Tucker Capps
Curriculum Vitae

capps@ou.edu | LinkedIn | Research Website | GitHub

Education

The University of Oklahoma, Norman, Oklahoma

Doctor of Philosophy, Astrophysics (**Qualifier Passed:** Jan 2025)	**May 2030**
Master of Science, Data Science and Analytics	**August 2025**
Bachelor of Science, Astrophysics, *Special Distinction*	**May 2023**
Bachelor of Arts, Mathematics, *Special Distinction*	**May 2023**

Research Experience

Doctoral Research, Dr. Michael Hayden   **August 2024 - Current**

The University of Oklahoma, Homer L. Dodge Department of Physics and Astronomy

Investigation of Stellar Migration in the Galactic Disk Using High Resolution Simulations

- Investigating stellar migration in non-axisymmetric galactic potentials to understand radial mixing and its influence on the chemical and kinematic evolution of disk galaxies.
- Developing and applying N-body simulations coupled with adaptive mesh refinement (AMR) methods to model gas dynamics and star–gas interactions at high spatial resolution.
- Expanding expertise in high-performance computing (HPC) environments, including parallelization strategies, code profiling, and optimization for large-scale astrophysical simulations.
- Exploring numerical methods for solving partial differential equations (PDEs) relevant to galactic dynamics and gas flows, emphasizing scalability and computational efficiency.
- Integrating multi-physics approaches to investigate the interplay between gravitational dynamics, hydrodynamics, and chemical enrichment in disk galaxies.
- Abstract accepted for presentation at the 2026 Winter Meeting of the American Astronomical Society, highlighting recent results on radial migration and chemo-dynamical evolution in simulated galactic disks.

Master's Thesis, Dr. Michael Hayden   **August 2024 - July 2025**

The University of Oklahoma, Gallogly College of Engineering

Predicting Stellar Ages from Chemical Abundances with XGBoost

- Developed a machine learning framework using XGBoost to predict stellar ages from chemical abundances derived from large spectroscopic surveys (e.g., GALAH DR4), enabling data-driven insights into galactic evolution.
- Implemented rigorous feature selection and hyperparameter optimization strategies to improve prediction accuracy and model interpretability, including cross-validation and residual analysis.
- Conducted in-depth analysis of chemical abundance importance and correlations to understand the astrophysical processes influencing stellar age distributions.
- Integrated Bayesian isochrone fitting techniques for ground-truth age estimation of training samples, combining traditional astrophysical methods with modern data science.
- Leveraged high-performance computing resources to handle large-scale datasets (400,000 stars), demonstrating strong skills in data pipeline development.

NASA OSTEM Internship, Dr. Irina Kitiashvili   **June 2024 - August 2024**

NASA Ames Research Center, NASA Advanced Supercomuting Division

Acoustic Power Mapping and Magnetic Field Prediction in Solar Active Regions

- Analyzed solar active regions to compute acoustic power maps, contributing to improved understanding of helioseismic signatures and potential flare precursors.
- Processed and interpreted large observational datasets using Fast Fourier Transform and advanced data analysis pipelines, enhancing skills in statistical methods and signal processing.
- Gained hands-on experience with the Pleiades high-performance computing environment and large-scale data assimilation techniques.
- Developed and implemented a random forest regression model to predict magnetic field magnitudes from acoustic power data, integrating machine learning methods into solar physics analysis.
- Presented findings to NASA mentors and researchers, further developing scientific presentation and technical writing abilities.

Undergraduate Capstone Research, Dr. Xinyu Dai   **May 2021 - May 2023**

The University of Oklahoma, Homer L. Dodge Department of Physics and Astronomy

Exploration of Microlensing Magnification Maps of RX J1131-1231

- Created Python scripts to alter input files for a Reverse Polygon Mapping simulation program run on the OSCER supercomputer, improving my ability to utilize high-performance computing resources.
- Consolidated output data into matrix form, convolved with smoothing and sharpening kernels, and applied thresholding to highlight microlensing caustics, reinforcing my knowledge of linear algebra and its applications to scientific image processing.
- Determined caustic density by convolving the image with source kernels that varied in size to account for finite source size effects, enhancing my proficiency in statistical analysis and the underlying physics.
- Presented the project methods and findings in an academic setting, honing my skills in effective communication.
- Gained a tremendous amount of understanding in microlensing, high-performance computing, and computational astrophysics methodologies.

