XIAOSHENG ZHAO

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RESEARCH INTERESTS

My research focuses on using machine learning (ML) to advance astronomy–using ML to uncover the Milky Way's composition and evolutionary history, to probe the universe's origin and content, and to bridge these scales. As a member of the Subaru Prime Focus Spectrograph (PFS) JHU Galactic Archaeology group, I develop and apply ML methods, including foundation models, to stellar spectra for chemical abundance and radial velocity estimation, and to constrain the inner dark matter profiles of dwarf spheroidal galaxies, maximizing the scientific yield of PFS.

EDUCATION

Tsinghua University Sep 2018 - Jun 2024
PhD in Astronomy
Advisor: Prof. Yi Mao
Thesis title: Explore the epoch of reionization with machine learning

Wuhan University Sep 2014 - Jun 2018
BS in Physics

PROFESSIONAL POSITION

Johns Hopkins University Aug 2024 - Now
Postdoctoral Fellow, focus–maximizing science return from PFS
Mentor: Prof. Alex S. Szalay & Prof. Rosemary F.G. Wyse

RESEARCH EXPERIENCE

University of Chinese Academy of Sciences/NAOC Jul 2024 - Aug 2024
Short-term visiting, focus–stellar spectra foundation models.
Host: Prof. Yang Huang

Institut d'Astrophysique de Paris Nov 2022 - May 2024
Long-term visiting, focus–(explainable) ML for astrophysics and cosmology
Mentor: Prof. Benjamin D. Wandelt

PUBLICATION

Refereed (first & second author)

Ordered embeddings and intrinsic dimensionalities with information-ordered bottlenecks.
Matthew Ho; **Xiaosheng Zhao**; Benjamin D. Wandelt
2025, Machine Learning: Science and Technology (MLST)

Simulation-based Inference of Reionization Parameters from 3D Tomographic 21 cm Light-cone Images. II. Application of Solid Harmonic Wavelet Scattering Transform.
Xiaosheng Zhao; Yi Mao; Shifan Zuo; Benjamin D. Wandelt
2024, ApJ, 973, 41

Can Diffusion Model Conditionally Generate Astrophysical Images?
Xiaosheng Zhao; Yuan-Sen Ting; Kangning Diao; Yi Mao
2023, MNRAS, 526, 1699

Implicit Likelihood Inference of Reionization Parameters from the 21 cm Power Spectrum
Xiaosheng Zhao; Yi Mao; Benjamin D. Wandelt
2022, ApJ, 933, 236

Simulation-Based Inference of Reionization Parameters From 3D Tomographic 21 cm Lightcone Images.
Xiaosheng Zhao; Yi Mao; Cheng Cheng ; Benjamin D. Wandelt
2022, ApJ, 926, 151

Conference proceedings

Finetuning Stellar Spectra Foundation Models with LoRA
Xiaosheng Zhao; Yuan-Sen Ting; Alexander S. Szalay; Yang Huang
2025, ICML 2025 Workshop on Machine Learning for Astrophysics

3D ScatterNet: Inference from 21 cm Light-cones
Xiaosheng Zhao; Shifan Zuo; Yi Mao
2023, ICML 2023 Workshop on Machine Learning for Astrophysics

Evaluating Summary Statistics with Mutual Information for Cosmological Inference.
Ce Sui; **Xiaosheng Zhao**; Tao Jing; Yi Mao
2023, ICML 2023 Workshop on Machine Learning for Astrophysics

Under review

SpecCLIP: Aligning and Translating Spectroscopic Measurements for Stars.
Xiaosheng Zhao; Xiaosheng Zhao; Yang Huang; Guirong Xue; Xiao Kong; Jifeng Liu; Xiaoyu Tang; Timothy C. Beers; Yuan-Sen Ting; A-Li Luo
2025, Submitted to AAS Journals

Likelihood-free Model Selection in Cosmic Reionization with Three-dimensional Tomographic 21 cm Lightcone Images.
T Binnie; **Xiaosheng Zhao**; JR Pritchard; Yi Mao
2025, Submitted to AAS Journals

Square Kilometre Array Science Data Challenge 3a: foreground removal for an EoR experiment.
A. Bonaldi; ...; **Xiaosheng Zhao**; ...
2025, Submitted to MNRAS

TALKS & PRESENTATIONS (SELECTED)

ICML2025 ML4Astro Jul 2025
Spotlight talk: *Finetuning Stellar Spectra Foundation Models with LoRA* *Vancouver, Canada*

JHU/STScI CAS wine & cheese seminar Apr 2025
Seminars: *From 21 cm Astrophysics to Galactic Archaeology: Enriching Physics-Driven Analysis with Machine Learning* *JHU, USA*

Astro Coffee Sept 2023
Informal talk: *Can Diffusion Model Conditionally Generate Astrophysical Images?* *IAS, USA*

Understanding the epoch of reionization Mar 2023
Contributed talk: *Implicit Likelihood Inference of Reionization Parameters from 21 cm Power Spectrum and solid harmonic wavelet scattering coefficients* *Sexten, Italy*

SAZERAC 21cm 2022 Mar 2022
Contributed talk: *Implicit Likelihood Inference of Reionization Parameters from the 21 cm Power Spectrum* *Virtual*

SAZERAC SIP, learning the high-redshift universe Feb 2022
Contributed talk: *Simulation Based Inference of Reionization Parameters From 3D Tomographic 21 cm Lightcone Images* *Virtual*

SKA CD/EoR Science Telecon Jul 2021
Contributed talk: *Simulation Based Inference of Reionization Parameters From 3D Tomographic 21 cm Images* *Virtual*

HERA telecon Jun 2021
Invited talk: *Simulation Based Inference of Reionization Parameters From 3D Tomographic 21 cm Images* *UC, Berkeley, USA*

OUTREACH & SERVICE

Reviewer for MNRAS, A&A, JCAP, and RAA.

MENTORING & TEACHING EXPERIENCE

Teaching Assistant in undergraduate *Physics* course. Feb - Jun 2019

SKILLS

Coding languages: {Python, Jax} (Fluent), {C, Shell, html&CSS}(Basic)
General: Astrophyscal data science and machine learning application with Pytorch, Pandas, Scikit-learn, Tensorflow, particularly for astronomy.

AWARDS

Comprehensive Scholarship (First-class) 2021 - 2022
(*University-level scholarship)*
AMD Scholarship 2020 - 2021
(*Top scholarship awarded to two graduate students in the department this year)*
Future Scholar Scholarship of Tsinghua University 2018
(*University-level scholarship)*
National Scholarship 2015 - 2016