Yufeng Luo

1000 E. University Ave., Dept 3905, Laramie, WY, 82071, USA

✉ yluo4@uwyo.edu ⋄ ⓖ [Brookluo](#)

RESEARCH INTEREST

My research interests include two general directions: Computational & data-driven astrophysics and High-Performance Computing. I am interested in exploring the physics of quasars and galaxy evolution using advanced computational techniques, such as machine learning. I would also like to study compact objects, such as black holes and neutron stars through simulations. I am particularly interested in applying HPC to improve and innovate research directions.

EDUCATION

University of Wyoming

Ph.D. in Physics (Astrophysics concentration) — est. 2026
   Minor in Interdisciplinary Computational Science

M.S. in Physics — May 2024

University of Illinois at Urbana-Champaign — May 2020

B.S. in Computer Science + Astronomy, Cum Laude — CGPA: 3.91/4.00

B.S. in Engineering Physics, Highest Honor — Dean's list

B.S. in Aerospace Engineering, Highest Honor

RESEARCH EXPERIENCE

Department of Physics and Astronomy — UWyo, WY

Research Assistant — *Aug 2021 - Present*

Advisor: Prof. Adam D. Myers

Images and Spectra Coanalysis SSL Foundation Model
- Designed a SSL foundation model to identify features in images and spectra simultaneously
- Curated the Legacy Survey imaging and DESI spectroscopic dataset to achieve fast IO access for the model training and inference
- Deployed and parallelized the model to 16 GPUs on NERSC Perlmutter Supercomputer
- Developed a metric to evaluate the performance of the model in various tasks, such as redshift estimation and type classification.

Bad Exposure Identification with Self-Supervised Learning
- Developed an SSL pipeline to identify bad exposures in DESI Legacy Imaging Surveys
- Compiled a set of 20,000 good and problematic exposures with labels for training and testing
- Improved the pipeline performance using Hyperparameter Optimization
- Parallelized the inference code for fast evaluation

DESI Lyman Alpha Emitter Pilot Study Using Wyoming-Infrared Observatory (WIRO)
- Led the project by planning and coordinating the WIRO observation to achieve optimal depth and quality of the images
- Developed the telescope focusing and data reduction pipeline to process images on NERSC efficiently
- Acquired astrometry data for images and cross-matched extracted sources to determine depth of the images

Search for Changing-Look AGN in DESI
- Comparing and cross-matching 750,000+ quasar spectra across Sloan Digital Sky Survey (SDSS) and Dark Energy Spectroscopic Instrument (DESI) surveys to study the variability of quasars
- Using statistical parameters such as χ^2 to quantify and identify spectra with extreme variability and changing look behavior

Argonne National Laboratory (ANL) — Lemont, IL

W. J. Cody Associate, Mathematics and Computer Science (MCS) Division — *May - Aug 2023, May - Aug, 2024*

Advisor: Dr. Dario Dematties, Dr. Rajesh Sankaran

Developing An Autonomous Curiosity-Driven Camera Control System

- Developed a camera control system based on the DayDreamer and IJEPA for autonomous control via maximal information entropy
- Connected the training of pattern recognition (ViT) and reinforcement learning agent through gradient prediction and matching
- Designed a distributed pipeline to achieve scheduling, communication, and evaluation for ML models' lifelong learning across several individual cameras each associated with an edge computing node

Self-Supervised Learning using IR and RGB Image Pairs for Edge Computing
- Gathered 1 million IR and RGB image pairs from coaxial cameras on three SAGE nodes located across the US
- Trained vision transformer (ViT) models in VICReg framework with the image pairs to recognize objects in the images without labels
- Optimized the ViT models with augmentations to improve the accuracy and generalization of the model
- Developed a workflow to streamline the image pair gathering, model training, and evaluation on ALCF ThetaGPU cluster

School of Computing UWyo, WY
Research Assistant *Jan 2022 - Aug 2022*
Advisor: Prof. Gabrielle D. Allen

Investigating the capability of PINN in solving PDEs and Einstein's equations
- Deployed and tested the Einstein Toolkit at the Advanced Research Computing Center (ARCC)
- Investigating the Physics Informed Neural Network (PINN) to solve partial differential equations
- Exploring applications of PINN in science, such as numerical relativity, and engineering
- Organized weekly colloquium for PINN, HPC, and AI perspectives

National Center for Supercomputing Applications (NCSA) UIUC, IL
Research Assistant *Jun - Dec 2017, Mar 2019 - Aug 2021*
Advisors: Dr. Roland Haas, Prof. Gabrielle D. Allen, Dr. Antonios Tsokaros

