Anshuman **Acharya**

Cosmological Simulations · Machine Learning · Early Universe

BCCP, Campbell Hall, University of California, Berkeley-94720, USA.

anshumana@berkeley.edu | anshumanastro.com | anshuman1998 | ORCID

Education

PhD, Astronomy — *Garching, DE*
Max Planck Institut für Astrophysik, LMU Munich — *Sep 2021 - May 2025*
Magna cum laude, **Thesis title:** *The Intergalactic Medium at the Epoch of Reionization*

Integrated Bachelors & Masters in Physics (*minor in Astronomy*) — *SAS Nagar, IN*
Indian Institute of Science Education and Research (IISER) - Mohali — *Aug 2016 - May 2021*
CPI (Cumulative Point Index): **9.3** (from a maximum of 10)

Appointments

BCCP Postdoctoral fellow, *University of California, Berkeley* — *Berkeley, USA*
Supervisor: Dr. Simone Ferraro — *Sep 2025 - Present*

Postdoctoral researcher, *Max Planck Institute for Astrophysics* — *Garching, DE*
Supervisor: Dr. Benedetta Ciardi — *Jun 2025 - Aug 2025*

PhD researcher, *Max Planck Institute for Astrophysics* — *Garching, DE*
Supervisors: Dr. Benedetta Ciardi, Prof. Volker Springel — *Sep 2021 - May 2025*

Team leader, *SKA Science Data Challenge 3b: Inference* — *Global*
Team Name: COnstraining The SKA 21-cm Signal (COTSS-21) — *Apr 2024 - May 2025*

Team member, *SKA Science Data Challenge 3a: Foregrounds* — *Global*
Team Name: Detection Of The SKA 21-cm Signal (DOTSS-21) — *Mar 2023 - Nov 2023*

Visiting PhD fellow, *NORDITA* — *Stockholm, SE*
Supervisors: Dr. Sambit K. Giri, Prof. Axel Brandenburg — *Apr & Jul 2023*

Visiting master's thesis researcher, *CfA, Harvard & Smithsonian* — *Cambridge, USA*
Supervisors: Dr. Vinay Kashyap, Prof. Kulinder Pal Singh — *May 2020 - May 2021*

DAAD WISE fellow, *ARI, Universität Heidelberg* — *Heidelberg, DE*
Supervisor: Prof. Andreas Just — *May 2019 - Jul 2019*

Research intern, *University of California, Santa Barbara* — *Santa Barbara, USA*
Supervisors: Prof. Robert Antonucci & Dr. Vikram Khaire — *May 2018 - Jun 2018*

Honors & Awards

International level

2024 **SKA Science Data Challenge 3a winner**: part of team DOTSS-21 that finished **1**st on the leaderboard.

2023 **NORDITA Visiting PhD Fellowship**: awarded 2 months of funding and travel support to work at NORDITA.

2020 **International Astronomy and Astrophysics Competition 2020 Finalist**: qualified in the Youth category (Credential ID: PF-2020-E72C6EDF3D4).

National level

2021 **Best Poster Award**: awarded by the Astronomical Society of India. *India*

2019 **WISE Fellowship**: awarded by the German Academic Exchange Service (DAAD). *Germany*

2019 **SWAN Imaging Challenge winner**: awarded by RRI (Raman Research Institute). *India*

2018 **"Touch the Jovian Moon" contest finalist**: team "Barhaspatya", awarded the top 10 award by ISRO (Indian Space Research Organisation). *India*

2016-21 **KVPY Fellowship**: awarded by the Department of Science and Technology (DST), Govt. of India. *India*

2014-16 **NTSE Scholarship**: awarded by the National Council of Education Research and Training (NCERT),Govt. of India. *India*

Institution level

2017 **C.N.R. Rao Foundation Prize**: awarded by IISER Mohali. *SAS Nagar, IN*

Grants

FY24	**Co-Investigator**: HST Cycle 32 AR 17865 - Metal Lines as Clues: Confining the Shape of the Extragalactic UV Background.	*USA*
FY23	**NORDITA Visiting PhD Fellowship**: $4.3k.	*Stockholm, SE*
FY21-25	**Computing**: 6 million CPU hours on Raven and Freya (MPCDF).	*Garching, DE*
FY21-25	**Max Planck Society PhD Fellowship**: funding for PhD salary, $170k.	*Garching, DE*
FY20	**Chandra Research Grant**: $10k.	*Cambridge, USA*
FY19	**DAAD WISE Fellowship**: $3.5k.	*Heidelberg, DE*
FY16-21	**KVPY Fellowship**: for undergraduate studies, $5.5k.	*India*
FY14-16	**NTSE Scholarship**: for high school studies, $2k.	*India*

