TANMAY SINGH

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Education

Arizona State University Aug 2023 – Present
SESE, PhD in Astrophysics **CGPA: 4/4**

Indian Institute of Technology, Delhi July 2019 – July 2023
Bachelor of Technology, Engineering Physics **CGPA: 8.51/10.0**

Publications

- **Singh, T.**, Borthakur, S., Nelson, D., Davé, R., & McCabe, T. (2026), "Analysis of Synthetic O VI Absorption Associated with Galaxy Groups in SIMBA and TNG50 Simulations," *ApJ*, 1003, 110. doi:10.3847/1538-4357/ae632b
- **Singh, T.**, Sathyanarayana Rao, M., & Basu Thakur, R. (2026), "Site Quality Analysis for an Indian Submillimeter Telescope: A Reanalysis-Based Approach," *AJ*, 171, 331. arXiv:2604.13487
- **Singh, T.**, Singh, R. A., Koike, F., Iizawa, M., & Azuma, Y. (2026), "Scattering Angle Dependence of Fano Resonance Profiles in Cold Atomic Collisions Analyzed with the Complex Valued w Parameter," *Indian J. Phys.*, 100, 2179. doi:10.1007/s12648-026-03956-2
- Roy, N., Borthakur, S., Heckman, T., & **Singh, T.** (2026), "Lighting Up the CGM: Strong, Jet-Aligned Hα Emission around Radio Galaxies," arXiv:2606.30088
- Borthakur, S., **Singh, T.**, French, D., Faerman, Y., Rubin, K., Koplitz, B., et al. (2026), "Revealing Cosmic Ecosystems with the Hubble Space Telescope in 2030s and Beyond," arXiv:2606.11506

Research Experience

O VI in the Intra-group Medium from SIMBA and IllustrisTNG Aug 2023 – Present
Graduate Research, SESE, ASU — Supervisor: Prof. Sanchayeeta Borthakur
- Compared O VI absorption from synthetic quasar spectra in SIMBA and IllustrisTNG with COS-IGrM observations; used XGBoost to identify the physical drivers of detectability (halo mass, impact parameter, stellar mass). Published in *ApJ* 1003, 110 (2026).

Multiphase Kinematics of the Circumgalactic Medium in IllustrisTNG Aug 2024 – Present
Graduate Research, SESE, ASU — Supervisor: Prof. Sanchayeeta Borthakur
- Built a 14,400-sightline mock-quasar experiment around M61 (NGC 4303) analogues in TNG50-1, generating synthetic *HST*/COS spectra for 9 transitions across 7 ions (`yt`, `Trident`, `pyGad`).
- Built a disk-ISM velocity pipeline and a 1.1M-cell, 11-ion absorber catalog showing HVCs are ionization-stratified: cool gas is ∼68% inflowing while O VI is outflow-dominated; assembled a benchmark of 172 observed sightlines from 10+ surveys.

Simulation-Based Inference for Circumgalactic Cloud Properties Jun 2026 – Present
Graduate Research, SESE, ASU — Supervisor: Prof. Sanchayeeta Borthakur
- Trained amortized neural posterior estimators (normalizing flows, `sbi` + PyTorch on A100 GPUs) with leave-one-group-out validation to quantify what a single COS spectrum constrains: line-of-sight gas position (AUC 0.74–0.82) and temperature spread are recoverable; cloud size and count are not.
- Identified and corrected a Jensen-inequality noise bias in apparent-optical-depth columns that mimicked a spurious 0.6 dex saturation correction.

Multiphase CGM Emission around Jet-Mode AGN in SIMBA Apr 2026 – Present
Graduate Research, SESE, ASU — Supervisor: Prof. Sanchayeeta Borthakur
- Built a `yt`/SPH pipeline producing jet-frame Hα surface-brightness and H I/Mg II/O VI column maps with CLOUDY emissivities; reproduced the DESI × LoTSS stacking of Roy et al. (2026) over 3,175 mock galaxies.
- Showed recombination and collisional emission predict Hα *depleted* along the jet axis ($\sim 35\sigma$), opposite to the observed excess, isolating shock ionization as the required mechanism.

