

Youssef Abdulghani

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Education

Doctor of Philosophy in Physics

Montana State University

Thesis: Parameter Estimation and Population Study of Black Hole Low Mass X-ray Binaries

Expected: May 2025

Bozeman, MT

Graduate Certificate in AI

Montana State University

Coursework included: Advanced ML, QML Project, Time Series Analysis, Methods of Data Analysis

December 2024

Bozeman, MT

Master of Science in Physics

Montana State University

May 2022

Bozeman, MT

Bachelor of Science in Physics with Concentration in Astrophysics

University of Science and Technology at Zewail City

Relevant coursework: Introduction to Particle Physics, Cosmology

February 2019

Cairo, Egypt

Technical Skills

Statistical Methods: MLR, Mixed Effects Models, Hypothesis Testing, Time Series Analysis (SARIMA), Experimental Design

AI/ML Concepts: Supervised Learning, Unsupervised Learning, Neural Networks, Random Forest, Decision Trees, kNN, Ensemble Methods, LSTM, GRU, Predictive Modeling, Monte Carlo, Bootstrapping, Uncertainty Quantification

Programming Languages: Python, R, Mathematica, MATLAB, SQL, OOP, and C++

Python Packages: NumPy, Matplotlib, SciPy, astropy, Scikit-learn, TensorFlow, and PyTorch

Software Tools: Jupyterlab, VS Code, Linux Systems, Slurm, Docker, Apptainer, Git, Github, and LaTeX

Work Experience

Researcher: Physics-AI

Montana State University: Department of Physics

June 2021 - Current

Bozeman, MT

- Utilized and trained Transformer, RNN (GRU, LSTM) and CNN models on time series data in TensorFlow to infer black hole accretion disk parameters, demonstrating advanced AI modeling techniques
- Implemented an SQLite database routine to access the simulations which resulted in reducing data loading by 60x, streamlining the simulation analysis process
- Optimized code for an HPC environment (MSU-Tempest), achieving a 100x acceleration in data synthesis, demonstrating the ability to deliver efficient hardware performance, a key requirement for high-performance AI applications
- Conducted comprehensive population statistical analysis on black hole X-ray binaries using hypothesis testing and data synthesis using simulations in the order of 10^7 , providing critical insights into astrophysical phenomena
- Deployed an online tool for rapid estimation of transient black hole X-ray binaries, facilitating real-time data analysis and decision-making
- Created a Python pipeline with multiprocessing capabilities for the X-ray binary distance project, achieving a 700% runtime speedup and greatly enhancing statistical framework efficiency
- Developed a Bayesian statistical framework using MCMC modeling to accurately constrain the distance of 26 black hole X-ray binaries, improving the precision of astrophysical measurements

Teaching Assistant: Physics I with Calculus Lab
Teaching Assistant: College Physics I Lab
Montana State University

Fall 2019, Spring 2020, Fall 2021, Spring 2023, Fall 2024
Summer 2020, Fall 2022
Bozeman, MT

- Delivered personalized support to students, significantly improving their lab skills and academic performance.
- Designed and delivered interactive lectures that enhanced students' understanding of physics principles, leading to a noticeable improvement in student comprehension
- Implemented innovative online learning tools to enhance student engagement and facilitate remote education
- Provided approximately 300+ hours of tutoring support at the Physics Help Center

Physics Content Developer
Nagwa Limited

February 2019 - June 2019
Cairo, Egypt

- Designed and developed more than 100 physics problems and answer keys for K-12 and college levels, enhancing educational content quality and accessibility while working in a multi-national team
- Led strategic meetings with upper management, including the CEO, to propose and implement technical enhancements in content presentation, driving innovation and quality improvements

Publications & Products

Refereed:

Abdulghani Y., Lohfink A.M., and Chauhan J. “A Dependable Distance Estimator to Black Hole Low-Mass X-ray Binaries”, MNRAS, vol. 530, no. 1, OUP, pp. 424–445, 2024. doi:10.1093/mnras/stae767
- Contribution: Led the project including analysis and writing

Chauhan J., Bharali P., Lohfink A., **Abdulghani Y.**, and Davidson E. “A spectral study of GRS 1915+105 during its March 2017 NuSTAR observations” MNRAS, vol. 527, no. 4, pp. 11801–11811, 2024
- Contribution: Manuscript writing and spectral data analysis

Software:

LMXBDq Tool – Rapid distance estimator for transient black hole binaries: solar.physics.montana.edu/youssef/lmxbd/
Bayesian Distance Calculator - Python - github.com/ysabdulghani/lmxbd

Other Relevant GitHub Projects:

K-means Clustering of Black Hole Spectral States – *Python* - github.com/ysabdulghani/lmxb-states-kmeans

Bayesian Time Series Analysis of Eagle Counts – *R* – Team Project - github.com/ysabdulghani/stat436-BayesTS

Statistical Study on Detected Exoplanets' Distance – *R* - github.com/ysabdulghani/stat512-exoplanets-distance

Grants

NASA's Swift Guest Investigator Cycle 19: Awarded grant (\$15,000) for a proposal on X-ray binaries **July 2023**

Outreach

American Astronomical Society (AAS) 243rd Meeting: Speaker - Research Contributed Talk **January 2024**