Hy Trac

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Highlights

Awards	2025 Buchalter Cosmology First Prize Simons Foundation Targeted Grants to Institutes
Leadership	Program Director, Astronomy and Astrophysics PhD Program Director, NSF REU in Physics and AI
Research Group	I have advised over 20 undergraduate students, 10 graduate students, and 7 postdoctoral fellows who have gone on to pursue graduate studies (e.g. Chicago, Harvard, UWM), postdoctoral research (e.g. Columbia, Harvard, Princeton), faculty positions (e.g. Cornell, STScI, UNLV), and careers in industry (e.g. Amazon, Apple, Google).

Appointments

07/2018 - **Associate Professor** with tenure
McWilliams Center for Cosmology, Dept. of Physics, Carnegie Mellon University

07/2016 - 06/2018 **Associate Professor** without tenure
McWilliams Center for Cosmology, Dept. of Physics, Carnegie Mellon University

07/2010 - 06/2016 **Assistant Professor**
McWilliams Center for Cosmology, Dept. of Physics, Carnegie Mellon University

08/2007 - 06/2010 **ITC Postdoctoral Fellow**
Institute for Theory and Computation, Harvard-Smithsonian Center for Astrophysics
Advisor Abraham Loeb

10/2004 - 07/2007 **Postdoctoral Research Associate**
Department of Astrophysical Sciences, Princeton University
Advisors David Spergel, Uros Seljak

Education

09/2000 - 09/2004 **PhD in Astronomy and Astrophysics**
Department of Astronomy and Astrophysics, University of Toronto
Out-of-core Hydrodynamic Simulations of Cosmological Structure Formation
Advisor Ue-Li Pen

09/1999 - 08/2000 **MSc in Astronomy and Astrophysics**
Department of Astronomy and Astrophysics, University of Toronto
Stochastic Bias and Redshift Distortions in the PSCz Survey
Advisor Ue-Li Pen

09/1995 - 05/1999 **BSc in Honours Physics and Astronomy**
Department of Physics and Astronomy, University of British Columbia
Discriminating between Models of Structure Formation using Topological Statistics
Advisors Paul Hickson, Robert Brandenberger

Select Publications ——— NASA Astrophysics Data System

2025 Buchalter Cosmology First Prize: Cain, C., McQuinn, M., Scannapieco, E., D'Aloisio, A., & **Trac, H.**, Kiloparsec-scale Turbulence Driven by Reionization May Grow Intergalactic Magnetic Fields, 2026, PRD, 113, 3050

Hsu, A., Ho, M., Lin, J., Markey, C., Ntampaka, M., **Trac, H.**, & Poczos, B., Reconstructing Galaxy Cluster Mass Maps using Score-based Generative Modeling, 2025, OJA, 8, 92

Mukherjee, D., Holgado, A.M., Go, O., & **Trac, H.**, Examining the Effects of Dark Matter Spikes on Eccentric Intermediate Mass Ratio Inspirals Using N-body Simulations, 2024, MNRAS, 20, 2335

MacCrann, N. & ACT Collaboration, The Atacama Cosmology Telescope: Reionization kSZ Trispectrum Methodology and Limits, 2024, MNRAS, 532, 4247

Mukherjee, D., Siraj, A., **Trac, H.**, & Loeb, A., Close Encounters of the Interstellar Kind: Exploring the Capture of Interstellar Objects in Near-Earth Orbit, 2023, MNRAS, 525, 908

Mukherjee, D., Zhu, Q., Go, O., Rodriguez, C., & **Trac, H.**, Evolution of Massive Black Hole Binaries in Collisionally Relaxed Nuclear Star Clusters - Impact of Mass Segregation, 2023, MNRAS, 518, 4801

Chen, N., **Trac, H.**, Mukherjee, S., & Cen, R., Patchy Kinetic Sunyaev-Zel'dovich Effect with Controlled Reionization History and Morphology, 2023, ApJ, ApJ, 943, 138

Ho, M., Ntampaka, M., Rau, M.M., Chen, M., Lansbury, A., Ruehle, F. & **Trac, H.**, The Dynamical Mass of the Coma Cluster from Deep Learning, 2022, Nature Astronomy, 6, 936

