Sayed Shafaat Mahmud

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EDUCATION

Colgate University - Hamilton, NY   June 2026
Bachelor of Arts - Double Major: Applied Mathematics & Physics and Astronomy   *GPA: 3.9/4.0*

COURSEWORK

Courses: Computational mathematics and numerical analysis, Linear Algebra, Electricity & Magnetism, Astronomical Data Analysis, Quantum Mechanics, Classical Mechanics, Computational Statistics, Electrodynamics, Relativity and Cosmology, Intermediate Astrophysics, Extragalactic Astronomy, Machine Learning in Biological Systems

Awards: Dean's Award with Distinction(2x), The Edwin Foster Kingsbury Prize for excellence in Physics and Astronomy, Honorable Mention: International Olympiad on Astronomy and Astrophysics 2021, Gold Honor: International Astronomy and Astrophysics Compt'22

RESEARCH EXPERIENCE

Using Generative AI to Infer Protoplanetary Disk Features | *Neal Turner, NASA JPL*   May 2024 - Present
- Developed a Variational Auto Encoder that trains on simulated images of protoplanetary disks to infer embedded planet masses, radial distance, dust-to-gas ratio of disks, composition, etc. in a Bayesian way. Due to the model's generative nature, it has the potential to be used as a simulation inference tool as well.
- This work underscores the first application of generative AI in the field of protoplanetary disk research.
- The paper has been accepted at Neural Information Processing Systems 2024 and can be found **here**.

Using Neural Network to Detect Dark Stars | *Cosmin Ilie, Colgate University*   May. 2023 – Present
- Actively leading and mentoring the Machine Learning wing of Colgate Dark Matter Research Group by connecting computational simulations of dark stars with observed data of some the most distant galaxy candidates from NASA's James Webb Space Telescope.
- Devised novel approaches for detecting dark matter signatures in the early universe by designing neural networks that train on synthetic spectral and photometric data with added gaussian noise.
- Detected 10 dark star candidates with a 95% confidence interval. 2 Papers expected to be submitted by February 2025. Preview of the papers can be found **here**.

Dark Star Simulation through Computational Physics | *Earl Bellinger, Yale University*   Aug 2022 – May 2024
- Incorporated novel equation of state for dark stars with Module for Experimental Stellar Astrophysics
- Learned coding with fortran, computational physics, stellar astrophysics theory, dark matter physics

Predicting Star Formation Rate Based on Photometry | *Tonima Ananna, Dartmouth*   Apr 2021 – Jun 2022
- Devised a new way to calculate star formation rates in galaxies based on SDSS photometric band fluxes using ML.
- Learned regression modelling, data analysis, SQL, galactic astrophysics, machine learning, writing academic papers

TALKS AND PRESENTATIONS

Using Neural Network to Detect Dark Star candidates in JWST Data
- The 245th American Astronomical Society Annual Meeting 2025, Baltimore, Maryland
- The AstroAI Workshop 2024, Center for Astrophysics, Harvard and Smithsonian, Harvard University
- The American Physical Society April Meeting 2024, Sacramento, California
- The Institute for AI and Fundamental Interactions Summer Workshop 2023, Northeastern University
- Keck Northeastern Astronomy Consortium 2023, Wesleyan University
- NY6 Liberal Arts Consortium 2023, Hobart and William Smith Colleges

Implementing MESA in Stellar Astrophysics research
- MESA Summer School 2023, Budapest, Hungary

Using VAEs for Parameter Inference of Protoplanetary Disks
- The Institute for AI and Fundamental Interactions Summer School 2024, Massachusetts Institute of Technology
- Keck Northeastern Astronomy Consortium 2024, Colgate University

Work and Leadership Experience

Bangladesh Olympiad on Astronomy and Astrophysics | *Mentor*   March 2022 – Present
Mentoring 20+ students focusing on Cosmology and Stellar Astrophysics for International Olympiads. Assisted in achieving 2 silver medals and 1 bronze at International Olympiad on Astronomy and Astrophysics 2023, Poland.

Colgate Residential Life | *Community Leader*   August 2023 – 2024
Provided support and guidance to a diverse community of 41 freshmen residents within the university housing.

Publications

1. **Mahmud, S**., Turner, N., Auddy, S., & Bary, J. (2024). *Using Variational Autoencoders to Infer the Masses of Exoplanets Embedded in Protoplanetary Disks.* Proceedings of the Neural Information Processing Systems (NeurIPS) 2024 Workshop on Machine Learning and the Physical Sciences. Available at: https://ml4physicalsciences.github.io/2024/files/NeurIPS_ML4PS_2024_170.pdf

2. **Mahmud, S.**, Siddiqa, A. A., & Ilie, C. (2024). *Using Neural Networks for Photometric Detection of Dark Star Candidates in the Early Universe.* (Expected submission to *The Astrophysical Journal*, February 2025). Draft available at: https://drive.google.com/file/d/1Nx659npCY2A8xzEwEr_A5JxwrE4SNPsI/view?usp=sharing

3. Siddiqa, A. A., **Mahmud, S.**, & Ilie, C. (2024). *Using Neural Networks for Spectroscopic Detection of Dark Star Candidates in the Early Universe.* (Expected submission to *The Astrophysical Journal*, February 2025). Draft available at: https://drive.google.com/file/d/1gFtIZaLxkUe8Ziq9YPTSEQL0OyeuFewH/view?usp=sharing

4. Ilie, C., **Mahmud, S.**, & Paulin, J. (2025). *Detecting Dark Star Candidates Based on JWST NIRSpec Spectra.* (In preparation for submission to *The Astrophysical Journal*, expected submission April 2025).

Teaching Experience

- **PHYS 131 Atoms and Waves** (Aug 2024 – Dec 2024)
  Teaching Assistant: Guided students through coursework on atomic physics and wave mechanics, conducted problem-solving sessions, and provided individual support.

- **PHYS 232 Introduction to Mechanics (Lab)** (Jan 2024 – May 2024)
  Teaching Assistant (Lab): Supervised and assisted students in laboratory experiments related to mechanics, ensured proper data collection and analysis, and evaluated lab reports.

- **O'levels Physics and Mathematics** (Aug 2020 – Feb 2022)
  Private Tutor: Provided personalized instruction in physics and mathematics for O'Level students, preparing them for standardized examinations with tailored lesson plans.

Skills

Programming Languages: Python, R, MATLAB, Fortran, SQL, Java, HTML
Machine Learning Frameworks: TensorFlow, PyTorch, VAEs, GANs, Diffusion Models, CNNs, Feed-Forward Neural Networks
Data Analysis & Visualization: Excel/Sheets, Google Docs, Mathematica, MATLAB, PowerPoint, Terminal
Astrophysical Tools: High-Performance Computing (HPC), MESA, TLUSTY
Version Control & Collaboration: Git/GitHub, Google Drive
Languages: English (Fluent), Bengali (Native), Hindi (Fluent), Urdu (Conversational), German (Basic)
Hobbies: Chess (Internationally rated), Soccer (Club Soccer), Cricket (Colgate Cricket Team), Guitar, Reading