

Tianji Zhou

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Education

Haverford College

BS. Physics and Astronomy, Scientific Computing Concentration

Sep 2022 - Present

Haverford, PA

- **GPA:** 3.989/4.000
- **Thesis Advisor:** Prof. Daniel Grin
- **Advanced Coursework:** General Relativity (Haverford, ASTR H325), Cosmological Physics (Swarthmore, PHYS S137), Observational Astronomy (Haverford, ASTR H341), Advanced Quantum Mechanics (Haverford, PHYS H302), Thermodynamics and the Introduction to Statistical Mechanics and Kinetic Theory (UPenn, PHYS P4401), Advanced Classical Mechanics (Bryn Mawr, PHYS B308), Advanced Electromagnetism (Haverford, PHYS H309), Astroparticle Physics (Haverford, PHYS H356), Differential Geometry (Haverford, MATH H337), and Probabilistic Models and Methods (Haverford, MATH H397)
- **Graduate Coursework:** Solid State Physics (Bryn Mawr, PHYS B522)
- **Graduate Level Topics Covered Under Research Credit/Independent Study:** The Expansion Rate and Growth of Structure Puzzles (Instructed by Prof. Bhuvnesh Jain, Supervised by Prof. Daniel Grin)

Publications

[1] **Uncertainty Quantification for the Relativistic Inverse Stellar Structure Problem**, Mar 2025

Lindblom, Lee & *Zhou, Tianji*

Physical Review D, 111, 063024

[2] **Chebyshev Based Spectral Representations of Neutron-Star Equations of State**, Oct 2024

Lindblom, Lee & *Zhou, Tianji*

Physical Review D, 110, 083030

Research Experience

Visiting Undergraduate Researcher

Under Mentorship of Dr. Nanoom Lee, Prof. Marc Kamionkowski's Group, William H. Miller III Department of Physics and Astronomy, Johns Hopkins University

Jun 2025 - Present

Baltimore, MD

Resolving Hubble Tension with Modification to Scale-/Time-Dependent Physics

- Developed and implemented simplified data-driven method for introducing minimal, scale-/time-dependent modifications to primordial power spectrum/electron mass to address Hubble tension.
- Integrated additional datasets—including ACT CMB power spectra, ACT lensing, and DESI Baryon Acoustic Oscillation (BAO)—to tighten cosmological constraints.
- Computed cosmology with Cosmic Linear Anisotropy Solving System (CLASS) code.

Undergraduate Researcher

Prof. Daniel Grin's Group, Department of Physics and Astronomy, Haverford College

May 2023 - Present

Haverford, PA

Model Independent Probes of Dark Sector Physics

- Developed method to constrain dark matter models using principal component analysis (PCA) and generalized dark matter (GDM) framework.
- Selected Wess-Zumino Dark Radiation model and Chameleon Early Dark Energy model as benchmarks.
- Computed equations of state and effective sound speeds of dark sectors to model GDM fluids through CLASS.
- Projected equations of state and effective sound speeds onto principal components of cosmological dark fluid.
- Inferred model constraints via Fisher matrix and PCA and compared against both traditional Fisher inference ("fishchips") method and Markov Chain Monte Carlo (MCMC) approach.

Visiting Undergraduate Researcher

Dr. Lee Lindblom's Group, Department of Physics, University of California at San Diego

Jun 2024 - Oct 2024

La Jolla, CA

Chebyshev-Based Spectral Representations of Neutron-Star Equations of State (See Publication [2])

- Developed causal parametric representations of neutron-star equations of state using Chebyshev polynomial-based spectral expansions, including both pressure-based and enthalpy-based representations.
- Implemented enthalpy-based and pressure-based representations in Python to represent equation of state.
- Optimized spectral parameters and calculated modeling errors using the Levenberg–Marquardt algorithm for first-order and second-order phase transition equations of state.
- Demonstrated that Chebyshev polynomial representations exhibit faster convergence in modeling errors compared to simple power-law representations.