Trac, H., Chen, N., Holst, I., Alvarez, M.A., & Cen, R., AMBER: A Semi-Numerical Abundance Matching Box for the Epoch of Reionization, 2022, ApJ, 927, 186

He, Y., **Trac, H.**, & Gnedin, N.Y., A Hydro-Particle-Mesh Code for Efficient and Rapid Simulations of the Intracluster Medium, 2022, ApJ, 925, 134

Ho, M., Farahi, A., Rau, M.M., & **Trac, H.**, Approximate Bayesian Uncertainties on Deep Learning Dynamical Mass Estimates of Galaxy Clusters, 2021, ApJ, 908, 204

Ho, M., Rau, M.M., Ntampaka, M., Farahi, A., **Trac, H.**, & Poczos, B., A Robust and Efficient Deep Learning Method for Dynamical Mass Measurements of Galaxy Clusters, 2019, ApJ, 887, 25

Ntampaka, M., **Trac, H.**, Sutherland, D.J. Fromenteau, S., Poczos, B., & Schneider, J., Dynamical Mass Measurements of Contaminated Galaxy Clusters using Machine Learning, 2016, ApJ, 831, 135

Trac, H., Cen, R., & Mansfield, P., SCORCH I: The Galaxy-Halo Connection in the First Billion Years, 2015, ApJ, 813, 54

Ntampaka, M., **Trac, H.**, Sutherland, D.J., Battaglia, N., Poczos, B., & Schneider, J. A Machine Learning Approach for Dynamical Mass Measurements of Galaxy Clusters, 2015, ApJ, 805, 50

Select Presentations

03/2025 **Learning to See the Dark Matter in Galaxy Clusters**
Astroparticle Seminar, Ohio State University

10/2024 **Learning to See the Dark Matter in Galaxy Clusters**
Cosmology Seminar, University of Michigan

09/2024 **Learning to See the Dark Matter in Galaxy Clusters**
Physics Colloquium, MgGill University

06/2024 **Galaxy Cluster Mass Reconstruction with HYPER Sims and Diffusion Models**
Cosmology Seminar, Institut d'Astrophysique de Paris

06/2024 **Reionization Modeling**, session chair and discussion leader
Reionisation in Relic Radiation Workship, Institut d'Astrophysique Spatiale

06/2022 **AMBER and HYPER Simulations of the SZ Effect Across Cosmic Time**
SZ Workshop, Center for Computational Astrophysics

03/2022 **A Semi-Numerical Abundance Matching Box for the Epoch of Reionization**
Reionization and Cosmic Dawn Workshop, Berkeley Center for Cosmological Physics

11/2021 **A Semi-Numerical Abundance Matching Box for the Epoch of Reionization**
Gnedin-Kravtsov Group Meeting, University of Chicago

11/2020 **Inferring Dark Matter in Galaxy Clusters with Bayesian Deep Learning**
Astronomy Colloquium, UC Riverside

10/2018 **The Reionization of Hydrogen: A Tale of Two Optical Depths**
Cosmology Seminar, Canadian Institute for Theoretical Astrophysics

09/2018 **Simulations and Constructions of the Reionization of Cosmic Hydrogen**
Revealing Cosmology and Reionization History with the IGM Workshop, IPMU

09/2018 **Cluster Cosmology with Forward Modeling and Machine Learning**
Astronomy Colloquium, Penn State University

01/2018 **Hydro Sims: Today and Tomorrow**
Modeling the Extragalactic Sky Workshop, BCCP

10/2017 **Weighing the Dark and Light in Cosmology with Machine Learning**
American Physical Society, Pittsburgh

07/2017 **Hydro Sims: Today and Tomorrow**
Simons Observatory Collaboration Meeting, UC San Diego

05/2017 **Weighing the Dark and Light in Galaxy Clusters with Machine Learning**
Machine Learning Symposium, CMU

02/2017 **New Ways to Use Dynamical Measurements of Galaxy Clusters**
Astronomy Colloquium, University of Washington

12/2016 **The Imprint of Patchy Reionization on the Cosmic Microwave Background**
Astrophysics Seminar, Center for Computational Astrophysics

