

Research Interest

I work with Shirley Ho and the Polymathic AI group at the Flatiron Institute on designing the architectures of multi-modal foundation models that can be fine-tuned to excel at a wide variety of downstream astronomical applications, as well as the techniques for performing distributed training of these models at scale.

Education

Ph.D., Princeton University. Astrophysical Sciences. 2022 - 2027
M.A., Princeton University. Astrophysical Sciences. 2022 - 2024
H.B.Sc., University of Toronto. Astronomy & Astrophysics and Statistics. 2018 - 2022

Publications

See publications on [arXiv](https://arxiv.org).

10. Neige Frankel, David W. Hogg, Scott Tremaine, Adrian Price-Whelan, **Jeff Shen** (2024). Iron Snails: non-equilibrium dynamics and spiral abundance patterns. Submitted to ApJ. arXiv: [2407.07149](https://arxiv.org/abs/2407.07149).
9. The Multimodal Universe Collaboration, including **Jeff Shen** (2024). The Multimodal Universe: Enabling Large-Scale Machine Learning with 70TBs of Astronomical Scientific Data. Submitted to NeurIPS 2024 Track on Datasets and Benchmarks.
8. Ruben Ohana et al., including **Jeff Shen** (2024). The Well: a Large-Scale Collection of Diverse Physics Simulations for Machine Learning. Submitted to NeurIPS 2024 Track on Datasets and Benchmarks.
7. **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](https://arxiv.org/abs/2310.20012).
6. **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](https://arxiv.org/abs/2305.15634).
5. Yan Liang, Peter Melchior, ChangHoon Hanh, **Jeff Shen**, Andy Goulding, Charlotte Ward (2023). Outlier Detection in the DESI Bright Galaxy Survey. ApJL 956 L6. arXiv: [2307.07664](https://arxiv.org/abs/2307.07664).
4. 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](https://arxiv.org/abs/2209.07489).
3. Deborah M. Lokhorst, Seery Chen, Imad Pasha, **Jeff Shen**, Evgeni I. Malakhov, Roberto G. Abraham, Pieter van Dokkum. 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](https://arxiv.org/abs/2209.07487)
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](https://arxiv.org/abs/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](https://arxiv.org/abs/2105.11572).

Honours and Awards

2024 - 2027	NSERC Postgraduate Scholarship - Doctoral (PGSD) Natural Sciences and Engineering Research Council of Canada
2022 Jan	Astrostatistics Student Paper Competition Finalist Astrostatistics Interest Group of the American Statistical Association
2021 - 2022	Dean's List Scholar University of Toronto
2021 May - 2021 Aug	Undergraduate Summer Research Fellowship Canadian Institute for Theoretical Astrophysics, University of Toronto
2020 May - 2020 Aug	Summer Undergraduate Research Program Award Dunlap Institute for Astronomy and Astrophysics, University of Toronto

Talks

2022 August	JSM 2022, Washington, D.C. Invited talk: "The Mass of the Milky Way from the H3 Survey."
2021 August	SDSS 2021 Collaboration Meeting, JHU/Online Lightning talk: "Predicting the ages of stars with machine learning."
2021 May	Stellar Stats Workshop, UofT/Online Lightning talk: "Estimating the mass distribution of the Milky Way with Bayesian multilevel models."
2021 May	Canadian Astronomical Society (CASCA) AGM, NRC Herzberg/Online Lightning talk: "Molecular gas in a gravitationally lensed galaxy group at $z = 2.9$."
2021 Apr	Vancouver Area Cosmology Meeting, UBC/SFU/TRIUMF/Online "Molecular gas in gravitationally lensed galaxies at $z = 2.9$."
2020 Oct	REQUIEM Galaxies Telecon, Online "Molecular gas in gravitationally lensed galaxies at $z = 2.9$."

Posters

2023 Dec	Machine Learning and the Physical Sciences Workshop, NeurIPS 2023, New Orleans "Multiscale feature attribution for outlier detection models."
2023 Jan	241st Meeting of the American Astronomical Society, Seattle "Stellar parameters for 220m stars from <i>Gaia</i> DR3 BP/RP spectra."
2021 May	Canadian Astronomical Society (CASCA) AGM, NRC Herzberg/Online "Molecular gas in a gravitationally lensed galaxy group at $z = 2.9$."
2020 Aug	Summer Undergraduate Research Program Poster Session, UofT/Online "Molecular gas in a gravitationally lensed galaxy group at $z = 2.9$." Awarded best poster.

Software

7. Integrated Nested Laplace Approximation in Python. <https://pyinla.readthedocs.io/en/latest/>
6. Fast posterior sampling with JAX. <https://gaul.readthedocs.io/en/latest/>
5. Probabilistic random forest regression algorithm. <https://github.com/al-jshen/prfr>
4. Comprehensive scientific computing package for Rust: linear algebra, statistics, numerical optimization, generalized linear models, and more. github.com/al-jshen/compute
3. Zero-dependency automatic differentiation package for Rust. <https://github.com/al-jshen/reverse>
2. Fast and easy random number generation in Rust with Wyrand. <https://github.com/al-jshen/alea>
1. Parallelized ray tracer for realistic scene rendering. <https://github.com/al-jshen/traycer>

Technical Skills

JAX, Stan, Pytorch, SQL, R, C++, Rust, L^AT_EX, regex, bash, git, Docker, Javascript, React

Teaching

- 2023 **Teaching Assistant**, Princeton University
AST 255: Life in the Universe (astrobiology course for physics, chemistry, and biology students)
- 2015 - 2018 **Python Workshop Lead**, Sir Winston Churchill Secondary, Vancouver, B.C.
Coordinated and delivered workshops to prepare students for national programming contest.

Outreach

- 2019 - 2021 **Space Science Journalist (Current in Space segment)**, *The Star Spot* podcast
Curate, write and record stories about the latest research and news in astronomy. Episodes 177 - end of show.

Press

- 2021 Jul **National Radio Astronomy Organization (NRAO) eNews**
Digital newsletter feature: “Molecular gas in high redshift galaxies”. https://science.nrao.edu/enews/14.7/index.shtml#molecular_gas
- 2020 Jul **SURP Student of the Week Feature**
Interview: <https://www.dunlap.utoronto.ca/surp-sow/sow12020/>