Shikhar Asthana

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Astrophysics researcher with expertise in computational modeling and high-performance computing. Skilled in developing GPU-accelerated simulations and handling large-scale data analysis. Strong experience in collaborating with geographically distributed teams and supporting data acquisition, processing, and quality control.

Academic Qualifications

Doctor of Philosophy   **University of Cambridge, UK**
Modeling the Epoch of Reionization   *Oct 2021 – Mar 2025*

Master of Science   **Indian Institute of Technology-Kharagpur, India**
Physics, *CGPA:9.62/10*   *Aug 2018 – May 2020*

Bachelors of Technology   **Delhi Technological University, India**
Mechanical Engineering, *83.6%*   *Aug 2013 – May 2017*

PhD thesis: Modeling the Epoch of Reionization

- Developed ATON-HE, a grid-based MPI and GPU code (C, $CUDA$) to solve the cosmological radiative transfer (RT) equation using the M1 closure scheme. This multi-frequency RT code follows the ionization states of hydrogen and helium, providing detailed insights into the reionization processes.
- Optimized simulation performance by implementing non-blocking communications and GPU streams, achieving a 30% increase in speed.
- Created and calibrated large-scale models (160 cMpc/h) to study reionization, focusing on the timing of reionization, the impact of helium on hydrogen reionization, the role of different ionizing sources, such as quasars and high-mass galaxies, the possibility of Lyman-α emitters at high redshift, and the excess photon production problem.
- Handled and analyzed large datasets (200 TB) by writing auxiliary Python scripts and compared the simulations with observations from JWST, HST and XQR-30.
- Assisted in writing proposals that successfully secured computational time on Piz Daint, Tursa, and CSD3 supercomputers.

Technical Skills

Programming and Scripting Languages...
- C, C++, Python, MATLAB, Yorick – Used for developing simulation models, data analysis scripts, and optimizing code performance.
- Python: NumPy, SciPy, Matplotlib – Analyzed simulation output, generated statistical insights, and visualized cosmological data.

High-Performance Computing...
- GPU Programming: CUDA, GPU Streams, HIP – Accelerated cosmological simulations through GPU .
- Parallel Programming: MPI – Implemented parallelism to enhance efficiency on multinode systems.
- Experience with supercomputers: CSD3, Tursa, Piz Daint, Frontier – Ran high-resolution simulations, utilizing more than 1 million GPU hours.

Software and Development Tools...
- Version Control: Git– Collaborated on code development and maintained version control for projects.
- Engineering Software: Solidworks, ANSYS-CFX – Created a SI engine on CAD, and ran fluid analysis.
- Text Processing: LaTeX, Emacs – Prepared scientific manuscripts and managed documentation efficiently.
- Web Design: HTML, CSS, JavaScript – Built a personal website to showcase research and projects.

Talks

Teaching Experience

Part II supervisions   **Introduction to Cosmology**
University of Cambridge   *Jan 2022 – May 2022, Jan 2024 – May 2024*

Conducted in-person supervision of over 20 students in cosmology, guiding them through problem sets and clarifying theoretical concepts.

Chegg   **Advanced Physics Tutor**
                                                 March 2018 – July 2018

Provided online tutoring in advanced physics, helping students understand complex subjects.

Equality, Diversity & Inclusion

- **Equity & Inclusion Committee Member**: Contributed to departmental efforts to foster an inclusive environment by organizing events such as Diwali celebrations and successfully advocating for visa cost reimbursement for international students.
- **EDI Data Analysis Team**: Assisted in collecting and analyzing survey data to identify areas of improvement within the department. Created visualizations to present findings and helped develop actionable recommendations to enhance equity and diversity.

Research Experience

○ **Radiative transfer simulation** — **Tata Institute of Fundamental Research, Mumbai**
Prof. Girish Kulkarni — *July 2020–June 2021*

Modified the ATON code for studying helium and hydrogen reionization from redshift 4-20, utilizing supercomputing resources (Piz Daint). Enhanced understanding of uncoupled RT simulations.

○ **Solar Sigmoid Detection** — **Indian Institute of Astrophysics, Bangalore**
Prof. Dipankar Banerjee — *May 2019–July 2019*

Created an automated detection program for solar sigmoids based on their shape from Carrington maps, employing MATLAB and image processing techniques.

○ **Supernovae and their host galaxies** — **Indian Institute of Astrophysics, Bangalore**
Prof. Firoza Sutaria — *December 2015-January 2016*

Analyzed the spatial distribution between supernovae and host galaxies using observational data from the IAU supernova list, ASAS-SN, and Asiago supernovae catalogue. Built foundational skills in astrophysical data analysis. Studied the distribution between

Master's thesis — **Power Spectrum of non-gaussian sky signals**
Prof. Somnath Bharadwaj — *July 2019–April 2020*

Created non-Gaussian sky signals and calculated their power spectrum. Explored effects on the Tapered Gridded Estimator calculation in 21 cm cosmology

Bachelor's thesis — **Variable compression internal combustion engine**
Prof. Naveen Kumar — *October 2014–April 2017*

Modeled a new variable compression ratio SI engine and designed a variable length intake manifold for a CI engine, employing Solidworks and ANSYS-CFX for performance optimization.

