

Kaylie Hausknecht

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EDUCATION

- **Massachusetts Institute of Technology** Cambridge, MA
Ph.D. Student in Physics Aug. 2024 - Present
- **Harvard College** Cambridge, MA
A.B. in Physics and Astrophysics Aug. 2019 - May 2024
Summa Cum Laude; GPA: 4.00/4.00
Senior Thesis: Inverse Design of Complex Fluids with Fully-Differentiable Lagrangian Particle Dynamics
- **Lynbrook Senior High School** Lynbrook, NY
Valedictorian; GPA: 105.2/100 Sep. 2015 - June 2019

AWARDS AND FELLOWSHIPS

- **Hertz Fellowship:** Highly selective Ph.D. fellowship that provides up to \$250,000 of support over five years; chosen as one of 18/800 applicants
- **Ida M. Green Fellowship:** A one-year fully funded Ph.D. fellowship that each MIT department is able to nominate one woman to receive
- **National Science Foundation Graduate Research Fellowship:** Three year Ph.D. grant from the National Science Foundation worth up to \$159,000
- **Sophia Freund Prize:** “Awarded annually to the students in the senior class of Harvard College who are graduating summa cum laude with the highest grade point average”
- **Thomas T. Hoopes Prize:** Awarded for “outstanding scholarly work or research”; received for my senior thesis entitled “Inverse Design of Complex Fluids with Fully-Differentiable Lagrangian Particle Dynamics”; winning theses are bound and displayed in Harvard’s Lamont Library
- **Bowdoin Prize in the Natural Sciences (2023):** One of Harvard’s oldest prizes that recognizes an essay of “originality and high literary merit” on the natural sciences; selected for my philosophy of physics essay entitled, “A Cautionary Tale on the Marriage of Mathematics and Physics,” which challenges the standard view on the well-known “unreasonable effectiveness of mathematics” problem in the epistemology of physics
- **Phi Beta Kappa Junior 24:** Among the first 24 students in the 2024 class (1800 students) elected to PBK
- **Sosland Prize in Expository Writing (2020):** Awarded to the best essay written in Expository Writing, a required class for all first-year students (~ 1600 in the 2023 class); selected for my essay on the ethics and philosophy of citizen science entitled, ‘Do-It-Yourself Biology: A Road to Innovation or a Threat to Safety?’
- **Sally Ride Internship Award:** Awarded yearly to 10 exceptional female interns (2,500 total NASA interns); provided funding for my internship and access to networking experiences with NASA leadership
- **John Harvard Scholar (2019-20 and 2021-22):** Honors students in the top 5% of their class
- **Research Fellowships:** Selected for both the Herchel-Smith Fellowship and Program for Research in Science and Engineering in the summers of 2020 and 2021
- **Intel International Science and Engineering Fair Winner:** Won 1st place and Best in Category in Physics/Astronomy; selected to present my work in Bulgaria; awarded an asteroid named [16100 Hausknecht](#)

INTERNSHIP EXPERIENCE

- **NASA Ames Research Center** Remote
Research Intern (Full-Time & Part-Time) Jan. 2021 - May 2022
Interned under Dr. Hamed Valizadegan in the Data Science Group, full-time in spring 2021 and part-time thereafter concurrently with school; worked on ExoMiner, a machine learning model for detecting exoplanets from space telescope data; my work specifically focused on model explainability and the design of post-hoc explainability tests to understand the physical reasons why certain signals are not exoplanets; our model found [301 new exoplanets](#) in all

- **NASA Langley Research Center**

Remote

Research Intern (Full-Time)

Aug. 2020 - Dec. 2020

Interned under Dr. Meelan Choudhari in the Computational Fluid Dynamics Group; built physics-based models accelerated by the use of convolutional neural networks to predict the location of laminar-turbulent transition on 2D swept airfoils; these models will be incorporated into NASA's industry flow solvers and are intended to be used for solving design problems in aerospace engineering

