

SNEH PANDYA

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SUMMARY

I am a fifth-year Ph.D. candidate in the Department of Physics at Northeastern University and a junior researcher at the NSF Institute for Artificial Intelligence and Fundamental Interactions (IAIFI). My research lies at the intersection of machine learning and cosmology, with a particular emphasis on particle cosmology and weak gravitational lensing. I also maintain broader interests in artificial intelligence, especially concerning the generalization properties of neural networks. My work draws on differentiable programming and simulations, Bayesian inference, optimal transport theory, and equivariance. Prior to beginning my Ph.D., I worked in AI and computational astrophysics.

EDUCATION

Northeastern University

2021-Present

Ph.D., Physics

Advisors: Jim Halverson & Jonathan Blazek

Expected Graduation: May 2026

University of Illinois at Urbana-Champaign

2017-2021

B.S., Physics, Minors in Mathematics & Astronomy

GPA: 3.79/4.00

Treasurer of Sigma Nu Fraternity

PAPERS

S. Pandya, Y. Yang, N. V. Alfen, J. Blazek, R. Walters. A Diffusion Generative Model for Galaxy Intrinsic Alignments. *In Progress*.

S. Pandya, J. Halverson. Differentiably Learning Probabilities in the Inflationary Multiverse. *In Progress*.

S. Pandya, Y. Yang, N. V. Alfen, J. Blazek, R. Walters. IAEmu: Learning Galaxy Intrinsic Alignment Correlations. *Under Review at Open Journal of Astrophysics, 2025*. arXiv:2504.05235

E. Berman, **S. Pandya**, J. McCleary, et al. On Soft Clustering for Correlation Estimators: Model Uncertainty, Differentiability, and Surrogates. *Open Journal of Astrophysics, 2025*. arXiv: 2504.06174

S. Pandya, P. Patel, M. Walmsley, B. Nord, A. Ciprijanovic. SIDDA: Sinkhorn Dynamic Domain Adaptation for Image Classification with Equivariant Neural Networks. *Mach. Learn.: Sci. Technol. 6 035032 (2025)*. arXiv:2501.14048

S. Pandya, J. Halverson. On the Generality and Persistence of Cosmological Stasis. *Phys. Rev. D 110, 075041 (2024)*. arXiv:2408.00835.


S. Pandya, Y. Yang, N. V. Alfen, J. Blazek, R. Walters. Learning Galaxy Intrinsic Alignment Correlations. *ICLR Data-centric Machine Learning Research (2024)*. arXiv:2404.13702.


S. Pandya*, P. Patel*, F. O., J. Blazek. E(2) Equivariant Neural Networks for Robust Galaxy Morphology Classification. *NeurIPS Machine Learning for the Physical Sciences (2023)*. arXiv:2311.01500.


S. Pandya*, J. Lin*, D. Pratap, X. Liu, M. Kind, V. Kindratenko. AGNet: Weighing Black Holes with Deep Learning. *MNRAS, 518, 4921 (2023)*. arXiv:2108.07749


S. Pandya*, J. Lin*, D. Pratap, X. Liu, M. Kind. AGNet: Weighing Black Holes with Machine Learning. *NeurIPS Machine Learning for the Physical Sciences (2020)*. arXiv:2011.15095


PUBLICLY AVAILABLE CODE

AGNet: Codebase accompanying arXiv:2011.15095 and arXiv:2108.07749. Implements a CNN-based modeling pipeline for predicting the spectroscopic redshift and mass of supermassive black holes. 

GCNNMorphology: Codebase accompanying arXiv:2311.01500. Implements a suite of $E(2)$ -equivariant CNNs for galaxy morphology classification using the Galaxy Zoo DECaLS dataset, aimed at exploring the generalization properties of equivariant models. The repository also includes tools for analyzing NN latent spaces and implementing differentiable genetic algorithms for adversarial attacks. 

diff-stasis: Codebase accompanying arXiv:2408.00835. Implements an end-to-end differentiable pipeline for simulating early universe dynamics. Utilizes **difffrax** for differentiable ODE solving and integrates with **numpyro** to enable differentiable sampling within the simulation framework. 

IAEmu: Codebase accompanying arXiv:2504.05235. Implements a NN-based emulator for learning intrinsic alignment correlation functions from halo-occupation distribution simulations. The framework also incorporates Hamiltonian Monte Carlo for differentiable sampling with the neural network. 

SIDDA: Codebase accompanying arXiv:2501.14048. Constructs a novel, semi-automatic, dataset-agnostic domain adaptation (DA) method leveraging the Sinkhorn divergence and optimal transport distances, designed to increase generalization performance across diverse datasets. 