Publications (my ADS library)

summary – total: 19; submitted: 3; citations: 147; h-index: 8; †: non-refereed

First Author

(7) Exploring the effect of different cosmologies on the 21-cm signal with POLAR ⟨*arXiv:2410.11620*⟩
A. ACHARYA,Q. MA, S. K. GIRI, B. CIARDI, R. GHARA, ET AL. [11 AUTHORS]
Monthly Notices of the Royal Astronomical Society, accepted

(6) Revised LOFAR upper limits on the 21-cm signal power spectrum at $z \approx 9.1$ using Machine Learning and Gaussian Process Regression ⟨*arXiv:2408.10051*⟩
A. ACHARYA,F. G. MERTENS, B. CIARDI, R. GHARA, L. V. E. KOOPMANS, S. ZAROUBI
Monthly Notices of the Royal Astronomical Society: Letters, Volume 534, Issue 1, pp.L30-L34

(5,†) Spectral Fit Residuals as an Indicator to Increase Model Complexity ⟨*arXiv:2401.06372*⟩
A. ACHARYA,V. L. KASHYAP
Research Notes of the AAS, Volume 8, Issue 1, id.1

(4) Cosmic variance suppression in radiation-hydrodynamic modeling of the reionization-era 21-cm signal ⟨*arXiv:2310.13401*⟩
A. ACHARYA,E. GARALDI, B. CIARDI, Q. MA
Monthly Notices of the Royal Astronomical Society, Volume 529, Issue 4, pp. 3793–3805 (2024)

(3) 21-cm Signal from the Epoch of Reionization: A Machine Learning upgrade to Foreground Removal with Gaussian Process Regression ⟨*arXiv:2311.16633*⟩
A. ACHARYA,F. G. MERTENS, B. CIARDI, R. GHARA, L. V. E. KOOPMANS, ET AL. [10 AUTHORS]
Monthly Notices of the Royal Astronomical Society, Volume 527, Issue 3, pp.7835-7846 (2024)

(2) X-ray Activity Variations and Coronal Abundances of the Star-Planet Interaction candidate HD 179949 ⟨*arXiv:2211.01.011*⟩
A. ACHARYA,V. L. KASHYAP, S. H. SAAR, K. P. SINGH, M. KUNTZ
The Astrophysical Journal, Volume 951, Issue 2, id.152, 19 pp. (2023)

(1) How Robust are the Inferred Density and Metallicity of the Circumgalactic Medium? ⟨*arXiv:2104.01182*⟩
A. ACHARYA,VIKRAM KHAIRE
Monthly Notices of the Royal Astronomical Society, Volume 509, Issue 4, pp.5559-5576 (2022)

Co-Author

(11) Sample Variance Denoising in Cylindrical 21-cm Power Spectra ⟨*arXiv:2507.12545*⟩
D. BREITMAN, A.MESINGER, S. G. MURRAY, AND **A. ACHARYA**
Astronomy & Astrophysics, submitted

(10) First upper limits on the 21-cm signal power spectrum of neutral hydrogen at z=9.16 from the LOFAR 3C196 field ⟨*arXiv:2504.18534*⟩
E. CECCOTTI, A. R. OFFRINGA, F. G. MERTENS, L. V. E. KOOPMANS, S. MUNSHI, J. K. CHEGE, ET AL. [19 AUTHORS] INCLUDING **A. ACHARYA**
Monthly Notices of the Royal Astronomical Society, submitted

(9) Square Kilometre Array Science Data Challenge 3a: foreground removal for an EoR experiment ⟨*arXiv:2503.11740*⟩
A. BONALDI, P. HARTLEY, R. BRAUN , S. PURSER, **A. ACHARYA**, K.AHN, ET AL. [184 AUTHORS]
Monthly Notices of the Royal Astronomical Society, submitted

(8) Constraints on the state of the IGM at $z \sim 8-10$ using redshifted 21-cm observations with LOFAR ⟨*arXiv:2505.00373*⟩
R. Ghara, S. Zaroubi, B. Ciardi, G. Mellema, S. K. Giri, **A. Acharya**, et al. [21 authors]
Astronomy & Astrophysics, Volume 699, id.A109, 21 pp.

(7) Deeper multi-redshift upper limits on the Epoch of Reionization 21-cm signal power spectrum from LOFAR between z=8.3 and z=10.1 ⟨*arXiv:2503.05576*⟩
F. G. Mertens, M. Mevius, L. V. E. Koopmans, A. R. Offringa, S. Zaroubi, **A. Acharya**, et al. [23 authors]
Astronomy & Astrophysics, Volume 698, id.A186, 32 pp.

