Tianji Zhou

370 Lancaster Ave, Haverford, PA 19041 | jzhou@haverford.edu | +1 (484)-253-8449

Education

Haverford College Sep 2022 - Present
BS. Physics and Astronomy, Scientific Computing Concentration Haverford, PA

- **GPA**: 3.99/4.00
- **Advanced Coursework:** General Relativity (Haverford, ASTR H325), Cosmological Physics (Swarthmore, PHYS S137), 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 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

Uncertainty Quantification for the Relativistic Inverse Stellar Structure Problem, Mar 2025
Lindblom, Lee & ***Zhou, Tianji***
Physical Review D, 111, 063024

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 Jun 2025 - Present
Under Mentorship of Dr. Nanoom Lee, Prof. Marc Kamionkowski's Lab, Department of Physics and Astronomy, The Johns Hopkins University Baltimore, MD

Solving Hubble Tension with Time/Scale-dependent Modification

- Improved the method to modify time/scale-dependent physical quantities with respect to time/scale to solve the Hubble tension by generalizing the assumptions.
- Included new datasets like cosmic microwave background lensing to constrain the modification of physical quantities.
- Computed the cosmology with the Cosmic Linear Anisotropy Solving System (CLASS) code.

Undergraduate Researcher May 2023 - Present
Prof. Daniel Grin's Lab, Department of Physics and Astronomy, Haverford College Haverford, PA

Model Independent Probes of Dark Sector Physics

- Developed a method to constrain dark matter models using principal component analysis (PCA) and the generalized dark matter (GDM) framework.
- Selected the Wess-Zumino Dark Radiation model and the Chameleon Early Dark Energy model as benchmarks, and derived expressions for the equations of state and effective sound speeds of dark sectors to describe the GDM fluids.
- Computed the equations of state and effective sound speeds using the Cosmic Linear Anisotropy Solving System (CLASS) code.
- Projected equations of state and effective sound speeds onto the principal components of the cosmological dark fluid;
- Inferred model constraints via Fisher matrix and PCA, and compared them against both the traditional Fisher

inference ("fishchips") method and Markov Chain Monte Carlo (MCMC) approach.

Visiting Undergraduate Researcher Jun 2024 - Oct 2024
Dr. Lee Lindblom's Lab, Department of Physics, University of California at San Diego La Jolla, CA

Chebyshev-Based Spectral Representations of Neutron-Star Equations of State

- 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 the 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 the Relativistic Inverse Stellar Structure Problem

- Numerically solved the 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 the generated data.
- Introduced 20%, 10%, 1% and 0.1% noise to the mass and radius data, recalculated the optimal spectral parameters and central pressure, and analyzed the resulting modeling errors.

Conferences and Additional Education

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

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

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

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

Keck Northeast Astronomy Consortium, Wellesley College, Oct 2022

Work Experience and Service

IDEA Seminar Student Organizer Sep 2022 - Present
Department of Physics and Astronomy, Haverford College Haverford, PA

- Invited an inspiring funding speaker to give a cosmology colloquium at Haverford College, arranged the agenda, and served as the local host, reaching over 50 attendees in the department.
- Organized student-led seminars, inviting speakers to raise awareness of Inclusion, Diversity, Equity, and Accessibility (IDEA) issues, reaching over 40 attendees in the department.
- Conducted a climate survey to identify potential IDEA issues within the department, analyzed climate survey data using Excel, summarized findings, provided recommendations for future surveys and departmental improvements, and presented at the department members' meeting.
- Hosted five movie nights for 50 students in total, fostering discussion around IDEA topics.
- Organized two art-expression events for 15 students in total to explore physics identity through creative mediums.

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 facilitate collaboration within the organization.
- Spearheaded the planning and execution of two successful movie nights, fostering a sense of community among over 30 physics students.
- Led the coordination of an REU (Research Experience for Undergraduates) Q&A session, providing valuable insights and networking opportunities for more than 20 aspiring researchers.
- Organized a physics social event, strengthening peer relationships and engagement among over 10 students.

Teaching Assistant and Grader for PHYS H214B Jan 2024 - May 2024
Department of Physics and Astronomy, Haverford College Haverford, PA

- Assisted in teaching and grading for 28 students in the Introductory Quantum Mechanics course.
- Held weekly office hours for 1.5 hours to assist students with coursework.
- Graded written homework assignments for 6 hours each week.

Teaching Assistant and Grader for PHYS H213A Sep 2023 - Dec 2023
Department of Physics and Astronomy, Haverford College Haverford, PA

- Assisted in teaching and grading for 29 students in the Waves and Optics course.
- Conducted weekly TA sessions for 2 hours, providing homework and Mathematica assistance.
- Graded written homework assignments for 5 hours each week.

Awards and Grants

Haverford KINSC Summer Scholars, Mar 2025
Haverford College, Amount: $5300

Haverford KINSC Conference Funding, Mar 2025
Haverford College, Amount: $1500

Haverford KINSC Workshop Funding, Jul 2024
Haverford College, Amount: $1500

Haverford KINSC Conference Funding, Apr 2024
Haverford College, Amount: $1500

Haverford KINSC Summer Scholars, Mar 2024
Haverford College, Amount: $5000

Haverford KINSC Summer Scholars, Mar 2023
Haverford College, Amount: $4600

Skills

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

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