BAAS*

Grants & Fellowships

2025-2028	Simons Collaboration , Simons Foundation	\$6,000,000
	Collaborator on a renewal grant for the Learning the Universe Simons Collaboration, securing \$6M in total funding (\$700K allocated to Columbia University) to advance research on machine learning analysis of cosmological and galaxy formation models. The grant emphasizes applications to next-generation observatories, including JWST, DESI, <i>Euclid</i> , and the Simons Observatory.	

2024-2025	NSF ACCESS Maximize Computing Grant , National Science Foundation Collaborator on a computing grant awarding 42 million CPU hours and 20 GPU-years to run advanced dark matter and hydrodynamical simulations, and to develop machine learning emulators for the Learning the Universe project.	\$438,732
2023-2025	ANR Appel à projets générique , Agence nationale de la recherche (French National Research Agency) Collaborator on an ANR AAPG grant (INFOCW) awarded to use state-of-the-art simulations and machine learning inference to analyze large-scale structure maps, with the aim of inferring the universe's cosmological parameters and initial conditions.	€304,261
2022-2025	NSF Astronomy and Astrophysics Research Grant , National Science Foundation Collaborator on a NSF grant (AST 2206055) awarding to develop new multiwavelength machine learning models to probe halo environments and galaxy formation in cluster- and group-scale systems.	\$538,957
2021	John Peoples, Jr. Research Fellowship in Physics , Department of Physics, CMU Recipient of full tuition and stipend, awarded annually to one outstanding physics graduate student.	\$40,000
2020	McWilliams-PSC Research Seed Grant , McWilliams Center for Cosmology Recipient of full tuition and stipend for pursuing innovative, high-impact scientific research.	\$40,000

Presentations

INVITED

- April 2025. *Learning the Universe: Building an Accelerated Modeling Pipeline for Cosmological Surveys*. Yale Data Science and Physics Seminar, Yale University, New Haven, CT
- March 2025. *Science or Serendipity? Validation Tests with Explanations*. Chesapeake ML-Astro Group, Space Telescope Science Institute, Baltimore, MD
- March 2024. *Introduction to the LtU-ILI Inference Pipeline*. Simulation Based Inference for Galaxy Evolution, University of Bristol, Bristol, UK
- November 2022. *Observational Inference with Machine Learning: Investigations in Galaxy Cluster Mass Estimation*. Institut d'Astrophysique de Paris Univers Seminar, Institut d'Astrophysique de Paris, Paris, FR
- March 2022. *Observational Inference in the Era of Machine Learning*. Yale Data Science X Astronomy & Astrophysics Seminar, New Haven, CT
- March 2022. *Observational Inference in the Era of Machine Learning*. Cosmic Physics Center, Fermilab, Batavia, IL
- February 2021. *Galaxy Cluster Mass Estimation Using Deep Learning*. NSF AI Planning Institute for Physics of the Future, Carnegie Mellon University, Pittsburgh, PA
- December 2020. *Galaxy Cluster Mass Estimation Using Deep Learning*. Artificial Intelligence Interest Group, Dark Energy Science Initiative
- June 2019. *Galaxy Cluster Mass Estimation Using Deep Learning*. Weak Lensing Seminar, Universitaets-Sternwarte der Ludwig-Maximilians-Universitaet, Munich, Germany

CONTRIBUTED

- May 2025. *Scientific Discovery from Ordered Information Decomposition*. Cosmic Horizons Conference, University of Texas at Austin, Austin, TX
- December 2024. *Practical Simulation-Based Cosmological Inference with Learning the Universe*. Cosmology and Galaxy Astrophysics with Simulations and Machine Learning 2024, Center for Computational Astrophysics, New York City, NY

May 2024. *Scientific Discovery from Ordered Information Decomposition*. European AI For Fundamental Physics Conference, Amsterdam, NL

November 2023. *Scientific Discovery from Ordered Information Decomposition*. Debating the Potential of Machine Learning in Astronomical Surveys, Institut d'Astrophysique de Paris, Paris, FR

April 2022. *Galaxy Cluster Mass Estimation Using Deep Learning*. Galaxy Clusters 2022: Challenging Our Cosmological Perspectives, Space Telescope Science Institute, Baltimore, MD

September 2021. *Galaxy Cluster Masses from Approximate Bayesian Deep Learning*. A Multi-Wavelength View of Galaxy Clusters: Deriving Masses in the Era of Wide-Field Surveys, European Space Agency

June 2020. *Galaxy Cluster Mass Estimation Using Deep Learning*. Astrostatistics Interest Group 2020 Student Paper Finalists, Joint Statistical Meeting, Philadelphia, PA

June 2019. *A Robust and Efficient Deep Learning Method for Dynamical Mass Measurements of Galaxy Clusters*. Artificial Intelligence Methods in Cosmology Workshop, Ascona, Switzerland.