(6) Constraints on the galaxy formation models during epoch of reionization with high redshift observations ⟨*arXiv:2504.19422*⟩
Q. Ma, X. Chen, M. Li, Q. Guo, B. Ciardi, **A. Acharya**, X. Wang
The Astrophysical Journal, Volume 986, Issue 1, id.5, 14 pp.

(5) Spectral modelling of Cygnus A between 110 and 250 MHz: Impact on the LOFAR 21-cm signal power spectrum ⟨*arXiv:2502.18459*⟩
E. Ceccotti, A. R. Offringa, L. V. E. Koopmans, F. G. Mertens, M. Mevius, **A. Acharya**, et al. [18 authors]
Astronomy & Astrophysics, Volume 696, id.A56, 22 pp.

(4) Application of 3D U-Net Neural Networks in Extracting the Epoch of Reionization Signal from SKA-Low Observations Based on Real Observations of NCP Field from LOFAR ⟨*arXiv:2412.16853*⟩
L-Y. Gao, L. V. E. Koopmans, F. G. Mertens, S. Munshi, Y. Li, et al. [14 authors] including **A. Acharya**
The Astrophysical Journal, Volume 988, Issue 1, id.84, 17 pp.

(3) Inferring IGM parameters from the redshifted 21-cm Power Spectrum using Artificial Neural Networks ⟨*arXiv:2407.03523*⟩
M. Choudhury, R. Ghara, S. Zaroubi, L.V.E. Koopmans, G. Mellema, et al. [11 authors] including **A. Acharya**
JCAP, Volume 2025, Issue 06, id.003, 32 pp.

(2) Probing the intergalactic medium during the Epoch of Reionization using 21-cm signal power spectra ⟨*arXiv:2404.11686*⟩
R. Ghara, A. K. Shaw, S. Zaroubi, B. Ciardi, G. Mellema, et al. [12 authors] including **A. Acharya**
Astronomy & Astrophysics, Volume 687, id.A252, 15 pp.

(1) Properties of Loss Cone Stars in a Cosmological Galaxy Merger Scenario ⟨*arXiv:2011.08216*⟩
B. Avramov, P. Berczik, Y. Meiron, **A. Acharya**, A. Just
Astronomy & Astrophysics, Volume 649, id.A41, 17 pp.

White papers

(1,†) Expanding Heliophysics to Engage in Interdisciplinary Star-Planet Interactions Studies ⟨*baas.aas.org*⟩
K. Garcia-Sage, A. O. Farrish, et al. [63 authors] including **A. Acharya**
Decadal Survey for Solar and Space Physics (Heliophysics) 2024-2033 white paper; Bulletin of the AAS, Vol. 55, No. 3, e-id. 121 (2023)

Seminar Presentations & Posters

Presentations

summary – invited: 5; contributed: 20

2025	**Invited talk**: ESO blackboard talk	*Garching, DE*
2025	**Contributed talk**: SKAO: A New Era in Astrophysics	*Görlitz, DE*
2025	**Contributed talk**: LOFAR EoR annual plenary meeting	*Bansko, BG*
2024	**Contributed talk**: Cosmology and galaxy astrophysics with simulations & Machine Learning at CCA, Flatiron Institute	*New York City, USA*
2024	**Invited talk**: University of Cambridge 21-cm Cosmology meeting	*Online*
2024	**Contributed talk**: RADIO2024 Annual Assembly	*Erlangen, DE*
2024	**Invited talk**: MPA Institute Seminar	*Garching, DE*

