

# Anshuman Acharya

ASTRONOMICAL SIMULATIONS · ASTROSTATISTICS · EARLY UNIVERSE

Max Planck Institut für Astrophysik, Karl-Schwarzschildstr.-1, 85748-Garching, Germany.

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## Education

### PhD, Physics

MAX PLANCK INSTITUT FÜR ASTROPHYSIK, LMU MUNICH

Garching, DE  
Sep 2021 - May 2025

### Integrated Bachelors & Masters in Physics (*minor in Astronomy*)

INDIAN INSTITUTE OF SCIENCE EDUCATION AND RESEARCH (IISER) - MOHALI  
CPI (Cumulative Point Index): **9.3** (from a maximum of 10)

SAS Nagar, IN  
Aug 2016 - May 2021

## Appointments

### PhD Researcher, Max Planck Institute for Astrophysics

ADVISORS: DR. BENEDETTA CIARDI, PROF. VOLKER SPRINGEL

Garching, DE  
Sep 2021 - Present

### Team Leader, SKA Science Data Challenge 3b: Inference

TEAM NAME: CONSTRAINING THE SKA 21-CM SIGNAL (COTSS-21)

Global  
Apr 2024 - Present

### Team Member, SKA Science Data Challenge 3a: Foregrounds

TEAM NAME: DETECTION OF THE SKA 21-CM SIGNAL (DOTSS-21)

Global  
Mar 2023 - Nov 2023

### Visiting PhD Fellow, NORDITA

ADVISORS: PROF. GARRELT MELLEMA, DR. SAMBIT K. GIRI, PROF. AXEL BRANDENBURG

Stockholm, SE  
Apr & Jul 2023

### Visiting Master's Thesis Fellow, Cfa, Harvard & Smithsonian

ADVISORS: DR. VINAY KASHYAP, PROF. KULINDER PAL SINGH

Cambridge, USA  
May 2020 - May 2021

### DAAD WISE Fellow, ARI, Universität Heidelberg

ADVISOR: PROF. ANDREAS JUST

Heidelberg, DE  
May 2019 - Jul 2019

### Research Intern, University of California, Santa Barbara

ADVISORS: PROF. ROBERT ANTONUCCI & DR. VIKRAM KHAIRE

Santa Barbara, USA  
May 2018 - Jun 2018

## Honors & Awards

### International level

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

### International Astronomy and Astrophysics Competition 2020

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 **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 for academic excellence:** awarded by IISER Mohali. SAS Nagar, IN

**Grants**

FY24 **Co-Investigator:** HST [AR 17865](#), passed Phase I review. USA  
FY23 **NORDITA Visiting PhD Fellowship:** \$4.3k. Stockholm, SE  
FY21-25 **Computing:** 6 million CPU hours on Raven and Freya machines (MPCDF). Garching, DE  
FY21-25 **Max Planck Society PhD Fellowship:** funding for PhD salary, \$135k. 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: 14; refereed: 8; submitted: 2; in-prep.: 3; citations: 37

*First Author* (\*: non-refereed) .....

**(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, submitted

**(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* .....

**(6) Deeper multi-redshift upper limits on the Epoch of Reionization 21-cm signal power spectrum from LOFAR between  $z=8.3$  and  $z=10.1$**  TBA  
F. G. MERTENS, M. MEVIUS, L. V. E. KOOPMANS, A. R. OFFRINGA, **A. ACHARYA**, ET AL.  
Monthly Notices of the Royal Astronomical Society, in-prep.

**(5) Square Kilometre Array Science Data Challenge 3a: foreground removal for an EoR experiment** TBA  
SKAO & PARTICIPATING TEAMS, INCLUDING **A. ACHARYA**  
Monthly Notices of the Royal Astronomical Society, in-prep.