Workshops and Professional Activities

○ **Poster Presentation: Reionization with GPU streams**, DiRAC Conference: Presented a poster on the speed up of Radiative transfer simulations using GPU streams.
○ **KICC Annual Report 2023**: Wrote an article about my research for the Kavli Institute for Cosmology Cambridge (KICC) annual report, highlighting key findings and ongoing work.
○ **Postgraduate Student Forum Committee Member**: Represented postgraduate cohorts in meetings to address grievances and concerns, ensuring that the voices of postgraduate members were heard and addressed.
○ **IoA Public Day** Helped organize public outreach events to engage the general public with astronomy, promoting interest in scientific research in 2022 and 2023.
○ **Fundamentals of Deep learning**, NVIDIA, September 2024: Attended a workshop focusing on Deep learning, neural networks, and advanced architectures.
○ **Scientific Machine Learning (SciML) Course**, DiRAC, September 2023: Participated in a course focused on introductory scientific machine learning techniques.
○ **Fundamentals of Accelerated Computing with CUDA C/C++**, July 2022: Attended a workshop on GPU programming and accelerated computing techniques.
○ **ICIC Data Analysis Workshop**, Imperial College London, September 2022: Engaged in a workshop on implementing Bayesian inference on complex scientific datasets.
○ **DiRAC OpenMP and AMD GPU Hackathon**, University College London, April 2023: Collaborated on optimizing computational codes using OpenMP and AMD GPU technologies.
○ **Science Exchange Program**, Shibaura Institute of Technology, Tokyo, Japan, January 2020: Participated in a science exchange program to foster international collaboration.

Academic Achievements

○ GRE Physics: 990/990
○ GRE General score: 169/170 Quantitative Reasoning, 159/170 Verbal Reasoning, 5/6 Analytical writing
○ TOEFL: 116
○ GATE Physics (Graduate Aptitude Test in Engineering) – 2018 Rank: 327 (98 percentile)
○ IIT JAM Physics (Joint Admission Test for M.Sc.) – 2018 Rank: 155(99 percentile)
○ IIT Mains – 2013: Rank: 99.4 percentile

Publications

Primary Author...

1. Asthana S., et al., 2025 MNRAS 539, L18 The ionizing photon budget and effective clumping factor in radiative transfer simulations calibrated to Lyman-α forest data
   Analysed different source models to look at the escape fractions and clumping factor.
2. Asthana, S. et al., 2024, arXiv:2409.15453, Submitted to MNRAS, The Impact of Faint AGN Discovered by JWST on Reionization
   Wrote the program to create a new source model to incorporate faint AGN as ionizing sources.
3. Asthana S., et al., 2024, MNRAS, 533, 2843 Late-End Reionization with ATON-HE: Towards Constraints from Lyman-α Emitters Observed with JWST
   Modified the code to include helium, and ran simulations to model varies different late-end reionization scenarios.

Co-author...

1. Khan, N. K., et al.,(incl. Asthana, S.) 2023, MNRAS, 530, 4920 Particle Initialization Effects on Lyman-α Forest Statistics in Cosmological SPH Simulations
   Assisted in running P-GADGET-3 with varying initial conditions.
2. Gaikwad P. et al., (incl. Asthana, S.) 2023, MNRAS, 525, 4093 Measuring the Photo-Ionization Rate, Neutral Fraction and Mean Free Path of HI Ionizing Photons at $4.9 \leq z \leq 6.0$ from a Large Sample of XShooter and ESI Spectra
   Calibrated a Radiative transfer simulation using ATON-HE which was compared to the EX-CITE simulations.
1. Asthana, S. et al., SAE Technical Paper 2016 A Comparative Study of Recent Advancements in the Field of Variable Compression Ratio Engine Technology
   Conducted extensive research on advancements in variable compression ratio technology, highlighting their potential benefits for fuel efficiency.
2. Singh, S., Asthana, S., et al., SAE Technical Paper 2016 Development of an Intake Runner of a CI Engine for Performance Enhancement and Emission Reductions Due to Variations in Air Flow Pattern within the Runner
   Played a significant role in designing and testing an optimized intake runner, demonstrating improvements in engine performance and emission reductions.
3. Singh, S., Asthana, S., et al., SAE Technical Paper 2016 Low Cost Optimization of Engine Emissions for an Intake Runner Designed for Medium Capacity CI Engine through Correlations between Emission Values and Intake Configurations
   Assisted in the design and analysis of intake configurations to achieve emission reductions, focusing on low-cost optimization techniques.

References

Prof. Martin Haehnelt

Position	Professor
Employer	Institute of Astronomy University of Cambridge
Email	haehnelt@ast.cam.ac.uk
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Prof. Girish Kulkarni

Position	Associate Professor
Employer	Department of Theoretical Physics Tata Institute of Fundamental Research
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Prof. James Bolton

Position	Professor
Employer	School of Physics & Astronomy University of Nottingham
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Phone	+44-1159-515132