YIQI (ANDREW) LIU

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EDUCATION

Princeton University — Princeton, NJ
Ph.D. in Physics — *(Expected) 2029*
M.A. in Physics — *Jan 2025*

- Research interests:
  Statistical Inference · Monte Carlo Methods · Machine Learning · Simulation-Based Inference
  Cosmic Microwave Background · Component Separation · Galactic Foregrounds
- Advisor: Jo Dunkley

Johns Hopkins University — Baltimore, MD
B.S. in Applied Mathematics & Statistics, Physics, and Mathematics — *May 2023*

- GPA: 3.99/4.00 (General Honors & Departmental Honors in all majors)
- Minor: Computer Science

RESEARCH EXPERIENCES

Graduate Researcher | *Simons Observatory (SO)* — Princeton, NJ | 2023 – Present
Mentors: Jo Dunkley, Susanna Azzoni

- Led a first-author study of model misspecification in cosmological inference using cross-spectrum component separation and realistic simulation ensembles.
- Developed regression and template-fitting estimators for multi-frequency polarization data, including weighted cross-template fits, harmonic filtering, and Monte Carlo uncertainty propagation.
- Designed Bayesian/MCMC and simulation analyses to quantify estimator bias, uncertainty, covariance, chance correlations, and robustness under foreground model misspecification.
- Built SO×Planck cross-correlation and calibration pipelines to validate instrument performance and foreground measurements against independent data.

Undergraduate Researcher | *Cosmology Large Angular Scale Surveyor* — Baltimore, MD | 2019 – 2023
Mentors: Charles L. Bennett, Tobias A. Marriage, Ivan L. Padilla

- Implemented and optimized a needlet-domain minimum-variance estimator for multi-frequency signal decomposition.
- Developed foreground masking and Fourier-space point-source detection methods and benchmarked estimator performance across frequency bands.
- Built Python diagnostics for temporal anomaly detection in observational time-series data using rolling-dispersion statistics.

Undergraduate Researcher | *Zakamska Astrophysics Group* — Baltimore, MD | 2021 – 2023
Mentors: Nadia L. Zakamska, Hsiang-Chih Hwang

- First-authored a peer-reviewed study modeling a compact binary system using spectral decomposition and time-series fitting.
- Developed automated Python pipelines for photometric and spectroscopic feature extraction in the time and frequency domains.

SELECTED TECHNICAL PROJECTS

Benchmarking Scientific Reasoning in AI Agents | *Terminal-Bench-Science* — 2026 – Present

- Design executable scientific tasks that test whether AI agents construct models that generalize beyond visible evaluation constraints.

- Authored a CMB inference benchmark targeting model misspecification and restrictive assumptions that can remain statistically adequate on observed data while failing under hidden evaluation conditions.
- Review astronomy and physics tasks for scientific validity, difficulty, verifier robustness, reproducibility, and potential shortcut solutions.

Representation Learning and Simulation-Based Inference for Cosmology 2026 – Present

- Developing VICReg-based self-supervised representations of simulated CMB observations for downstream inference of the tensor-to-scalar ratio r.
- Investigating learned low-dimensional summaries that retain cosmological parameter information while remaining robust to foreground and observational variation.
- Exploring simulation-based inference for likelihood-free posterior estimation using learned representations.

Reinforcement Learning for Sequential Auto-Bidding Spring 2026

- Developed PPO agents for sequential decision making in a replay-based auction environment subject to budget and cost-per-action constraints.
- Extended the policy with temporal observation stacking and recurrent representations to capture nonstationary market dynamics and long-horizon dependencies.
- Evaluated reward shaping, market-state features, and alternative policy architectures through controlled experiments and ablations.

Transformer Inference Systems Benchmarking Spring 2026

- Designed controlled experiments to study the compute–memory tradeoff of KV caching in decoder-only transformers across prompt and generation lengths.
- Benchmarked decoding throughput, end-to-end latency, cache footprint, and GPU memory behavior under cached and non-cached inference.
- Characterized cache-memory scaling, prefix reuse, CUDA allocator behavior, and performance degradation under CPU–GPU memory offloading.

SELECTED PUBLICATIONS

See NASA ADS and Google Scholar for the full list of publications.

Yiqi Liu et al.

The Simons Observatory: Assessing the Impact of Dust Complexity on the Recovery of Primordial B-modes
Published in *JCAP* (2025), DOI: 10.1088/1475-7516/2025/11/024

Yiqi Liu, Hsiang-Chih Hwang, Nadia L. Zakamska, John R. Thostensen

CSS1603+19: a low-mass polar at the cataclysmic variable period minimum
Published in *MNRAS* (2023), DOI: 10.1093/mnras/stad1156

SELECTED AWARDS

2023	Donald E. Kerr Memorial Award *JHU, top 2 graduating seniors majoring in physics*
2023	Applied Math & Statistics Achievement Award *JHU, top 6 graduating seniors majoring in applied math & statistics*
2022	ΣΠΣ Physics Honors Society
2022	Provost's Undergraduate Research Award *JHU, $6,000 in funded research support*
2020–2021	Bloomberg Distinguished Professor Research Fellowship ×2 *JHU, $10,000 in funded research support*
2020–2022	Dean's List

SELECTED PRESENTATIONS

Invited Talks

2025 Oct "The impact of dust complexity on the recovery of r"
Pan-Experiment Galactic Science Group — *Los Angeles, CA*

2025 July "From the Impact of Dust Complexity to Beyond"
2025 Simons Observatory Collaboration Meeting — *Philadelphia, PA*

2024 July "Understanding the impact of dust complexity on bias in r"
2024 Simons Observatory Collaboration Meeting — *Chicago, IL*

Oral Presentations

2026 Mar "Simons Observatory: Assessing and Modeling Foreground Complexity in CMB Analyses"
2026 American Physical Society Global Physics Summit — *Denver, CO*

2025 June "Understanding the impact of dust complexity on the recovery of the tensor-to-scalar ratio"
246th Meeting of the American Astronomical Society — *Anchorage, AK*

Posters

2023 Mar "CMB analysis using the global-NILC method"
2023 American Physical Society March Meeting — *Las Vegas, NV*

2023 Jan "CSS1603+19: a low-mass polar at the cataclysmic variable period minimum"
241st Meeting of the American Astronomical Society — *Seattle, WA*

TEACHING

2023 Spring — Teaching Assistant, EN.553.430/630 Intro to Statistics (Undergraduate/Graduate, 82 students)
Graduate-level introductory statistics course covering stochastic convergence, point estimation, hypothesis testing, and interval estimation.

2022 Fall — Teaching Assistant, EN.553.633 Monte Carlo Method (Graduate, 60 students)
Graduate-level course covering pseudorandom number generators and classical Monte Carlo algorithms including Metropolis–Hastings.

2020/2022 Fall — Teaching Assistant, AS.171.103 General Physics I (Undergraduate, 23 students, 2 semesters)
Undergraduate introductory course in classical mechanics.

SKILLS

Programming: Python (NumPy, SciPy, Pandas, PyTorch, scikit-learn), C++, C, SQL, Bash, Mathematica

Statistics & Machine Learning: Bayesian Inference, MCMC, Monte Carlo Methods, Regression, Covariance Estimation, Time-Series and Spectral Analysis, Reinforcement Learning, Representation Learning, Simulation-Based Inference

Computing: High-Performance Computing (Slurm), Git, JupyterLab, LaTeX

Languages: English (fluent), Mandarin (native)