2024 **Contributed talk**: Cosmic Dawn at High Latitudes, the Swedish Academy of Sciences — *Stockholm, SE*
2024 **Contributed talk**: AstroAI Workshop at AstroAI, Center for Astrophysics, Harvard & Smithsonian — *Cambridge, USA*
2024 **Contributed talk**: COSMO21: Statistical Challenges in 21st Century Cosmology — *Chania, GR*
2024 **Contributed talk**: LOFAR EoR annual plenary meeting — *Groningen, NL*
2024 **Invited talk**: SKA India 21-cm CD/EoR Bi-weekly Meeting — *Online*
2023 **Contributed talk**: RADIO2023 & GLOW Annual Assembly — *Bochum, DE*
2023 **Contributed talk**: Reionization in the Summer — *Heidelberg, DE*
2023 **Contributed talk**: LOFAR EoR annual plenary meeting — *Online*
2023 **Invited talk**: NORDITA Astrophysics Seminar — *Stockholm, SE*
2023 **Contributed talk**: 15th IMPRS on Astrophysics Student Symposium — *Garching, DE*
2022 **Contributed talk**: RADIO2022 & GLOW Annual Assembly — *Berlin, DE*
2022 **Contributed talk**: 5th Global 21-cm Workshop — *Berkeley, USA*
2022 **Contributed talk**: Turbulence Day Workshop — *Garching, DE*
2022 **Contributed talk**: LOFAR EoR Plenary Meeting — *Paris, FR*
2022 **Invited talk**: 1st Astronomy Student and Alumni Symposium, IISER Mohali — *Mohali, IN*
2021 **Contributed talk**: 12th IMPRS on Astrophysics Student Symposium — *Garching, DE*
2021 **Contributed talk**: Chandra Data Science Workshop — *Cambridge, USA*
2021 **Contributed talk**: XMM-Newton 2021 Science Workshop: A High-Energy view of Exoplanets & their Environments — *Madrid, ES*
2021 **Contributed talk**: "Fundamentals of Gaseous Halos" - Kavli Institute of Theoretical Physics, UC Santa Barbara — *Santa Barbara, USA*

Posters

2023 **IAP Symposium 2023: *New simulations for new problems in galaxy formation***: "Cosmic variance suppression in RHD modelling of the Reionization era 21-cm signal" — *Paris, FR*
2022 **Cool Stars 21**: "X-ray Variability in SPI Candidate HD179949". — *Toulouse, FR*
2022 **XXXXth Meeting of the Astronomical Society of India**: "X-ray Variability in the HD179949 System" in the category of "Stars, ISM and Galaxy". — *Roorkee, IN*
2021 **XXXIXth Meeting of the Astronomical Society of India**: "How Robust are the Inferred Density and Metallicity of the Circumgalactic Medium?" in the category of "Stars, ISM and Galaxy". — *Bangalore, IN*

Skills

Data Analysis:
- ◇ **LOFAR:** power spectrum fitting from high-redshift observational data cubes.
- ◇ **JWST:** photometric and spectroscopic data of high-redshift galaxies.
- ◇ **Chandra:** stellar spectroscopic data.
- ◇ **HST:** FOC (Faint Object Camera) UV data.

Languages: Python (AstroPy, Matplotlib, NumPy, Pandas, pyTorch, SciPy), C/C++, Fortran, Bash.
Statistical Techniques: MCMC, Bayesian analysis, Machine Learning, Neural Networks.
Other Tools: HPC, `CLOUDY` (photoionization modelling), Astronomer's Proposal Tool (APT) for JWST, DS9 (image processing), `CIAO` (Chandra Interactive Analysis of Observations), `Sherpa` for Chandra spectral fitting, LaTeX.

Scientific Outreach

2025 **ZetaGravit**: Podcast on "Listening to the Early Universe". — *Online*
2024 **MPA Open Day**: Volunteer for hands-on activities to teach astrophysical concepts to **1200+ people**. — *Garching, DE*
2024 **Vidped: Voice of the Young**: Interview on being an astrophysicist. — *Online*

2024	**Singularity: The Astronomy Club, IISER Kolkata**: outreach talk on "The Epoch of Reionization".	*Online*
2024	**SciAstra**: Live Q&A session on astronomy with high-school students.	*Online*
2024	**Chandigarh University Astronomy Club**: Delivered lectures on "*Cosmological Simulations & Structure formation*."	*Online*
2023	**Taraansh, Astronomy club, YCCE**: Lecture on "Machine Learning in Astrophysics".	*Online*
2022	**Astronomy Club, IISER Mohali**: talk on the "Epoch of Reionization".	*SAS Nagar, IN*
2022	**Aakashganga, IISER Pune**: talk on the "Epoch of Reionization".	*Online*
2022	**Luminosity Podcast series**: Interview on applying for an astrophysics PhD.	*Online*
2021	**Student Development Council, IISER Bhopal**: Panelist to advise undergraduate students applying for the DAAD WISE fellowship.	*Online*
2021	**Citizens of Science**: Interviewed astronomer Dr. Mayuri S. Rao (RRI) about transitioning from engineering to astronomy.	*Online*
2021	**Sigma Xi Research Society, VIT**: Outreach talk and Q&A on "Pursuing a career in Research" to undergraduates.	*Online*
2021	**DAAD (German Academic Exchange Service) India**: Panelist for the WISE Virtual Summer Academy's panel discussion.	*Online*
2021	**Astronomy Club, IISER Mohali**: Outreach talk on my Master's thesis research and X-ray Astronomy.	*SAS Nagar, IN*
2021	**Heeel Foundation**: Outreach event on "Simplifying Scientific Jargon" for girl students from public schools of the state of Uttarakhand, India. In particular, I translated scientific terms from English to Hindi for facilitating better understanding.	*Online*
2020	**Astronomy Club, IISER Mohali**: Outreach talk at the *Internship Webinar Series* on CV design and networking.	*Online*
2020	**Physics After Engineering (PAE) Astro Wing**: Panelist to advise engineering graduates transitioning to astronomy.	*Online*
2019	**Astronomy Club, IISER Mohali**: Outreach talk on the DAAD WISE program and my internship at the Universität Heidelberg.	*SAS Nagar, IN*
2017	**IIT Kharagpur, Bhubaneswar Extension Centre**: Invited by Subhadhra Educational and Charitable Trust to give a talk on "Basic Science Research and Why It Matters", at Science Movement 2017 to high school students.	*Bhubaneswar, IN*