May 2018. *Improving Mass Measurements of Galaxy Clusters through Applications of Machine Learning*. Machine Learning in Science and Engineering Conference, Carnegie Mellon University, Pittsburgh, PA

April 2015. *Dynamic Particle Control and Simulation*, NCSA Students Pushing Innovation Seminar, National Center for Supercomputing Applications, Urbana, IL

December 2014. *Gestural Recognition of Human Expression*, NCSA Students Pushing Innovation Seminar, National Center for Supercomputing Applications, Urbana, IL

Teaching Experience

Fall 2024	Frontiers of Astrophysics , Guest Lecturer	Columbia
Summer II 2021	Introduction to Astronomy , Instructor	CMU
Spring 2021	Advanced Computational Physics , Teaching Assistant	CMU
Fall 2019	Matter & Interactions I , Teaching Assistant	CMU
Summer II 2019	Physics I for Engineering Students , Teaching Assistant	CMU
Summer II 2019	Physics for Future Presidents , Teaching Assistant	CMU
Summer I 2019	Physics II for Engineering and Physics Students , Teaching Assistant	CMU
Spring 2019	Physics II for Engineering and Physics Students , Teaching Assistant	CMU
Fall 2018	Matter & Interactions I , Teaching Assistant	CMU
Spring 2018	Physics II for Engineering and Physics Students , Teaching Assistant	CMU
Fall 2017	Matter & Interactions I , Teaching Assistant	CMU

Undergraduate Mentoring

2024-	Chaipat Tirapongprasert , Columbia University
2024-2025	Thais Velazquez , Barnard College
2023-	Antoine Bourdin , Université de Montréal
2023-	Kalvyn Adams , University of Colorado, Boulder
2022-2024	Alan Hsu , Carnegie Mellon University, <i>Now PhD at Harvard University</i>
2023-2024	Caleb Ogle , University of Colorado, Boulder, <i>Now PhD at University Wisconsin, Milwaukee</i>
2022-2023	Joyce Lin , Carnegie Mellon University, <i>Now PhD at University Wisconsin at Madison</i>
2022-2023	Kevin Hu , Yale University
2021	Bryant Dean , Morehouse College
2020-2021	Faith Ruehle , Carnegie Mellon University
2019-2020	Alexa Lansberry , Carnegie Mellon University

Relevant Graduate Coursework

PHYSICS

Classical Electrodynamics I (33-761)
Quantum Mechanics I (33-755)
Quantum Mechanics II (33-756)
Statistical Mechanics (33-765)
Intro. to Cosmology (33-778)
Particle Physics (PT-705)

MACHINE LEARNING

Intro. to Machine Learning (10-701)
Probability & Mathematical Statistics (36-700)
Advanced ML Theory & Method (10-716)
Probabilistic Graphical Models (10-708)
Convex Optimization (10-725)
Graduate Artificial Intelligence (15-780)
Machine Learning in Practice (10-718)
MultiModal Machine Learning (11-777)
Advanced Deep Learning (10-707)

Conferences & Workshops

2025	Simulation-Based Inference for Galaxy Evolution Workshop , Scientific Organizing Committee	<i>Bristol, UK</i>
2024	Cosmology and Galaxy Astrophysics with Simulations and Machine Learning Conference , Scientific Organizing Committee	<i>New York City, NY</i>
2024	Simulation-Based Inference for Galaxy Evolution Workshop , Scientific Organizing Committee	<i>Bristol, UK</i>

Service & Outreach

2024-	Aquila Consortium Contact Unit , Committee Member
2023	Learning Learning the Universe , Organizer and Presenter
2022	Astronomy on Tap - Pittsburgh , Presenter
2021	Carnegie Science Center , Career Panelist
2020-2021	McWilliams Software Seminar Series , Organizer
2020-2021	Vera Computing System Commissioning Committee , Committee Member
2017-2021	Department of Physics Industry Speaker Seminar Series , Founder, Organizer
2019-2020	CMU Data Science Club , Project Lead

Peer Review

The Astrophysical Journal
Nature Astronomy
Journal of Cosmology and Astrophysics
Monthly Notices of the Royal Astronomical Society

Professional Memberships

Simons Collaboration on Learning the Universe
Aquila Consortium
LSST-Dark Energy Science Collaboration
American Statistical Association