

# Anning Gao

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## RESEARCH INTERESTS

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1. Observational cosmology: redshift survey / lensing / CMB, BAO, Lyman- $\alpha$  forest, non-standard statistics
2. Medium physics: IGM & reionization, CGM & galaxy ecosystem, multiband observation (UV / radio / ...)
3. Galaxy physics: co-evolution with dark matter halo & SMBH, star formation activity, feedback from AGN & SN
4. Statistics & machine learning: Bayesian methods, neural network applications on observations & numerical simulations

## EDUCATION

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### Tsinghua University

*B.S. in Physics*

2020 - 2025

Beijing, China

- Thesis: Cosmology Constraints from Cosmic Void Size Function

### The Ohio State University

*Ph.D. in Astronomy*

2025 - Present

Columbus, Ohio, USA

- Advisor: Prof. Yuan-Sen Ting

## PUBLICATION

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**A. Gao**, J. X. Prochaska, et al., "Measuring the Mean Free Path of HI Ionizing Photons at  $3.2 \leq z \leq 4.6$  using DESI Y1 Quasars", 2025, *Astrophysical Journal Letters* 981 L27, [arXiv:2411.15838](https://arxiv.org/abs/2411.15838).

## RESEARCH EXPERIENCE

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### Measuring the Mean Free Path (MFP) of HI Ionizing Photons using DESI Data

Jul. 2023 - Sep. 2024

*Supervisor: Prof. Jason X. Prochaska (UC Santa Cruz)*

- Constructed the dataset from DESI Y1 QSO spectra, which is  $\sim 10$  times larger than previous datasets.
- Wrote the [package for MFP calculation](#) and measured the MFP at  $3.2 < z < 4.6$  with unprecedented precision
- Validated our result on the selection of quasar SED, the treatment of Lyman series opacity and the MFP definition.
- Confirmed that MFP evolves much slower than previous estimates with high confidence.
- Our result presents challenges to the current IGM absorber models and gives new constraints on the reionization history.

### Constraining the Cosmology with Void Size Function based on Delaunay Triangulation

Mar. 2024 - Present

*Supervisor: Prof. Cheng Zhao (Tsinghua University)*

- Constructed the void catalog from 40,000 Quijote halo catalogs with different cosmological parameters.
- Trained an AI-based emulator to predict the void size function under different cosmologies.
- Tested the emulator on Quijote and performed MCMC fitting for the cosmological parameters.
- **Future:** Improve the method to remove the severe systematics and apply the method to the BOSS galaxy catalog.

### High-redshift CGM OVI Absorption Analysis using DESI Data

Feb. 2023 - Feb. 2024

*Supervisor: Prof. Zheng Cai and Dr. Siwei Zou (Tsinghua University)*

- Fitted the continuum of  $\sim 15,000$   $z > 2.5$  DESI QSO spectra with a newly proposed unsupervised machine learning method.
- Visually inspected  $\sim 2000$  spectra to find DLA-related OVI absorption features, found  $\sim 30$  OVI absorption candidates and fitted the Voigt profile to extract column densities and the Doppler parameter.
- Statistically analysed the OVI absorption sample to find the properties of high- $z$  warm-phase CGM.
- Performed simulations using Cloudy to get ionization parameters and hydrogen number densities that cannot be directly observed.

SCIENTIFIC TALKS

<b>Measuring the Mean Free Path of HI Ionizing Photons using DESI Data</b> · Oral Presentation, 2024 DESI Summer Meeting, Marseille, France	Jul. 2024
<b>Introduction to Normalizing Flow</b> · Machine Learning Seminar, Department of Astronomy, Tsinghua University	May. 2024
<b>Measuring the Mean Free Path of HI Ionizing Photons using DESI Data</b> · Oral Presentation, 2023 PKU Undergraduate Astronomy Symposium, Beijing, China	Sep. 2023

SKILLS

**Skilled in:** Python, C/C++, Mathematica, Shell/Bash,  $\LaTeX$ , Git.

**Experienced with:**

- Packages & softwares for IGM and absorption analysis: Cloudy, VoigtFit, Pyigm, Linetools
- Manipulating catalogs, analyzing dataset and visualization
- Machine learning and building neural network models: normalizing flow, operator learning, ...
- Statistical analysis: MCMC sampling, Bayesian inference, nonparametric methods, ...

SCHOLARSHIPS AND AWARDS

Scholarship of the National Astronomical Observatory of China	2024
Lin-bridge Scholarship, Department of Astronomy, Peking University	2023
Chi-Sun Yeh Scholarship, Member of the Tsinghua Xuetang Talents Program	2021, 2022, 2023
Scholarship for Academic Excellence, Department of Physics, Tsinghua University	2021, 2022, 2024
University Fellowship, The Ohio State University	2025