Long-term Outreach

SciAstra: Mentor for astronomy.	*2023-Present*
Citizens of Science: Mentor for PhD applications.	*2020-Present*
Quora: Top Writer in 2018, with 10 million+ views, and 4000+ followers.	*2016-Present*
Other social media: Providing direct consultation to 4500+ Indian high-school students on college applications and academia.	*2016-Present*

Science Working Group memberships

Learning the Universe (LtU): "Synthetic Observations" working group.	*2025-Present*
German LOW frequency (GLOW): "Short-Wavelength Radio Astronomy & New Initiatives".	*2024-Present*
Square Kilometre Array Observatory (SKAO): "Epoch of Reionization".	*2022-Present*
LOw Frequency ARray (LOFAR): "Epoch of Reionization" Key Science Project.	*2021-Present*

Conferences/Meetings Leadership

2024 **Hackathon organizer**: at the AstroAI workshop, CfA, Harvard. *Cambridge, USA*
2022 **LOC**: for the 13th IMPRS Student Symposium at MPA. *Garching, DE*
2021 **LOC**: for Radio 2021 and GLOW Symposium at MPA. *Garching, DE*
2019 **Volunteer**: for ICGC at IISER Mohali. *Mohali, IN*

Training

Courses & Summer Schools

Unraveling Galaxy Evolution with JWST
IMPRS Heidelberg Summer School *Sep 2023*
5-day summer school on writing JWST proposals, and accessing and processing JWST data.

Large Scale Structure
IMPRS on Astrophysics 1-week workshop *Jun 2023*
Instructor: Dr. Fabian Schmidt (MPA Garching).

Cosmic Structure Formation
IMPRS on Astrophysics 1-week workshop *Mar 2023*
Instructor: Prof. Volker Springel (MPA Garching).

Galactic Dynamics
IMPRS on Astrophysics 1-week workshop *Jun 2022*
Instructor: Dr. Ortwin Gerhard (MPE Garching).

Machine Learning for Astrophysics
Catania, INAF *May 2022*
3-day course on the application of ML/DL methods to open problems in astrophysics.

Bayesian Methods for Astronomers
IMPRS on Astrophysics 1-week workshop *May 2022*
Instructor: Dr. Stefano Andreon (INAF).

Gravitational Wave Astrophysics
IMPRS on Astrophysics 1-week workshop *Mar 2022*
Instructor: Dr. Adrian Hamers (MPA Garching).

AGN Physics
IMPRS on Astrophysics *Jul 2021*
Instructor: Dr. Thomas Boller (MPE Garching).

21 cm Cosmology and Epoch of Reionisation
Indian Institute of Science and SKA (Square Kilometre Array) India *Jun 2021*
2-week online summer school by SKA India, IISc (Indian Institute of Science), Bangalore and NCRA (National Centre for Radio Astrophysics), Pune.

Self-paced Courses

Data-driven Astronomy, *Credential ID: LWAW866P45NK* *Coursera*
University of Sydney *August 2020*
Instructor: Prof. Tara Murphy and Dr. Simon Murphy. Focussing on working with large datasets (using SQL), and application of ML for classification in astrophysical data (using Python).

Applied Machine Learning in Python, *Credential ID: 39YZVQTRPK2Z* *Coursera*
University of Michigan *July 2020*
Instructor: Dr. Kevyn Collins-Thompson. Focussing on techniques and methods of machine learning. Worked on an independent project on "Understanding and Predicting Property Maintenance Fines" based on a data challenge from the Michigan Data Science Team (MDST).

Applied Plotting, Charting & Data Representation in Python, *Credential ID: 4M95CVFX78J6* *Coursera*
University of Michigan *June 2020*
Instructor: Dr. Christopher Brooks. Focussing on data representation using Matplotlib including an independent project.