Studying the Evolution Stability of Rotating Neutron Stars Using Supercomputer Simulations
- Investigated the evolution stability of a single rotating neutron star under various density perturbation schemes by creating numerical relativity simulations using the Einstein Toolkit on XSEDE supercomputers
- Created 4 Einstein Toolkit thorns using C++ to add density perturbations and to compute angular momentum and stellar modes of the neutron stars
- Analyzed the simulation data and performed analyses on physical parameters to observe the instability growth of the neutron stars with different initial configurations, including spheroids and tri-axial ellipsoids.
- Developed an automatic data parsing and analysis pipeline to analyze the simulation output data regularly and efficiently

Computational Reproducibility of Numerical Results with the Einstein Toolkit
- Conducted reproducibility study by installing and deploying the Einstein Toolkit on various supercomputers, including Stampede2, Comet, and commercial HPC Cloud, generating neutron star simulation data
- Compared and analyzed our simulation results with the results data published in the IllinoisGRMHD paper

DataVault: An Open-Source Data Storage Framework for the Einstien Toolkit
- Main developer of the Einstein Toolkit DataVault for depositing and sharing numerical simulation waveforms, funded by NSF
- Developed four plugins to achieve the basic functionality of the DataVault, which includes metadata extraction and storage, semantic file search, result download, and user authentication with CILogon
- Built the containerized version of the DataVault to achieve easy deployment with Docker

Department of Astronomy UIUC, IL
Research Assistant *Jun 2019 - Aug 2021*
Advisor: Prof. Tony Wong

Developing the Python Extragalactic Database for Galaxy Evolution (EDGE)
- Implemented a Python package `edge_pydb` for the CARMA EDGE database to extract FITS image into HDF5 & CSV and provide more capabilities for advanced data analysis

- Designed a hex grid image sampler for processing the EDGE-CALIFA images to better sample pixel information
- Developed a BPT uncertainty analysis algorithm for the `edge_pydb` to filter data with high confidence level
- Applied machine learning algorithms to find a multilinear star formation law using 16 parameters for 126 galaxies in the EDGE database
- Analyzed the correlations between depletion, orbital and Jeans timescales to more accurately model the star formation law

PUBLICATIONS

10. **Luo, Y.**, Myers, A., Drlica-Wagner, A., Dematties, D., et al., "A Self-Supervised Learning Method for Bad Exposure Identification" (In prep.)

9. Wong, T., Cao, Y., **Luo, Y.**, Bolatto, A., Sánchez, S.F., et al., "The EDGE-CALIFA Survey: An Extragalactic Database for Galaxy Evolution Studies" (ApJS, *arXiv:* 2401.13181, 2024)

8. **Luo, Y.**, Tsokaros, A., Haas, R., Uryū, K., "General Relativistic Stability and Gravitational Wave Content of Rotating Triaxial Neutron Stars" (Symmetry, *arXiv:* 2312.16728, 2024)

7. **Luo, Y.***, Myers, A., Dey, A., Schlegel, D., Lang, D., Zhou, R., "DESI-LAE Pilot Study with Wyoming Infrared Observatory" (AAS 241, iPoster, 2023)

6. **Luo, Y.**, Zhang, Q., Haas, R., Etienne, Z., Allen, G., "HPC-driven computational reproducibility in numerical relativity codes: A use case study with IllinoisGRMHD" (Class. Quantum Gravity, *arXiv:* 2307.01343, 2023)

5. Aleo, P. D., Malanchev, K., Sharief, S., Jones, D. O., et al. (incl. **Luo, Y.**)., "The Young Supernova Experiment Data Release 1 (YSE DR1): Light Curves and Photometric Classification of 1975 Supernovae" (ApJS, 2023).

4. **Luo, Y.**, Haas, R., Zhang, Q., Allen, G. "DataVault: A Data Storage Infrastructure for the Einstein Toolkit" (Class. Quantum Gravity, *arXiv:* 2012.06635, 2021).

3. Ellison, S., Wong, T., Sanchez, S., Colombo, D., et al. (incl. **Luo, Y.**)., "The EDGE-CALIFA Survey: Central molecular gas depletion in AGN host galaxies - a smoking gun for quenching?" (MNRAS Letters, 2021).

2. Sánchez, S.F, Barrera-Ballesteros, J.K., Colombo, D., Wong, T., et al. (incl. **Luo, Y.**). "The EDGE-CALIFA survey: The local and global relations between Σ_*, Σ_{SFR} and Σ_{mol} that regulate star-formation" (MNRAS, 2021).