Matched Comparison of Circumgalactic O VI in FIRE-2, TNG50, and SIMBA Jun 2026 – Present
Graduate Research, SESE, ASU — Supervisor: Prof. Sanchayeeta Borthakur
- Produced identical-methodology O VI column and surface-brightness maps for mass-matched galaxies across three hydrodynamic solvers; wrote a windowed-FFT power-spectrum estimator showing SIMBA's resolution imposes ∼43 kpc effective smoothing.
- Reproduced the public IllustrisTNG emission-line rendering backend locally, matching the live server to $\leq$0.002 dex on 12 reference renders.

Spectral Classification of AGN and Supernovae with BLOG Jan 2024 – Present

Graduate Research, SESE, ASU — Supervisors: Prof. Siddharth Srivastava and Prof. Rolf Jansen

- Developing a contingent Bayesian-logic (BLOG) model classifying AGN and supernova spectra from emission-line detections, widths and ratios, with dust attenuation and variability models.

Preliminary Site Quality Analysis for an Indian Sub-millimeter Telescope May 2022 – Jul 2022

Visiting Research Intern, Raman Research Institute — Supervisor: Prof. Mayuri S. Rao

- Assessed Ladakh sites for ISRO's planned 6-m sub-mm/THz telescope using NASA and ECMWF PWV data. Published in *AJ* 171, 331 (2026).

Angular Dependence of Fano Profile in Ultra-Cold Atomic Collisions Mar 2022 – Apr 2023

Sophia University — Supervisors: Prof. Fumihiro Koike and Prof. Yoshiro Azuma

- Studied the scattering-angle dependence of the Fano parameter in cold H–Kr collisions. Published in *Indian J. Phys.* 100, 2179 (2026).

Talks and Presentations

Invited

- *From O VI in Galaxy Groups to the Multiphase Gas Around Galaxies*, ROE, Univ. of Edinburgh Jul 2026
- *From Simulations to Spectra: Probing the Intragroup Medium with O VI*, SOTU Seminar, TIFR, Mumbai May 2026

Contributed

- *Inferring CGM Cloud Properties Using Simulation-Based Inference*, SBI for Galaxy Evolution 2026, Cambridge Jun 2026
- *Looking at the Sky through Radio Eyes: 21-cm Cosmology*, Student Lecture, IIT Delhi Sep 2022
- *Preliminary Site Quality Analysis for an Indian Sub-mm Telescope*, VSM Presentation, RRI, Bengaluru Jul 2022

Posters

- *Analysis of Synthetic O VI Absorption in Galaxy Groups of SIMBA and IllustrisTNG*, AAS 247, Phoenix, AZ Jan 2026
- *Scaling Synthetic Absorption Spectroscopy for IllustrisTNG*, URSSI Summer School for Open Science Aug 2025

Awards and Achievements

- **Summer Exploration Graduate (SEG) Fellowship**, School of Earth and Space Exploration, ASU 2024, 2026
- **PanIIT USA Graduate Scholarship** 2023
- **Summer Undergraduate Research Award** (SURA), IIT Delhi; selected from 27 proposals 2021
- **International Theoretical Physics Olympiad**: Rank 12 of 276 teams Jan 2021
- **University Physics Competition**: Silver Medal (top 12 of 340 teams), *Ion Thrusters to Saturn* Nov 2020
- Preliminary discovery of 3 asteroids, DST-IASC Asteroid Search Campaign 2022

Teaching Experience

- **Guest Instructor, AST 531: Graduate Galaxies & Cosmology**, SESE, ASU Fall 2026
- **Teaching Assistant, AST 121: Introduction to Astronomy Laboratory**, SESE, ASU Spring 2025
  Taught and supervised three lab sections: lectures, grading, and telescope-based experiments and night-sky observing.

Observing and Service

- **Co-PI, 12m Telescope (AZ)**: Connecting Molecular Gas to the CGM; 51 hrs of CO(1–0) Oct–Nov 2023
- **Co-PI, Hectochelle (AZ)**: Unveiling the Hidden Disks of Nearby Galaxies Sep 2023
- **International Student Advocate**, SESE Graduate Council Aug 2025 – Present

Technical Skills

Programming: Python (primary), C/C++, Java, Julia, MATLAB, Bash, SQL

Astro & Simulation: yt, Trident, PyGAD, CAESAR, CLOUDY, Astropy, CASA; TNG50, SIMBA, FIRE-2

ML/Inference: PyTorch, scikit-learn, XGBoost, `sbi`, Bayesian Logic (BLOG), posterior calibration

HPC & Tools: SLURM (A100 GPUs), MPI, Globus, HDF5/FITS, Panel/Bokeh, Git, Docker, QGIS, LaTeX