Hurum Maksora Tohfa

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Education

University of Washington
PhD in Astrophysics — August 2023 - Present
MS in Astrophysics (GPA 3.9) — August 2023 - 2025
Bryn Mawr College
Magna Cum Laude (GPA 3.8)
Hons in Physics and Mathematics with concentration in scientific computing — September 2018 - May 2022
(Honors Thesis: CMB Spectral distortion due to variation in the fine structure constant)

Technical Skills

Programming Languages: Python, Julia, R, Java, Mathematica

Machine Learning: Neural Networks, Domain Adaptation, Deep Learning Frameworks

Data Analysis: Large-scale dataset processing, Bayesian statistics, Monte Carlo simulation, Time series analysis

High-Performance Computing: Parallel processing, GPU acceleration, Simulation frameworks (MP-Gadget, Batoid)

Mathematical Methods: Statistical modeling, Optimization, Numerical methods, Signal processing

Publications (167 citations)

- Tohfa, H.; et al. (2026).”An emulator for the ionizing photon mean free path in ultra-high resolution simulations: the implications of mean free path measurements for the reionization history.”. *Submitted, preprint on ArXiv: 2602.03923*.
- Tohfa, H.; et al. (2023).”Forecast Cosmological Constraints with the 1D Wavelet Scattering Transform and the Lyman-α forest.”. *Physical Review Letters (Vol. 132, No. 23). doi: 10.1103/PhysRevLett.132.231002*
- Tohfa, H.; et al. (2023).”A Cosmic Microwave Background Search for Fine-Structure Constant Evolution.” *Physical Review D (Vol. 109, No. 10). doi: 10.1103/PhysRevD.109.103529*
- Cain, C.; et al. including Tohfa, H. (2026).”Introducing SAGUARO – Simulating IGM Evolution and Environments At High Resolution: Setup and First Results.” *Submitted to JCAP, preprint on ArXiv: 2603.25788*.
- Jacobson-Galan, W. V.; et al. including Tohfa, H. (2023).”SN 2023ixf in Messier 101: Photo-ionization of Dense, Close-in Circumstellar Material in a Nearby Type II Supernova.” *The Astrophysical Journal Letters, 954, L42. doi:10.3847/2041-8213/acf2ec*.

Awards and Recognition

American Institute of Physics SPS Outstanding Undergraduate Research Award, MIT Summer Research Grant, Velay Fellowship 2020, Bryn Mawr College Summer Science Research Grant, Bryn Mawr College Merit Scholarship 2018-2022

Research Experiences

Department of Astronomy, University of Washington — September 2023 - Present
Advisor: Professor Andrew Connolly

- Deploying the first neural network to control telescope optics in real-time operations for the Vera Rubin Observatory Active Optics System (AOS). Developed deep learning pipeline using convolutional neural networks to estimate wavefront aberrations from out-of-focus sensor images, achieving 30× faster inference than the baseline Transport of Intensity Equation solver while meeting stringent optical quality requirements (0.079” RMS error). Applied transfer learning techniques on 256,000 simulated images and 2.1M real telescope observations, enabling parallel processing critical for Rubin’s 36-second survey cadence and delivering improved performance in challenging conditions including camera vignetting and crowded stellar fields and deployed on sky (in prep).

- Developing adaptive neural compression algorithms that automatically identify and preserve scientifically critical features while achieving 30× compression ratios. The network learns importance patterns from data without supervision, maintaining 99% detection accuracy for sparse structures. Implementing GPU-accelerated pipeline using TensorFlow/CUDA for real-time deployment on a simulation data.

Advisor: Professor Matthew McQuinn

- Developed deep learning emulator for predicting the ionizing photon mean free path during cosmic reionization, trained on high-resolution (2 kpc) radiation-hydrodynamic simulations spanning 126 parameter combinations. Built residual multi-layer perceptron achieving 1.6% median prediction error across four orders of magnitude in mean free path, enabling millisecond inference versus hundreds of CPU-hours per simulation. Applied emulator to constrain reionization history from observed mean free path measurements at z = 5-6, finding best-fit reionization midpoint at z = 6.8 ± 1.2 with 10% neutral hydrogen persisting to z ¡ 6 at 1σ confidence, consistent with Planck CMB and kinetic Sunyaev-Zeldovich constraints. Calculated ionizing emissivity evolution without assuming power-law opacity scaling, revealing 2-3× decline between z = 6 and 4.8 that standard column density distribution evolution cannot explain (Submitted).

- Enhanced MP-Gadget simulation framework by implementing baryon streaming physics modules to analyze the impact of relative velocity between dark matter and baryons on halo mass distributions and formation dynamics.

Advisor: Professor Eric Agol

- Developed PeriodicOrbitTTV.jl, a Julia package for constraining orbital parameters of resonant planetary systems by combining periodic orbit theory with transit timing variation (TTV) observations. Implemented Levenberg-Marquardt optimization using automatic differentiation to search for configurations where planetary systems return to identical relative positions after characteristic timescales, reducing free parameters while enabling characterization of long-period systems impractical to observe completely. Demonstrated that enforcing periodic orbit constraints breaks the mass-eccentricity degeneracy inherent in TTV-only fits—while multiple mass-eccentricity combinations produce identical transit timing patterns over dozens of transits, only specific configurations satisfy the global requirement that systems return to exact initial states after one period. Validated methodology by reproducing the 8:4:2:1 resonant periodic orbit of HR 8799 maintaining stability over 10,000 years, and showed using synthetic data that combined periodic orbit and TTV constraints determine planetary masses and eccentricities more precisely than either method alone.

