Tianji Zhou

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Education

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

- **GPA**: 3.983/4.0
- **Advanced Coursework:** Topics in Cosmology: The Expansion Rate or Growth of Structure Puzzles & Deep Learning in Astrophysics (UPenn), General Relativity (Haverford), Cosmological Physics (Swarthmore), Advanced Classical Mechanics (Bryn Mawr), Advanced Electromagnetism (Haverford), and Astroparticle Physics (Haverford)

Research Experience

Visiting Undergraduate Researcher Jun 2024 - Present
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 solve 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.

Influence of Data Noise on Spectral Representation in 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 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.

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 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 constrain the GDM fluids.
- Computed the equations of state and effective sound speeds using the Cosmic Linear Anisotropy Solving System (CLASS) code.
- Projected the equation of state and effective sound speed onto the principal components of the cosmological dark fluid.

Work Experience and Service

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

- 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 survey data using Excel, summarized findings, and provided recommendations for future surveys and departmental improvements.

Secretary of Society of Physics Students Sep 2022 - Present
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.

Publications

Chebyshev Based Spectral Representations of Neutron-Star Equations of State Aug 2024
Lindblom, Lee & ***Zhou, Tianji***
Submitted to Physical Review D

Awards and Grants

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

Conferences and Additional Education

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

Skills

Language: English (Fluent), Chinese (Native), Shanghainese (Native), Latin (Elementary)

Software: Python, Mathematica, LaTeX, Linux

Package: NumPy, SciPy, Matplotlib, Pandas