Jui-Teng (Roy) Hsu

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Research Statement

My research interests lie at the intersection of computational and theoretical astrophysics. I am currently investigating gas interactions in the intracluster medium by numerically modeling plasma flows. Through understanding fundamental plasma processes, I aim to extend these methods to high-energy environments, such as accretion flows around compact objects.

Education

University of Massachusetts Amherst, Amherst, Massachusetts — Sep. 2025 - Present
Doctor of Philosophy in Astronomy, in progress, GPA: 4.00/4.00

Muhlenberg College, Allentown, Pennsylvania — May 2024
Bachelor of Science in Physics and Computer Science

Research Experiences

Probing Cluster Plasma Physics with Simulations of Jellyfish Tails — Aug. 2025 - Present
University of Massachusetts Amherst - Initial Research Project
Advisor: Dr. Yuan Li

- Investigating the turbulent mixing processes between intracluster medium (ICM) and interstellar medium (ISM) in jellyfish galaxy tails driven by Kelvin-Helmholtz Instability (KHI)
- Studying key physical processes, including viscosity, conduction, magnetic fields, and radiative cooling, by extending the Enzo-E astrophysical simulation code
- Utilizing high-performance computing (HPC) resources to run large-scale magnetohydrodynamic (MHD) zoomed-in simulations of jellyfish galaxies in cluster environments
- Contributing to the open source Enzo-E codebase by implementing new physics modules
- Analyzing simulation data using Python (numpy, scipy, matplotlib) and yt

Zeeman Spectral Modeling Code Repository — Jun. 2023 - Aug. 2023
National Radio Astronomy Observatory Summer Research Assistantship
Advisor: Dr. Preshanth Jagannathan (NRAO)

- Assessed the efficacy of Zeeman spectral line modeling with frequentist and Bayesian approaches
- Created a Python package and implemented Markov Chain Monte Carlo (MCMC) sampling methods for automated, unsupervised Zeeman spectral modeling
- Optimized the software deployment on HPC clusters through parallelization
- Validated software reliability by outperforming published results in VLA Zeeman data tests

Atmospheric Muon Rates Code Repository & Detector Report — Jun. 2022 - May 2023
Muhlenberg College Physics Capstone Project
Mentored by Dr. Brett Fadem (Muhlenberg)

- Developed, from scratch in C++, numerical simulation models of atmospheric cosmic ray muons, incorporating relevant physical processes (e.g., relativity, decay, and energy loss)
- Built a functioning muon telescope using scintillators and SiPMs to detect muons, integrating circuit design and signal processing techniques
- Utilized Arduino and Python (numpy, scipy, matplotlib) for data collection, analysis, and fitting observed muon rates to theoretical distributions (Poisson and $\cos^2\theta$ distributions)

Awards and Honors

Dr. Robert A. Boyer Prize in Physics   2024

Presidential Scholarship ($30,000/year)   2022-2024

Supercomputing Awards

PI on "Probing Cluster Plasma Physics with Simulations of Jellyfish Tails"
NSF ACCESS. Proposal ID: PHY240275. Award: 400,000 ACCESS credits
Start Date: 2024-10-09. End Date: 2026-04-09.

Publications & Conference Presentations

"Zeeman Spectral Line Modeling"

243rd Meeting of the American Astronomical Society   Jan. 2024
Published in *Research Notes of the AAS*, DOI: [10.3847/2515-5172/ad9c6c](10.3847/2515-5172/ad9c6c)   Dec. 2024

"Computational Simulation of Atmospheric Muon Rates"

Fall Meeting of the Division of Nuclear Physics, American Physical Society (APS)   Oct. 2022

Skills

- Programming languages: Python, C/C++, Bash, Java
- OS & Software: Linux, LaTeX, Git/Github, Athena++, Mathematica

Relevant Coursework

Physics & Astronomy (* indicates Graduate Level)
Computational Methods*, Radiative Processes*, Electromagnetism*, Statistical Mechanics*, Stellar Physics*, Interstellar Medium*, Quantum Mechanics, Analytical Mechanics

Computer Science & Mathematics
Operating Systems, Computer Architecture, Data Structures & Algorithms, Real Analysis, Linear Algebra, C Programming

Teaching Experience

Teaching Assistant, University of North Texas   Sep. 2024 - Jan. 2025

- Prepare and conduct lectures on introductory astronomy labs for undergraduate students enrolled in PHYS 1052 - The Solar System and PHYS 1062 - Stars and the Universe

Workshop Tutor, Muhlenberg College   Sep. 2022 - May. 2024

- Organize the general computer science workshops for students enrolled in CS courses ranging from introductory to advanced levels including CS 2, Data Structures & Algorithms, and AI.

References

- Dr. Yuan Li   Email: yuanli@umass.edu
  Assistant Professor, Department of Astronomy, University of Massachusetts Amherst

- Dr. Preshanth Jagannathan   Email: pjaganna@nrao.edu
  Associate Scientist, National Radio Astronomy Observatory

- Dr. Brett Fadem   Email: brettfadem@muhlenberg.edu
  Professor, Department of Physics, Muhlenberg College

- Dr. Jorge Silveyra   Email: silveyrj@lafayette.edu
  Assistant Professor, Department of Computer Science, Lafayette College