Department of physics, UC Riverside September 2022 - August 2023

Advisor: Professor Simeon Bird

- Implemented wavelet scattering transforms as feature extraction technique, demonstrating order-of-magnitude improvement in parameter constraint precision over traditional power spectrum methods using Fisher information matrix analysis

Microsoft Research, Redmond, WA

Research Intern May 2022 - August 2022

Mentor: Dr. Simon David William Frost

- Designed noise filtering pipeline and feature extraction system for multi-class classification problems. Developed time-series LSTM network that outperformed existing GAN baseline by 10%, implementing comprehensive evaluation framework to validate model performance against ecological ground truth data.

Department of Physics and Astronomy, Haverford College

Advisor: Professor Daniel Grin

- Numerically solved dynamic equations of scalar field for BSBM and Runaway Dilaton model, analytically solving the equations at boundaries to validate results, constrained free parameters in the models with Planck 2018, QSO data using Principal Component Analysis and Monte Carlo simulation, forecasted uncertainties in the possible detection of the fine structure constant in Simons Observatory CMB experiment.

Kavli Institute for Astrophysics, Massachusetts Institute of Technology
Research Intern May 2021 - September 2021
Advisor: Professor Michael McDonald

- Numerically showed that relationship between the pressure of X-Ray cavities and luminosity can be generalized as a cluster property and analytically proving that the geometry of the cavity is the main catalyst behind the scatter seen in the pressure-luminosity relationship, determed the exact correlation between distance from the cavity and cavity radius where most of the detected cavities are seen.

Department of Physics, Bryn Mawr College
Undergraduate Research Assistant May 2019 - August 2019
Advisor: Professor Michael Schulz

- Analytically solved the field equations for Lifshitz metric and finding the correlation function using AdS/CFT correspondence that specified ultralocality of the field.

Department of Physics, Bryn Mawr College
Undergraduate Research Assistant December 2018 - May 2019
Advisor: Professor David Schaffner
Wrote a program in Python using bi-spectral analysis to find the bi-coherence to see at which energy modes the energy transfer takes place in plasma. The program is now being used to understand the stability of transient spiral arms in galaxies.
Relevant Course Work: Machine Learning, Statistical Methods, Computational Physics, Data Structures and Algorithms, Applied Statistics, Advanced Mathematics (Real Analysis, Linear Algebra, Differential Equations)

Teaching Experience

University of Washington, Seattle, WA
Teaching Assistant for Introduction to Astronomy (Fall 2023)
Teaching Assistant for The Planets (Winter 2024)
Teaching Assistant for The Planets (Spring 2024)
Haverford College, Haverford, PA
Teaching Assistant for Phys-309 (Advanced Electromagnetism), Fall 2021
Teaching Assistant for Phys-303 (Statistical Mechanics and Thermodynamics), Fall 2021
Teaching Assistant for Phys-302 (Advanced Quantum Mechanics), Spring 2021
Teaching Assistant for Phys-308 (Advanced Classical Mechanics), Fall 2020
Teaching Assistant for Math-121 (Multivariable Calculus), Spring 2020
Student Consultant for Teaching and Learning Center (Fall 2019, Summer 2020, Fall 2020, Fall 2021)
Bryn Mawr College, Bryn Mawr, PA
Peer Tutor (Introductory Physics, Modern Physics), Fall 2020 – Spring 2022
Quantitative Center Tutor, Fall 2020 – Spring 2022
Teaching Assistant for Phys-101: Introductory Physics (Fall 2019) and Phys-102: Introductory Physics II (Spring 2019 and Spring 2020)

Presentations

Tohfa. Hurum, "Fine structure constant variation due to special variation," Virtual Summer Research Symposium, Haverford College, PA, 2020
Tohfa. Hurum Maksora, "Fine structure constant variation," American Physical Society, NY, 2022
Tohfa. Hurum Maksora, "Fine structure constant variation," American Astronomical Society, CA, 2022
Tohfa. Hurum Maksora, "Understanding X-ray Cavities," MIT Summer Research Symposium, Massachusetts Institute of Technology, MA, 2021
Tohfa. Hurum, Pandey, Shiksha, Khan, Faryal, "Computing Lifshitz Field Theory Correlation Functions Using the AdS/CFT Correspondence," Summer Science Research Symposium, Bryn Mawr College, PA, 2019
Tohfa. Hurum, Pandey, Shiksha, "Bispectrum Analysis on non-linear system," Spring Research Symposium, Bryn

Mawr College, PA, 2019

Other: LICK workshop in observational astronomy 2023, Center for Matter at Atomic Pressures Summer School 2021 (selected to receive a stipend), CMB-S4 Summer School 2021