

Yufeng Luo

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RESEARCH INTEREST

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

EDUCATION

University of Wyoming

Aug 2021 - present

Ph.D. in Physics (Astrophysics concentration)

University of Illinois at Urbana-Champaign

May 2020

B.S. in Computer Science + Astronomy, Cum Laude

Cumulative GPA: 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

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 (CLAGN) 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

Advisor: Dr. Dario Dematties

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
- Presented the result at a student lightning talk seminar

School of Computing

UWyo, WY

Research Assistant

Jan 2022 - Aug 2022

Advisor: Prof. Gabrielle D. Allen

Investigate 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)

Research Assistant

Advisors: Dr. Roland Haas, Prof. Gabrielle D. Allen, Dr. Antonios Tsokaros

UIUC, IL

Jun - Dec 2017, Mar 2019 - Aug 2021

Evolution stability of rotating neutron stars

- 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 Einstein 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
<https://datavault.dev.ncsa.illinois.edu>
- Built the containerized version of the DataVault to achieve easy deployment with Docker

Department of Astronomy

Research Assistant

Advisor: Prof. Tony Wong

UIUC, IL

Jun 2019 - Aug 2021

Develop the EDGE python database

- 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 https://github.com/tonywong94/edge_pydb
- 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 & PRESENTATIONS

10. **Luo, Y.**, Tsokaros, A., Haas, R., Uryū, K., “General Relativistic Stability and Gravitational Wave Content of Rotating Triaxial Neutron Stars” (Submitted to *Symmetry*, 2023)
9. **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)
8. Wong, T., Cao, Y., **Luo, Y.**, Bolatto, A., Sánchez, S.F., et al., “The EDGE-CALIFA Survey: An Extragalactic Database for Galaxy Evolution Studies” (Submitted to *Astronomical Journal*)
7. **Luo, Y.**, Haas, R., Zhang, Q., Allen, G. “DataVault: A Data Storage Infrastructure for the Einstein Toolkit” (Class. Quantum Gravity, *arXiv: 2012.06635*, 2021).
6. 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).

5. 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).
4. 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).
3. **Luo, Y.** “DataVault: A Simulation Storage Framework for the Einstein Toolkit”, North American Einstein Toolkit Workshop (Oral presentation, 2020).
2. Sampat, J., **Luo, Y.**, Thawesee, J., Anderson, I., “The Frontier Mission Design Document”, 2017 AAS/AIAA Astrodynamics Specialist Conference, (AAS 17-754., 2017)
1. **Luo, Y.*** “Hardware-In-Loop test platform for SASA”, UIUC Undergraduate Research Poster Competition, 2017

AWARDS & COMPUTING ALLOCATIONS

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

TEACHING EXPERIENCE

Physics 3640 Modern Electronics and Experiment Techniques <i>Teaching Assistant</i>	UWyo, WY Fall 2021
Physics 1220 Electricity, Magnetism and Thermal Physics <i>Lab Teaching Assistant</i>	UWyo, WY Fall 2021
Astronomy 100 Introduction to Astronomy <i>Course Assistant</i>	UIUC, IL Spring 2017

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)

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

Research Professor of Physics

National Center for Supercomputing Applications

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Dr. Tony Wong

Professor of Astronomy

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