Select Activities

03/2025 -	**Astronomy and Astrophysics PhD**, program director
09/2024 -	**Astronomy and Astrophysics PhD**, committee member
12/2023 - 06/2024	**Reionisation in Relic Radiation Workshop**, scientific organizing committee
03/2023 -	**NSF REU in Physics and AI**, program director
06/2022 - 09/2022	**Reionization on a Blackboard Workshop**, scientific organizing committee
01/2022 - 05/2024	**Astro Seminars**, chair
09/2020 -	**CMB-S4**, collaboration member
09/2020 - 08/2023	**NSF AI Physics SURP**, program coordinator
09/2018 - 08/2021	**Physics Graduate Admissions**, chair
04/2018 - 04/2018	**NASA Earth and Space Science Graduate Fellowships**, reviewer
04/2018 - 04/2020	**CMU Faculty Senate**, physics representative
08/2017 - 12/2017	**Redeveloped Physics 33241: Intro to Comp Physics**, instructor
09/2016 - 10/2016	**NASA Astrophysics Theory Program**, reviewer
07/2016 - 05/2018	**Physics Colloquium**, chair
06/2016 -	**Simons Observatory**, collaboration member
04/2014 - 05/2014	**DOE Advanced Scientific Computing Research**, reviewer
03/2014 - 04/2014	**NASA Earth and Space Science Graduate Fellowships**, reviewer
01/2014 - 05/2014	**Redeveloped Physics 33466: Extragalactic Astrophysics and Cosmology**, instructor
01/2012 - 04/2015	**Physics Graduate Admissions**, committee member
11/2011 - 05/2012	**The Epoch of Reionization Workshop**, scientific organizing committee
03/2011 - 05/2011	**NASA Explorer 2011 Science Missions of Opportunity**, reviewer
01/2011 - 05/2011	**Redeveloped Physics 33777: Introductory Astrophysics**, instructor
01/2010 - 06/2010	**Great Lakes Cosmology Workshop**, scientific organizing committee
10/2004 -	**Atacama Cosmology Telescope**, collaboration member

Teaching

01/2025 - 05/2025 **Sophomore Colloquium**
1 semester, FCE: teaching 3.9, course 3.6

08/2022 - **Introduction to Computational Physics**
4 semesters, FCE: teaching 4.42, course 4.33

01/2022 - 05/2024 **Upperclass Colloquium**
4 semesters, FCE: teaching 4.31, course 4.16

08/2017 - 12/2020 **Introduction to Computational Physics**
4 semesters, FCE: teaching 4.21, course 4.14

01/2014 - **Extragalactic Astrophysics and Cosmology**
12 semesters, FCE: teaching 4.63, course 4.63

01/2013 - 05/2015 **Physics for Engineering Students I**
3 semesters, FCE teaching 3.77, course 3.95

08/2011 - 12/2012 **Introductory Astrophysics**
3 semesters, FCE: teaching 4.50, course 4.25

Undergraduate Students

09/2025 - **Katherine Choi**, sophomore at CMU

09/2025 - 12/2025 **Marco Esparza**, applying for graduate studies and industry jobs

05/2025 - **Molly Abramson**, NSF REU in Physics and AI

08/2024 - 05/2025 **Iris Reed**, graduate studies at Northeastern University

08/2024 - 12/2024 **Leo Hsu**, applying for graduate studies and industry jobs

05/2024 - **Zhennan Li** (SJTU), graduate studies at CMU

05/2024 - 10/2024 **Xinyi Zhao** (SJTU), junior at Shanghai Jiao Tong University

01/2024 - 12/2024 **Jacques Moye**, applying for graduate studies and industry jobs

08/2023 - 05/2024 **Jayanth Tumuluri**, industry

06/2023 - 12/2023 **Eileen Xiao**, graduate studies at CMU

05/2022 - 05/2023 **Joyce Lin**, NSF Graduate Research Fellowship at University of Wisconsin-Madison

08/2021 - 05/2023 **Alan Hsu**, graduate studies at Harvard University

05/2021 - 07/2021 **Bryant Dean** (Morehouse College), engineering at Georgia Institute of Technology

01/2020 - 05/2020 **Emeline Fromont**, graduate studies at University of Maryland

