

Research Interests

I research deep neural networks that learn efficiently and generalize robustly through self-supervision and principled, domain-informed architectural biases. I am particularly interested in multimodal foundation models and generative approaches that combine disparate data and transfer across domains.

Education

M.A., Ph.D. — Princeton University	2022 - 2027
Specialization: Machine learning for the physical sciences.	
Advisor: Shirley Ho.	
H.B.Sc. — University of Toronto	2018 - 2022
Majors: Astrophysics and Statistics.	

Experience

AI/ML Research Intern — Netflix	May 2026 - Aug 2026
Content Representation Models team. Developed a retrieval-capable multimodal embedding model with a novel architecture and a generative/contrastive/distillation pretraining recipe.	
Researcher — Polymathic AI	Oct 2023 - Present
Self-supervised multimodal foundation models for the physical sciences.	
Graduate Researcher — Princeton University	Sep 2022 - Present

Awards & Honours

GQS PhD Fellowship in Physics (\$100,000 USD)	2025 - 2026
Citadel GQS; awarded only to one PhD student in the country	
NSERC Postgraduate Scholarship - Doctoral (PGS-D) (\$113,667 CAD)	2024 - 2027
Natural Sciences and Engineering Research Council of Canada	
Astrostatistics Student Paper Competition Finalist (\$1,100 USD)	2022 Jan
Astrostatistics Interest Group of the American Statistical Association	
Dean's List Scholar	2021 - 2022
University of Toronto	
Undergraduate Summer Research Fellowship (\$8,396 CAD)	2021 May - 2021 Aug
Canadian Institute for Theoretical Astrophysics, University of Toronto	
Summer Undergraduate Research Program Award (\$9,500 CAD)	2020 May - 2020 Aug
Dunlap Institute for Astronomy and Astrophysics, University of Toronto	

Publications [\[arXiv\]](#) [\[Google Scholar\]](#) * indicates equal contribution.

First Author

10. **Jeff Shen**, Zhejian Zhou, Ryan Lee, Jonathan May, Shirley Ho (2026). FLASHMAP: Flow Map Speculative Decoding. arXiv: [2610.24365](#). Project page: <https://jshen.net/flashmap>.
9. **Jeff Shen** (2026). MUSHY: Multimodal Flow-Based Amortized Bayesian Inference for Spectroscopic Data Fusion. Accepted at Machine Learning and the Physical Sciences Workshop on 10 Oct 2026. arXiv: [2609.15945](#).
8. **Jeff Shen**, Joshua S. Speagle, Shirley Ho (2026). Homogeneous Stellar Parameters from Heterogeneous Spectra with Deep Learning. ApJ 1007 69. arXiv: [2604.25786](#).

7. **Jeff Shen***, Lindsay M. Smith* (2025). ALICE: An Interpretable Neural Architecture for Generalization in Substitution Ciphers. arXiv: [2509.07282](#). Project page: <https://jshen.net/alice>.
6. **Jeff Shen**, Francois Lanusse, Liam Parker, et al. (2025). Universal Spectral Tokenization via Self-Supervised Panchromatic Representation Learning. Accepted at NeurIPS Workshop on Machine Learning and the Physical Sciences on 23 Sep 2025. arXiv: [2510.17959](#).
5. Liam Parker*, Francois Lanusse*, **Jeff Shen***, et al. (2025). AION-1: Omnimodal Foundation Model for Astronomical Sciences. Accepted at NeurIPS 2025 Main Conference on 18 Sep 2025 and as an oral presentation at NeurIPS 2025 AI4Science Workshop on 23 Sep 2025. arXiv: [2510.17960](#).
4. **Jeff Shen**, Peter Melchior (2023). Multiscale Feature Attribution for Outliers. Accepted at NeurIPS Workshop on Machine Learning and the Physical Sciences on 27 Oct 2023. arXiv: [2310.20012](#).
3. **Jeff Shen**, Joshua S. Speagle, J. Ted Mackereth, Yuan-Sen Ting, Jo Bovy (2023). Disentangling Stellar Age Estimates from Galactic Chemodynamical Evolution. ApJ 960 84. arXiv: [2305.15634](#).
2. **Jeff Shen**, Gwendolyn M. Eadie, Norman Murray, Dennis Zaritsky, Joshua S. Speagle, Yuan-Sen Ting, Charlie Conroy, Phillip A. Cargile, Benjamin D. Johnson, Rohan P. Naidu, Jiwon Jesse Han (2022). The Mass of the Milky Way from the H3 Survey. ApJ 925 1. arXiv: [2111.09327](#).
1. **Jeff Shen**, Allison W. S. Man, Johannes Zabl, Zhi-Yu Zhang, Mikkel Stockmann, Gabriel Brammer, Katherine E. Whitaker, and Johan Richard (2021). Molecular gas in a gravitationally lensed galaxy group at $z = 2.9$. ApJ 917 79. arXiv: [2105.11572](#).

Major Contributions

2. Rudy Morel, Francesco P. Ramunno, **Jeff Shen**, et al. (2025). Predicting partially observable dynamical systems via diffusion models with a multiscale inference scheme. Accepted at NeurIPS 2025 Main Conference on 18 Sep 2025. arXiv: [2511.19390](#).
1. The Multimodal Universe Collaboration, including **Jeff Shen** (2024). The Multimodal Universe: Enabling Large-Scale Machine Learning with 100TB of Astronomical Scientific Data. Accepted at NeurIPS 2024 Track on Datasets and Benchmarks on 26 Sep 2024. arXiv: [2412.02527](#).