Teaching Experience

Graduate Teaching Assistant   **August 2024 - Current**

The University of Oklahoma, Homer L. Dodge Department of Physics and Astronomy

- Designed and delivered lectures for undergraduate astronomy lab courses, guiding students through observational techniques and foundational astrophysics concepts.
- Taught students to operate telescopes and astronomical instrumentation, including hands-on sessions in object finding, data acquisition, and observational planning.
- Instructed students in the use of astronomical software for data analysis and visualization, enhancing technical proficiency and scientific rigor.
- Contributed to the reform and rewriting of laboratory curriculum materials to improve clarity, engagement, and educational outcomes.
- Mentored students in scientific writing and presentation, promoting strong communication skills and critical thinking.

Physics Peer Learning Assistant   **August 2021 - March 2023**

The University of Oklahoma, Student Learning Center

- Tutored and mentored students, in sections of 20+ students, enrolled in Physics I & Physics II courses required by their degree program, including engineering, health sciences, and physics major students.
- Utilized Socratic questioning to effectively aid students in finding their weak points and guide them in such a way that they could come to an answer by themselves.
- Prepared mini-lectures for large tutoring sessions that occurred before exams.
- Regularly involved students in their own learning by allowing them to explain their understanding and assess their own progress, practice active participation to avoid receiving an answer without any understanding, and teach me utilizing the Feynman technique.

- Provided concrete comparisons and demonstrations that allowed students to relate the subject material to things they already knew.

Community Leadership

Engineer **August 2024 - Current**

The University of Oklahoma, Lunar Sooners Astronomy Outreach

- Maintain and manage astronomical equipment, including telescopes, mounts, and associated electronics, ensuring readiness for public outreach events.
- Plan and execute weekly star parties, facilitating hands-on observing experiences for students and community members.
- Engage diverse audiences at schools, museums, and libraries, providing educational programming and promoting science literacy. More than 600 shool-aged students have been reached in Fall 2025 alone.
- Support event logistics and safety, and assist with setup, troubleshooting, and technical demonstrations.
- Collaborate with co-executives to expand outreach opportunities and improve community impact.

Outreach Coordinator **August 2021 - May 2023**

The University of Oklahoma, Society of Physics Students

- Helped plan and execute bi-monthly meetings, ensuring engaging content and consistent member participation.
- Led a comprehensive CV writing workshop, offering students essential tools and guidance for showcasing their academic and professional accomplishments.
- Collaborated in conducting a Python coding seminar, empowering peers with essential programming skills relevant to modern physics research.
- Championed environmental responsibility through community service activities alongside colleagues, strengthening camaraderie among Society members.
- Created a safe, inviting space for physics and astronomy undergraduate students to congregate, reinforcing community in the department.

Honors and Awards

Meritorious Scholarship in Physics and Astronomy	**2021-2023**
Marvin Martin Mueller Scholarship, $2,000	**2022-2023**
Michael Ruby History of Physics Scholarship, $2,000	**2021-2022**

Technical Skills

- **Programming & Scripting:** Python (astropy, pandas, numpy, matplotlib, scipy, scikitlearn, tensorflow, keras, pytorch, pyspark), R, Java, C++, SQL, LaTeX
- **Simulation & Modeling:** High-performance computing (parallelization, MPI, OpenMP basics), N-body simulations, adaptive mesh refinement (AMR), numerical solutions to PDEs
- **Machine Learning & Data Science:** XGBoost, random forest, scikit-learn, deep learning frameworks, feature selection and model tuning, large-scale data pipeline development, statistical analysis

References Available Upon Request