01/2020 - 05/2020 **Faith Ruehle**, industry

03/2019 - 12/2019 **Nihar Dalal**, graduate studies at Ohio State University

04/2018 - 05/2019 **Daniel Glazer**, graduate studies at University of Chicago

06/2016 - 05/2019 **Ian Holst**, graduate studies at University of Chicago

09/2017 - 12/2018 **Desmond Reed**, software engineer

10/2015 - 05/2018 **Minghan Chen**, graduate studies at UC Santa Barbara

10/2011 - 05/2014 **Phil Mansfield**, Cutkosky award (CMU), McCormick Graduate Fellowship at Chicago

04/2011 - 05/2012 **Matt Dailey**, software engineer at Amazon

01/2011 - 05/2012 **Yelena Goryunova**, graduate studies at Dartmouth College

Graduate Students

01/2026 - **Fatemeh Hafezianzadeh**

09/2025 - **Zhennan Li**

09/2019 - 05/2025 **Dipto Mukherjee**
PhD, *Accelerating the Next Frontier of Gravitational Waves: Advanced Computational Methods & Simulations*
GPU-ML engineer at Apple

09/2018 - 05/2024 **Nianyi Chen**
PhD, *Modeling of Galaxy and Massive Black Hole Evolution Since Cosmic Dawn*
Peoples Graduate Fellowship (CMU), McWilliams Graduate Fellowship (CMU), Schmidt Futures Postdoctoral Fellowship at Institute for Advanced Study (IAS) & Max Planck Institute for Astrophysics (MPA)

01/2022 - 12/2022 **Carleen Markey**
Masters, ARCS Graduate Fellowship (CMU), hockey analyst with New Jersey Devils

09/2017 - 08/2022 **Matt Ho**
PhD, *Galaxy Cluster Mass Estimation with Machine Learning*
Peoples Graduate Fellowship (CMU), Simons Foundation Postdoctoral Fellowship at Institut d'Astrophysique de Paris (IAP) & Columbia University

01/2017 - 08/2021 **Yizhou He**
PhD, *A Hydro-Particle-Mesh Code for Efficient and Rapid Simulations for Cosmology with the Sunyaev-Zel'dovich Effect*
Data scientist at national company in China

02/2017 - 12/2020 **Aristide Doussot**
Masters internship (CMU), postdoctoral fellow at Institut d'Astrophysique de Paris (IAP), research engineer at Laboratoire d'Études du Rayonnement et de la Matière en Astrophysique et Atmosphères (LERMA)

09/2012 - 10/2017 **Michelle Ntampaka**
PhD, *Cosmology with Galaxy Cluster Dynamics using Machine Learning and Forward Modeling*
M. Hildred Blewett Graduate Fellowship (CMU), McWilliams Graduate Fellowship (CMU), Harvard Data Science Initiative Postdoctoral Fellowship at Center for Astrophysics (CfA), Associate Astronomer & Deputy Head of the Data Science Mission Office at Space Telescope Science Institute (STScI)

01/2012 - 09/2016 **Paul La Plante**
PhD, *Large-Scale Simulations of Hydrogen and Helium Reionization*
HERA postdoctoral fellow at University of Pennsylvania, BCCP Postdoctoral Fellowship at UC Berkeley, Assistant Professor-in-Residence at University of Nevada, Las Vegas (UNLV)

Postdoctoral Fellows

09/2018 - 10/2021 **Qirong Zhu**
McWilliams Postdoctoral Fellowship (CMU), software engineer at Ansys

09/2018 - 10/2019 **Arya Farahi**
McWilliams Postdoctoral Fellowship (CMU), faculty at UT Austin

11/2017 - 08/2021 **Markus Rau**
DOE/NSF-funded postdoctoral fellow (CMU), postdoctoral fellow at Argonne National Laboratory, lecturer at New Castle University

09/2015 - 04/2016 **Layne Price**
DOE-funded postdoctoral fellow (CMU), data scientist at Amazon

09/2014 - 07/2018 **Anson D'Aloisio**
NSF-funded postdoctoral fellow at University of Washington, faculty at UC Riverside

09/2010 - 08/2014 **Aravind Natarajan**
McWilliams Postdoctoral Fellowship (CMU), data scientist at Google

09/2011 - 08/2014 **Nick Battaglia**
McWilliams Postdoctoral Fellowship (CMU), Lyman Spitzer Jr Postdoctoral Fellowship at Princeton, faculty at Cornell