Anshuman **Acharya**

PhD Student · Computation & Statistics · Early-Universe Cosmology
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Education

PhD, Physics — *Garching, DE*
Max Planck Institut für Astrophysik, LMU Munich — *Sep 2021 - Present*

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

PhD Researcher, *Max Planck Institute for Astrophysics* — *Garching, DE*
Advisor: Dr. Benedetta Ciardi — *Sep 2021 - Present*

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

Visiting PhD Fellow, *NORDITA* — *Stockholm, SE*
Advisors: Prof. Garrelt Mellema, Dr. Sambit K. Giri, Prof. Axel Brandenburg — *Apr & Jul 2023*

Visiting Master's Thesis Fellow, *Center for Astrophysics, Harvard & Smithsonian* — *Cambridge, USA*
Advisors: Dr. Vinay Kashyap, Prof. Kulinder Pal Singh — *May 2020 - May 2021*

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

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

Publications (my ADS library)

summary – total: 12; refereed: 10; submitted: 2; in-prep.: 2; citations: 23

First Author (∗: non-refereed)

(7) Exploring the effect of different cosmologies on the 21-cm signal with Polar — *TBA*
A. Acharya, Q. Ma, S. K. Giri, B. Ciardi et al.
Monthly Notices of the Royal Astronomical Society, in-prep.

(6) Revised LOFAR upper limits on the 21-cm signal power spectrum at $z \approx 9.1$ using Machine Learning and Gaussian Process Regression — *TBA*
A. Acharya, F. G. Mertens, B. Ciardi, R. Ghara, L. V. E. Koopmans, S. Zaroubi
Monthly Notices of the Royal Astronomical Society Letters, submitted

(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.
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

(4) Spectral modelling of Cygnus A between 110 and 250 MHz: Impact on the LOFAR 21-cm signal power spectrum *TBA*
E. Ceccotti, A. R. Offringa, L. V. E. Koopmans, F. G. Mertens, M. Mevius et al. including **A. Acharya**
Astronomy & Astrophysics, in-prep.

(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. including **A. Acharya**
JCAP, submitted

(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. including **A. Acharya**
Astronomy & Astrophysics, submitted

(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, V. S. Airapetian, O. Cohen, et al. including **A. Acharya**
Decadal Survey for Solar and Space Physics (Heliophysics) 2024-2033 white paper e-id. 121; Bulletin of the AAS, Vol. 55, No. 3, e-id. 121 (2023)

Honors & Awards

International level

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

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	**DAAD 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 member of "Barhaspatya", IISER Mohali. Top 10 award by ISRO (Indian Space Research Organisation) for designing a mission proposal for a lander to Europa.	*India*
2016-21	**Kishore Vaigyanik Protsahan Yojana (KVPY) Fellowship**: Awarded by the Department of Science and Technology (DST), Govt. of India.	*India*
2014-16	**National Talent Search Examination (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 for academic excellence**: Awarded by IISER Mohali.	*SAS Nagar, IN*

Grants

FY23	**NORDITA Visiting PhD Fellowship**: funding for travel and accommodation for a 2 month research stay ($4.3k).	*Stockholm, SE*
FY21-25	**Max Planck Society PhD Fellowship**: funding for the PhD salary at MPA.	*Garching, DE*
FY20	**Chandra Research Grant**: funding for a 6-month visit to the Smithsonian Astrophysical Observatory ($10k).	*Cambridge, USA*
FY19	**DAAD WISE Fellowship**: funding for a 3-month internship at the University of Heidelberg ($3.5k).	*Heidelberg, DE*
FY16-21	**KVPY Fellowship**: funding supporting Bachelor's and Master's studies and summer research internships ($5.5k).	*India*
FY14-16	**NTSE Scholarship**: funding supporting for last two years of high school ($2k).	*India*

Seminar Presentations & Posters

Presentations

2024	**Invited talk**: MPA Institute Seminar	*Garching, DE*
2024	**Contributed talk**: Cosmic Dawn at High Latitudes Conference at 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	*Ra'anana, IL*
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*