ACADEMIC RESEARCH PROJECTS

- **Senior Thesis in Physics - Inverse Design of Complex Fluids with Fully-Differentiable Lagrangian Particle Dynamics (Prof. Michael Brenner):** Working on combining a differentiable Navier Stokes solver with a differentiable molecular dynamics engine to enable Lagrangian studies of complex flows (e.g. with suspensions and interacting particles) that include the effects of molecular diffusion; the ability to differentiate through entire simulations provides a new way to approach multi-parameter inverse design/flow control problems in fluid mechanics
- **Junior Thesis in Astrophysics - Evidence for High Redshift Galaxy Mergers From the James Webb Space Telescope (Prof. Avi Loeb):** Identified potentially merging galaxies by modeling galaxy halo properties from their photometry and finding pairs with overlapping virial radii that, thus, share a halo; results provide a mechanism for alleviating the tension found between high redshift JWST galaxies and standard cosmological models by showing that the number density of massive halos is being overcounted
- **Black Hole-Neutron Star Mergers as Sources of r-Process Enrichment in Ultra Faint Dwarf Galaxies (Prof. Edo Berger):** Used population synthesis models determine if black hole-neutron star (BH-NS) mergers could be sources of r-process enrichment; used numerical relativity simulations to model the rate of r-process enrichment in ultra faint dwarf galaxies, which are anomalously rich in metals; found that, together, BH-NS and NS-NS mergers may explain the rate of r-process enrichment in these galaxies
- **Machine Learning Correlates the Charge Density Wave with the Local Gap in Cuprate Superconductors (Prof. Jennifer Hoffman):** Developed a new convolutional neural network architecture designed to study scanning tunneling microscope (STM) images of superconductors and obey the physical symmetries in the data; trained models to identify the relationship between local doping and charge density waves on carefully simulated synthetic data; used the trained model to generalize and make predictions on real STM data

PUBLICATIONS

- **HARDMath: A Benchmark Dataset for Challenging Problems in Applied Mathematics;** Jingxuan Fan*, Sarah Martinson*, Erik Wang*, **Kaylie Hausknecht***, Jonah Brenner, Danxian Liu Nianli Peng, Corey Wang, Michael Brenner (2024). Submitted to NeurIPS.
- [**Control of Flow Behavior in Complex Fluids Using Automatic Differentiation;**](#) Mohammed Alhashim, **Kaylie Hausknecht**, Michael Brenner (2024). Submitted to PNAS.
- **Normal Class Explainability: A Case Study on Applying Deep Neural Networks to Exoplanet Hunting;** Hamed Valizadegan, Miguel Martinho, **Kaylie Hausknecht** (2023). Submitted to journal.
- [**ExoMiner: A Highly Accurate and Explainable Deep Learning Classifier that Validates 301 New Exoplanets;**](#) Hamed Valizadegan, Miguel Martinho, Laurent S. Wilkens, Jon M. Jenkins, Jeffrey Smith, Douglas A. Caldwell, Joseph D. Twicken, Pedro C. Gerum, Nikash Walia, **Kaylie Hausknecht**, Noa Y. Lubin, Stephen T. Bryson, Nikunj C. Oza (2022). *The Astrophysical Journal*, 926(2), 120.

*equal contribution

CONFERENCE PRESENTATIONS (PRESENTER BOLDED)

- **"Inverse Design of Complex Fluids with Fully Differentiable Particle Dynamics,"** **Kaylie Hausknecht**, Mohammed Alhashim, Michael Brenner. Institute for Artificial Intelligence and Fundamental Interactions Summer Workshop, Cambridge, MA, August 2024.
- [**"Inverse design and optimization of stochastic particle dynamics in complex flows,"**](#) **Alp Sunol**, **Kaylie Hausknecht**, Mohammed Alhashim, Michael Brenner. American Physical Society March Meeting, Minneapolis, March 2024.
- [**"Optimizing Mixing in Porous Media via Automatic Differentiation,"**](#) **Kaylie Hausknecht**, Mohammed Alhashim, Michael Brenner. American Physical Society Division of Fluid Dynamics Annual Meeting, Washington DC, November 2023.