Uncertainty Quantification for Relativistic Inverse Stellar Structure Problem (See Publication [1])

- Numerically solved Oppenheimer–Volkoff equations to compute mass and radius data of neutron stars from a specified equation of state.
- Utilized the Levenberg–Marquardt algorithm to determine optimal Chebyshev-based spectral parameters and central pressures based on generated data.
- Introduced 20%, 10%, 1%, and 0.1% noise to mass and radius data, recalculated optimal spectral parameters and central pressure, and analyzed resulting modeling errors.

Specialized Training and Summer Schools

Perimeter Scholars International (PSI) Start Satellite Program, Bishop's University, May 2025

- Topics: Path Integrals, Quantum Information and Thermodynamics, Numerical Methods and Condensed Matter Physics, and Symmetries

ACT + SPT CMB Analysis Summer School, The University of Chicago, Jul 2024

Conferences and Talks

KINSC Undergraduate Science Research Symposium, Haverford College, Sep 2025

- Poster Titled: Resolving the Hubble Tension via Scale-Dependent Physics

Undergraduate Cosmology Workshop, Massachusetts Institute of Technology, Jul 2025

- Presentation Titled: Resolving the Hubble Tension via Scale-Dependent Physics

APS Global Physics Summit 2025, American Physical Society, Mar 2025

- Presentation Titled: Uncertainty Quantification for the Relativistic Inverse Stellar Structure Problem

Start Talking Science, Science History Institute, Nov 2024

- Poster Titled: Chebyshev Based Spectral Representations of Neutron-Star Equations of State

Keck Northeast Astronomy Consortium, Colgate University, Sep 2024

- Presentation Titled: Uncertainty Quantification for the Relativistic Inverse Stellar Structure Problem

Undergraduate Cosmology Workshop, Massachusetts Institute of Technology, Jul 2024

- Presentation Titled: Model-independent Probes of Dark Sector Physics

APS April Meeting, American Physical Society, Apr 2024

- Poster Titled: Model-independent Probes of Dark Sector Physics

Keck Northeast Astronomy Consortium, Wesleyan University, Oct 2023

- Presentation Titled: The Behavior of The Equation of State and The Sound Speed for The Dark Matter Fluid of The Wess-Zumino Dark Radiation Model

KINSC Undergraduate Science Research Symposium, Haverford College, Sep 2023

- Poster Titled: The Behavior of The Equation of State and The Sound Speed for The Dark Matter Fluid of The Wess-Zumino Dark Radiation Model

Work Experience and Service

IDEA Seminar Student Organizer

Sep 2022 - Present

Department of Physics and Astronomy, Haverford College

Haverford, PA

- Organized and hosted department-wide Cosmology Colloquium, coordinating agenda and logistics as local host, attracting over 50 attendees.
- Led student-faculty panels on Inclusion, Diversity, Equity, and Accessibility (IDEA), inviting guest speakers and engaging more than 40 participants across the department.
- Designed and analyzed a departmental climate survey, presenting findings and actionable recommendations to faculty and students.
- Hosted community-building events such as movie nights, nitrogen ice cream socials, and dinner gatherings to strengthen departmental connection.

Teaching Assistant and Grader

Sep 2023 - Present

Department of Physics and Astronomy, Haverford College

Haverford, PA

- Served as TA and grader for General Relativity, Waves and Optics, and Introductory Quantum Mechanics.
- Held weekly office hours to support students' understanding of course material and problem-solving techniques.
- Graded weekly written homework assignments and provided feedback to enhance learning outcomes.
- Guided students through questions in flipped-classroom settings to promote active learning.

Secretary of Society of Physics Students

Sep 2022 - May 2024

Department of Physics and Astronomy, Haverford College

Haverford, PA

- Compiled and distributed weekly meeting summaries to enhance communication and coordination across the organization.
- Organized series of community-building events—including movie nights, REU Q&A session, and physics social—to foster engagement and share academic and career insights.

Skills

Language: English (Fluent), Mandarin (Native), Shanghainese (Native), Cantonese (Elementary)

Software: Python, Mathematica, \LaTeX , Linux, HTML, MATLAB