SUYASH KUMAR

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EDUCATION

The University of Chicago, PhD Candidate, Astronomy and Astrophysics — September 2022 — June 2027 (expected)
PhD thesis: Chemical enrichment in extragalactic gaseous halos — Advisor: Prof. Hsiao-Wen Chen

University of California, Los Angeles, Bachelor of Science, Physics — September 2018 — March 2022

PUBLICATIONS

- ”Non-equilibrium ionization in the multiphase circumgalactic medium – impact on quasar absorption-line analyses” by **Kumar** and Chen, accepted to The Open Journal of Astrophysics, arXiv:2501.13170 (2025)
- ”On the Nature of the C IV-bearing Circumgalactic Medium” by **Kumar** et al., accepted to The Open Journal of Astrophysics, arXiv:2408.15824 (2024)

TALKS

- ”Tracing CGM feedback through chemical enrichment patterns”, contributed talk, Perimeter Institute, Waterloo (2025)
- ”Constraining non-equilibrium ionization in the CGM”, invited remote talk, Niels Bohr Institute, Copenhagen (2025)
- ”Chemical enrichment in the circumgalactic medium”, invited talk, UMich, Ann Arbor (2025)
- ”The C IV-bearing circumgalactic medium in distant galaxies”, contributed talk, IUCAA, Pune (2024)

EXPERIENCE

PhD Candidate, UChicago Astrophysics Department — August 2022 — Present

- Performed Bayesian modeling to infer physical properties of galactic environments from high-dimensional spectral data (up to ~ 80 model parameters)
- Built a parallelized, interactive inference engine that reduces MCMC sampling runtimes from 4+ hours to under 10 minutes per system, enabling faster hypothesis iteration
- Tackled severe parameter degeneracies by integrating well-motivated priors into the inference loop, balancing statistical flexibility with physical interpretability
- Identified fundamental shortcomings in existing astrophysical equilibrium models, and proposed a more accurate, physics-driven framework to fully explain observed galaxy spectra
- Published research in peer-reviewed journals and released open-sourced modular software tools used by other researchers

AI Hackathon Lead, UChicago Data Science Institute — April 2025 — July 2025

- Led runner-up team for the UChicago AI+Science PhD hackathon, invited by organizers to extend project post-hackathon. Led ML infrastructure development to process the entire experimental dataset while handling inconsistencies
- Built a message-passing Graph Neural Network (GNN) to predict atomic orbital binding energies, incorporating delta learning to improve upon lookup-based estimates
- Designed robust data cleaning and parsing routines to handle inconsistencies in molecular structure representations and improve feature encoding
- Developed a scalable training pipeline on an HPC cluster for grid-based hyperparameter tuning across multiple model variants

Satellite Operations Lead, UCLA Space Physics Dept. — September 2019 — June 2022

- Led operations for two NASA CubeSats, designing real-time control protocols and coordinating with international ground stations for continuous orbital coverage
- Built and tested command-and-control software to interface with spacecraft hardware, integrating telemetry processing and fault detection routines
- Applied Least Squares Spectral Analysis to magnetic field time-series data, identifying sensor misalignments through matrix-based geometric modeling (~ 10 parameters)
- Engineered custom filters to denoise telemetry streams, significantly improving signal-to-noise ratio in orbital magnetometer data
- Enabled first detection of elusive magnetospheric waves by resolving previously uncorrected detector orientation errors

AWARDS

- Neubauer Research Fellowship winner at UChicago, $40k award (2022 — 2027)
- Awarded travel grant from the American Astronomical Society to attend conference at IUCAA, Pune (2024)
- Rewarded two nights on Magellan Telescopes in Chile for observing distant galaxies as part of PhD thesis (2023)

TEACHING

- Teaching assistant for four astrophysics courses designed for non-majors (UChicago, 2022 — 2023)

MENTORING

- Advising second-year undergraduate student from Taiwan participating in UChicago research exchange program (2025)
- Advising high-school student participating in UChicago lab school summer research program (2025)

SKILLS

- Mathematics and statistics — Bayesian inference, Monte Carlo methods, probability theory, estimation techniques, linear algebra, time-complexity optimization, numerical methods, vector calculus, graph theory
- Programming and systems — Python, Git, Bash, parallel computing, scientific pipeline development, HPC workflows, environment management (Conda, pip), reproducibility tools (.yml)
- Machine learning tools — PyTorch, CNNs, GNNs, Gaussian processes, ensemble methods, multivariate regression, hyperparameter optimization