- [“Optimization of Complex Fluid Flows using End to End Differentiable Immersed Boundary Algorithm,”](#) Mohammed Alhashim, Kaylie Hausknecht, Michael Brenner. American Physical Society Division of Fluid Dynamics Annual Meeting, Washington DC, November 2023.
- [“Optimizing Chaotic Mixing with Automatic Differentiation,”](#) Kaylie Hausknecht, Mohammed Alhashim, Michael Brenner. AI Institute in Dynamic Systems, Seattle, WA, July 2023.
- [“A Novel Explainability Framework for Transit Signal Machine Classifiers,”](#) Hamed Valizadegan, Miguel Martinho, Kaylie Hausknecht. American Astronomical Society, June 2022
- [“Do Black Hole–Neutron Star Mergers Contribute to the \(r-Process\) Enrichment in our Universe?”](#) Kaylie Hausknecht and Floor Broekgaarden. European Astronomical Society Annual Meeting, Virtual, June 2021.
- [“Machine Learning Correlates Charge Density Wave with the Local Gap in Cuprate Superconductors,”](#) Kaylie Hausknecht, Tatiana Webb, Michael Boyer, Yi Yin, Takeshi Kondo, Tsunehiro Takeuchi, Hiroshi Ikuta, Eric Hudson, Jenny Hoffman. American Physical Society March Meeting, Virtual, March 2021.
- [“Exploring Data-driven Modeling of Boundary Layer Transition,”](#) Meelan Choudhari, Mujeeb Malik, Pedro Paredes, Muhammed Zafar, Heng Xiao, Jordan Berninger, Kaylie Hausknecht, Richard Qiu, and Jakub Perlin, SIAM Conference on Computational Science and Engineering, March 2021
- [“Machine Learning Correlates Charge Density Wave with the Local Gap in Cuprate Superconductors,”](#) Kaylie Hausknecht, Tatiana Webb, Michael Boyer, Yi Yin, Takeshi Kondo, Tsunehiro Takeuchi, Hiroshi Ikuta, Eric Hudson, Jenny Hoffman. American Physical Society Conference for Undergraduate Women in Physics, Virtual, January 2021.
- [“Local correlations in disordered materials with neural networks,”](#) Kaylie Hausknecht, Tatiana Webb, Jennifer Hoffman, Machine Learning Quantum Matter Data Simons Foundation, January 2020
- [“Machine Learning Correlates CDW Properties with Local Gap in Cuprates,”](#) Kaylie Hausknecht, Tatiana Webb, Michael Boyer, Yi Yin, Takeshi Kondo, Tsunehiro Takeuchi, Hiroshi Ikuta, Eric Hudson, Jenny Hoffman. American Physical Society March Meeting, Boston, MA, March 2019.
- [“Cuprate Quantum Phase Transition Probed by Nanoscale Density Wave Inhomogeneity,”](#) Tatiana Webb, Kaylie Hausknecht, Michael Boyer, Yi Yin, Debanjan Chowdhury, Yang He, Takeshi Kondo, Tsunehiro Takeuchi, Hiroshi Ikuta, Eric Hudson, Mohammad Hamidian, Jennifer Hoffman, American Physical Society March Meeting, Boston, MA, March 2019
- [“Identifying Inhibitors of T-Cell Activation in Microgravity: Proposal for the International Space Station”](#) Kaylie Hausknecht, International Space Station R&D Conference, San Francisco, CA, July 2018.

TEACHING

- **Course Assistant at Harvard University:**
 - Physical Mathematics (Applied Math 201, graduate-level course) with Prof. Brenner Fall 2023
 - Introductory Mechanics and Relativity (Physics 15a) with Dr. Morin Fall 2021
 - Linear Algebra and Real Analysis I (Math 23a) with Dr. Bamberg Summer & Fall 2020
 - Theory of Calculus (RA-23) with Dr. Bamberg: Aug. 2020
- Led initiative to develop and teach a 2-week course to prepare incoming Harvard freshmen, whose high school math classes were cut short by the pandemic, for college-level math; had more than 100 enrollees