1. Barrera-Ballesteros, J.K., Sánchez, S.F., Heckman, T., Wong, T., et al. (incl. **Luo, Y.**). "EDGE-CALIFA survey: Self-regulation of Star formation is at kpc scales" (MNRAS, 2021).

PRESENTATIONS

Dec 2024 Bad Imaging Exposure Identification with Self-Supervised Learning, *DESI Winter Meeting*

Jun 2020 DataVault: A Simulation Storage Framework for the Einstein Toolkit", *North America Einstein Toolkit Workshop*

Aug 2017 Sampat, J., **Luo, Y.**, Thawesee, J., Anderson, I., "The Frontier Mission Design Document", *2017 AAS/AIAA Astrodynamics Specialist Conference*, (AAS 17-754)

Apr 2017 **Luo, Y.** "Hardware-In-Loop test platform for SASA", UIUC Undergraduate Research Poster Competition

AWARDS & COMPUTING ALLOCATIONS

Cloud avoidance and prediction with self-supervised learning	ALCF, 2023
Director's Discretionary award, PI: Yufeng Luo, 2,000 GPU Node Hours, 20 TB storage	
Numerical simulations of rotating neutron stars with Einstein Toolkit	NCAR/NWSC, 2022
WYOM0144, PI: Yufeng Luo, 1,220,000 Core Hours, 30 TB campaign storage	
School of Computing Inaugural Research Fellowship	UWyo, 2022
School of Computing Graduate Computing Scholars Award	UWyo, 2023-2024

SKILLS

Programming:
- *Advanced:* Python, MATLAB, Shell/UNIX, Jupyter
- *Proficient:* C/C++, Java, JavaScript, HTML, LaTeX, PyTorch
- *Familiar:* Julia, Verilog, MIPS, Haskell, Prolog, Mathematica, R, SQL, MongoDB, TensorFlow

Supercomputer: TACC Stampede2, NWSC Cheyenne, NERSC Perlmutter, ALCF ThetaGPU
HPC: SLURM, PBS, openMP, openMPI, openACC
Version Control: Git, SVN
Data Visualization: Tableau, VisIt
CAD: Siemens NX, PTC CREO, Solidworks
Language: Chinese (Native), English (Bilingual), Japanese (Intermediate), German (Basic)

LEADERSHIP

Association for Computing Machinery (ACM)   UWyo, WY
Secretary, Vice President   *March 2023 - Present*

- Established the ACM student chapter in Wyoming with three other members to promote CS education on campus
- Organize ACM speaker seminar to invite world-renowned computer scientists to visit and build collaboration
- Develop and plan a campus-wide hackathon with 30 students and raised funding from company sponsors

Graduate Student Committee for Physics and Astronomy (GradSCAP)   UWyo, WY
Founder, International Student Representative   *Dec 2022 - May 2024*

- Found GradSCAP to bridge students and faculty on graduate student life and departmental issues
- Pushed for positive changes on student-advisor relationship and written qualification exam procedure
- Hosted international graduate student events to help int'l students address their concerns on research, academics and culture differences

STUDENTS MENTORED

Dixon Reid
Undergrad, DESI image and spectra analysis

Salma Borchani
Undergrad, Bad exposure Identification with Self-Supvised Learning

TEACHING EXPERIENCE

Physics 1110 General Physics I: Mechanics, Waves, and Heat   UWyo, WY
Lab Teaching Assistant, 17 students, Fall 2024

Physics 1220 Engineering Physics II: Electricity, Magnetism and Thermal Physics   UWyo, WY
Teaching Assistant, 31 students, Fall 2024
Lab Teaching Assistant, 63 students, Fall 2021

Physics 3640 Modern Electronics and Experiment Techniques   UWyo, WY
Teaching Assistant, 32 students, Fall 2021

Astronomy 100 Introduction to Astronomy   UIUC, IL
Course Assistant, Spring 2017

REFERENCES

Dr. Adam D. Myers
Professor of Physics and Astronomy
University of Wyoming
geordiemyers@gmail.com

Dr. Gabrielle D. Allen
Director of School of Computing
University of Wyoming
gdallen@uwyo.edu

Dr. Roland Haas
Senior Research Programmer
National Center for Supercomputing Applications
rhaas@illinois.edu

Dr. Tony Wong
Professor of Astronomy
University of Illinois at Urbana-Champaign
wongt@illinois.edu