Coauthor

9. Payel Mukhopadhyay et al., including **Jeff Shen** (2026). Emergent Transfer of a Physics Foundation Model from Simulation to Laboratory Turbulence. Preprint. arXiv: [2606.01470](#).
8. Abigail Petulante et al., including **Jeff Shen** (2026). The Multimessenger Universe as a Training Ground for Frontier AI. Nature Astronomy 10, 938-946. [Nature Astronomy](#).
7. Siavash Golkar et al., including **Jeff Shen** (2026). MIMIC: A Generative Multimodal Foundation Model for Biomolecules. Preprint. arXiv: [2604.24506](#).
6. Michael McCabe et al., including **Jeff Shen** (2025). Walrus: A Cross-Domain Foundation Model for Continuum Dynamics. Accepted to ICML 2026 (Spotlight) on 30 April 2026. arXiv: [2511.15684](#).
5. Neige Frankel, David W. Hogg, Scott Tremaine, Adrian Price-Whelan, **Jeff Shen** (2025). Iron Snails: non-equilibrium dynamics and spiral abundance patterns. ApJ 987 81. arXiv: [2407.07149](#).
4. Ruben Ohana et al., including **Jeff Shen** (2024). The Well: a Large-Scale Collection of Diverse Physics Simulations for Machine Learning. Accepted at NeurIPS 2024 Track on Datasets and Benchmarks on 26 Sep 2024. arXiv: [2412.00568](#).
3. Yan Liang, Peter Melchior, ChangHoon Hahn, **Jeff Shen**, Andy Goulding, Charlotte Ward (2023). Outlier Detection in the DESI Bright Galaxy Survey. ApJL 956 L6. arXiv: [2307.07664](#).

2. Seery Chen, Deborah M. Lokhorst, **Jeff Shen**, Imad Pasha, Evgeni I. Malakhov, Roberto Abraham, Pieter van Dokkum (2022). The Dragonfly Spectral Line Mapper: design and first light. Proc. SPIE 12182, Ground-based and Airborne Telescopes IX, 121824E. arXiv: [2209.07489](#).
1. Deborah M. Lokhorst, Seery Chen, Imad Pasha, **Jeff Shen**, Evgeni I. Malakhov, Roberto G. Abraham, Pieter van Dokkum (2022). The pathfinder Dragonfly Spectral Line Mapper: pushing the limits for ultra-low surface brightness spectroscopy. Proc. SPIE 12182, Ground-based and Airborne Telescopes IX, 121821T. arXiv: [2209.07487](#)

Talks

Schwab Group Meeting, CUNY/Princeton	Oct 2025
Invited talk: “ALICE: An Interpretable Neural Architecture for Generalization in Substitution Ciphers.”	
Princeton University Machine Learning Journal Club, Princeton	Sep 2025
Invited talk: “ALICE: An Interpretable Neural Architecture for Generalization in Substitution Ciphers.”	
Multimessenger Astronomy in the Era of Foundational AI, Nashville	Aug 2025
Invited talk: “Multimodal Foundation Models for Astrophysics.”	
JSM 2022, Washington, D.C.	Aug 2022
Invited talk: “The Mass of the Milky Way from the H3 Survey.”	
SDSS 2021 Collaboration Meeting, JHU/Online	Aug 2021
Lightning talk: “Predicting the ages of stars with machine learning.”	
Stellar Stats Workshop, UofT/Online	May 2021
Lightning talk: “Estimating the mass distribution of the Milky Way with Bayesian multilevel models.”	
Canadian Astronomical Society (CASCA) AGM, NRC Herzberg/Online	May 2021
Lightning talk: “Molecular gas in a gravitationally lensed galaxy group at $z = 2.9$.”	
Vancouver Area Cosmology Meeting, UBC/SFU/TRIUMF/Online	Apr 2021
“Molecular gas in gravitationally lensed galaxies at $z = 2.9$.”	
REQUIEM Galaxies Telecon, Online	Oct 2020
“Molecular gas in gravitationally lensed galaxies at $z = 2.9$.”	

Posters

NeurIPS 2025, San Diego	Dec 2025
“AION-1: Omnimodal Foundation Model for Astronomical Sciences.”	
Machine Learning and the Physical Sciences Workshop, NeurIPS 2025, San Diego	Dec 2025
“Universal Spectral Tokenization via Self-Supervised Panchromatic Representation Learning.”	
Meta PhD Forum 2025, Menlo Park	Oct 2025
Invited poster: “AION-1: Omnimodal Foundation Model for Astronomical Sciences.”	
NeurIPS 2024, Vancouver	Dec 2024
“The Multimodal Universe: Enabling Large-Scale Machine Learning with 100 TBs of Astronomical Scientific Data.”	
Machine Learning and the Physical Sciences Workshop, NeurIPS 2023, New Orleans	Dec 2023
“Multiscale feature attribution for outlier detection models.”	
241st Meeting of the American Astronomical Society, Seattle	Jan 2023
“Stellar parameters for 220m stars from <i>Gaia</i> DR3 BP/RP spectra.”	
Canadian Astronomical Society (CASCA) AGM, NRC Herzberg/Online	May 2021
“Molecular gas in a gravitationally lensed galaxy group at $z = 2.9$.”	
Summer Undergraduate Research Program Poster Session, UofT/Online	Aug 2020
“Molecular gas in a gravitationally lensed galaxy group at $z = 2.9$.” Awarded best poster.	

Professional service

Reviewer for NeurIPS (2025, 2026), ICLR (2026), RAS Techniques and Instruments.