WORK

Department of Energy SCGSR Fellow

August 2024 - February 2025

Fermilab

Batavia, IL

- Studying generalization of neural networks, at an architectural (equivariance) level and in the training of NNs (domain adaptation).

SPIN Intern & NSF REU Fellow

August 2019 - May 2021

National Center for Supercomputing Applications

Urbana, IL

- Utilized HAL supercomputing cluster to accelerate neural network training time, execute data simulation pipeline to expand training data set, and create informative visualizations for a general audience.

SCHOOLS & WORKSHOPS

IAIFI PhD Summer School and Workshop (**Organizer, Presenter**) *August 2025*
IAIFI PhD Summer School and Workshop (**Organizer**) *August 2024*
IAIFI PhD Summer School and Workshop (**Organizer**) *August 2023*
IAIFI PhD Summer School and Workshop *August 2022*
Princeton Deep Learning Theory Summer School *July 2021*

CONFERENCES & PRESENTATIONS

FirstPrinciples, *Oral Presentation* 2025
NSF-Simons Open SkAI, *Poster* 2025
IAIFI Workshop, *Oral Presentation* 2025
IAIFI Summer School, *Tutorial Lead* 2025
NSF-Simons SkAI Institute Undergraduate Symposium, *Lightning Talk* 2025
DESC Intrinsic Alignment Telecon, *Oral Presentation* 2025
NSF-Simons SkAI Institute, *Oral Presentation* 2025
Institute of Astrophysics of the Canary Islands, *Oral Presentation* 2025
Fermilab AI Meeting, 2025
Cosmology & Galaxy Astrophysics w/ Simulations & ML 2024 @ Flatiron, *Oral Presentation* ... 2024

echoIA LILAC Workshop @ Harvard, <i>Lightning Talk</i>	2024
IAIFI Workshop @ MIT, <i>Poster</i>	2024
Tufts University, <i>Oral Presentation</i>	2024
Fermilab Surveys Meeting, <i>Oral Presentation</i>	2024
Neural Information Processing Systems (NeurIPS) Workshop, <i>Poster</i>	2023
Mathematical Physics Days, <i>Oral Presentation</i> (Video)	2021
Illinois Astrofest, <i>Poster (1st Place)</i>	2021
Neural Information Processing Systems (NeurIPS) Workshop, <i>Poster</i> (Video, Poster)	2020
Illinois Undergraduate Research Symposium, <i>Poster</i> (Video, Poster, Press)	2020

OUTREACH


John Hersey High School, <i>Lecture</i> , “Synergies Between AI & Physics”	2025
Northeastern University, <i>Seminar</i> , “Machine Learning, Neural Networks, & All That”	2022
Urbana High School, <i>Lecture</i> , “Black Holes & AI”	2020
John Hersey High School, <i>Lecture</i> , “Black Holes & AI”	2020

AWARDS & RECOGNITION

Fiddler Innovation Undergraduate Fellowship Award	2021
<i>National Center for Supercomputing Applications</i>	<i>Urbana, IL</i>

- \$1500 awarded to undergraduate students showing outstanding contributions during the Summer 2020 REU Inclusion program. The Fiddler Fellowship award is part of a \$2 million-dollar endowment from Jerry Fiddler and Melissa Alden to the University of Illinois in support of student interdisciplinary research initiatives through the Illinois eDream Institute at NCSA.

SERVICE & TEACHING

IAIFI PhD Summer School Tutorial	2025
Constructed a code tutorial outlining distance based and adversarial domain adaptation methods, presented to 200+ students. Code is publicly available. 	

International Conference on Machine Learning (ICML)	2025
Reviewer for the GenBio workshop and ML4Astro workshop	

International Conference on Learning Representations (ICLR)	2023
Reviewer for the ICLR-DMLR workshop	

Conference on Neural Information Processing Systems (NeurIPS)	2022, 2023
Reviewer for NeurIPS-AI4Science workshop	

International Conference on Machine Learning (ICML)	2022
Reviewer for the ICML-AI4Science workshop	

Department of Physics	2021-2023
<i>Northeastern University</i>	<i>Boston, MA</i>

- Teaching assistant, Physics for Life Sciences Lab / Physics for Engineering Lab
- Teaching assistant, Physics for Engineering Discussion
- Teaching assistant, Graduate Computational Physics
- Teaching assistant, Undergraduate Computational Physics

Programming: Python, scientific computing, differentiable programming, probabilistic programming
Other: rock-climber, lifter, photographer, concert-goer, washed-up tennis player, record-collector