Computer 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

2024 **Vidped: Voice of the Young**: Interviewed about becoming an astrophysicist. *Online*
2024 **Singularity: The Astronomy Club, IISER Kolkata**: Invited talk on "The Epoch of Reionization". *Online*
2024 **SciAstra**: Live Q&A session on astronomy with Indian high-school students. *Online*
2024 **Chandigarh University Astronomy Club**: Delivered lectures on "Cosmological Simulations & Structure formation" for undergraduates as a part of a month-long astrophysics crash course. *Online*
2023 **Taraansh, Astronomy club, YCCE**: Invited talk on "Machine Learning in Astrophysics". *Online*

2022	**Astronomy Club, IISER Mohali**: Invited talk on the "Epoch of Reionization".	*SAS Nagar, IN*
2022	**Aakashganga, IISER Pune**: Invited talk on the "Epoch of Reionization".	*Online*
2022	**Luminosity Podcast series**: Interview about life at IISER Mohali and applying for a PhD.	*Online*
2021	**Student Development Council, IISER Bhopal**: Panelist to advise undergraduate students applying to 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**: Invited talk on "Pursuing a career in Research" followed by an interactive session with students.	*Online*
2021	**DAAD (German Academic Exchange Service) India**: Panelist for the WISE Virtual Summer Academy's panel discussion.	*Online*
2021	**Astronomy Club, IISER Mohali**: Invited talk on my Master's thesis research and X-ray Astronomy.	*SAS Nagar, IN*
2021	**Heeel Foundation**: Invited to give a talk on "Research as a Career choice" for girl students from public schools of the state of Uttarakhand, India. I also **taught them basic scientific terms and jargon they may encounter in English**.	*Online*
2020	**Astronomy Club, IISER Mohali**: Invited talk at the *Internship Webinar Series* on CV design and networking.	*Online*
2020	**Physics After Engineering (PAE) Astro Wing**: Panelist in a panel discussion addressing engineering graduates interested to pursue astronomy research.	*Online*
2019	**Astronomy Club, IISER Mohali**: Invited 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

Telegram group: Providing direct consultation and answers to high-school students on applying to research-oriented undergraduate programs in India, academia, etc. with 4500+ members.	*2020-Present*
Quora: One of the Top Writers of 2018, with 9 million+ views on 2000+ answers, and ≈4000 followers on the topic of natural sciences undergraduate education in India.	*2016-Present*

Science Working Group memberships

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

2022	**LOC**: 13th IMPRS Student Symposium.	*Garching,DE*
2021	**LOC**: Radio 2021 and GLOW Symposium.	*Garching,DE*

2019 **Volunteer**: International Conference for Gravitation & Cosmology (ICGC) *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, accessing and processing observed data from JWST to study galaxies across redshifts.

Large Scale Structure
IMPRS on Astrophysics *Jun 2023*
Instructor: Dr. Fabian Schmidt (MPA Garching). 1-week advanced course on Large Scale Structure from galactic to cosmological scales.

Cosmic Structure Formation
IMPRS on Astrophysics *Mar 2023*
Instructor: Prof. Volker Springel (MPA Garching). 1-week advanced course on studying structure formation using cosmological simulations.

Galactic Dynamics
IMPRS on Astrophysics *Jun 2022*
Instructor: Dr. Ortwin Gerhard (MPE Garching). 1-week advanced course on the theoretical background of galactic dynamics, and the basics of N-body simulations.

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

Bayesian Methods for Astronomers
IMPRS on Astrophysics *May 2022*
Instructor: Dr. Stefano Andreon (INAF). 1-week advanced course on implementing Bayesian statistics for model selection.

Gravitational Wave Astrophysics
IMPRS on Astrophysics *Mar 2022*
Instructor: Dr. Adrian Hamers (MPA Garching). 1-week advanced course on gravitational waves, and the basics of signal processing for GW detection.

AGN Physics
IMPRS on Astrophysics *Jul 2021*
Instructor: Dr. Thomas Boller (MPE Garching). 1-week advanced course on the theoretical background of AGN Physics.

***Summer School:* 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, implementing algorithms, and learning from data by using ML tools. Worked on files from exoplanet surveys, pulsar detections, galaxy clusters, etc., using Python and SQL.

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. Worked on an independent project and reported the results of the same graphically keeping in mind the principles taught in the course.