**(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⟩](https://arxiv.org/abs/2407.03523)  
M. CHOUDHURY, R. GHARA, S. ZAROUBI, L.V.E. KOOPMANS, G. MELLEMA, ET AL. [11 AUTHORS] INCLUDING **A. ACHARYA**  
JCAP, submitted

**(2) Probing the intergalactic medium during the Epoch of Reionization using 21-cm signal power spectra** [⟨arXiv:2404.11686⟩](https://arxiv.org/abs/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⟩](https://arxiv.org/abs/2011.08216)  
B. AVRAMOV, P. BERCIK, 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⟩](https://baas.aas.org)  
K. GARCIA-SAGE, A. O. FARRISH, V. S. AIRAPETIAN, O. COHEN, ET AL. [63 AUTHORS] 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)

## Seminar Presentations & Posters

*Presentations* .....

- |      |  |                |
|------|--|----------------|
| 2024 | <b>Invited talk:</b> University of Cambridge 21-cm Cosmology meeting                                 | Online         |
| 2024 | <b>Invited talk:</b> MPA Institute Seminar   | Garching, DE   |
| 2024 | <b>Contributed talk:</b> Cosmic Dawn at High Latitudes Conference at the Swedish Academy of Sciences | Stockholm, SE  |
| 2024 | <b>Contributed talk:</b> AstroAI Workshop at AstroAI, Center for Astrophysics, Harvard & Smithsonian | Cambridge, USA |
| 2024 | <b>Contributed talk:</b> COSMO21: Statistical Challenges in 21st Century Cosmology                   | Chania, GR     |
| 2024 | <b>Contributed talk:</b> LOFAR EoR annual plenary meeting  | Groningen, NL  |
| 2024 | <b>Invited talk:</b> SKA India 21-cm CD/EoR Bi-weekly Meeting  | Online         |
| 2023 | <b>Contributed talk:</b> RADIO2023 & GLOW Annual Assembly  | Bochum, DE     |
| 2023 | <b>Contributed talk:</b> Reionization in the Summer  | Heidelberg, DE |

2023	<b>Contributed talk:</b> LOFAR EoR annual plenary meeting	<i>Ra'anana, IL</i>
2023	<b>Invited talk:</b> NORDITA Astrophysics Seminar	<i>Stockholm, SE</i>
2023	<b>Contributed talk:</b> 15th IMPRS on Astrophysics Student Symposium	<i>Garching, DE</i>
2022	<b>Contributed talk:</b> RADIO2022 & GLOW Annual Assembly	<i>Berlin, DE</i>
2022	<b>Contributed talk:</b> 5th Global 21-cm Workshop	<i>Berkeley, USA</i>
2022	<b>Contributed talk:</b> Turbulence Day Workshop	<i>Garching, DE</i>
2022	<b>Contributed talk:</b> LOFAR EoR Plenary Meeting	<i>Paris, FR</i>
2022	<b>Invited talk:</b> 1st Astronomy Student and Alumni Symposium, IISER Mohali	<i>Mohali, IN</i>
2021	<b>Contributed talk:</b> 12th IMPRS on Astrophysics Student Symposium	<i>Garching, DE</i>
2021	<b>Contributed talk:</b> Chandra Data Science Workshop	<i>Cambridge, USA</i>
2021	<b>Contributed talk:</b> XMM-Newton 2021 Science Workshop: A High-Energy view of Exoplanets & their Environments	<i>Madrid, ES</i>
2021	<b>Contributed talk:</b> "Fundamentals of Gaseous Halos" - Kavli Institute of Theoretical Physics, UC Santa Barbara	<i>Santa Barbara, USA</i>

## Posters .....

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

## 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, L<sup>A</sup>T<sub>E</sub>X.

## Scientific Outreach

2024	<b>Vidped: Voice of the Young: Interview</b> on being an astrophysicist.	<i>Online</i>
2024	<b>Singularity: The Astronomy Club, IISER Kolkata:</b> outreach talk on "The Epoch of Reionization".	<i>Online</i>
2024	<b>SciAstra: Live Q&amp;A session</b> on astronomy with high-school students.	<i>Online</i>
2024	<b>Chandigarh University Astronomy Club:</b> Delivered lectures on "Cosmological Simulations & Structure formation" for undergraduates as a part of a month-long astrophysics crash course.	<i>Online</i>
2023	<b>Taraansh, Astronomy club, YCCE:</b> Lecture on "Machine Learning in Astrophysics".	<i>Online</i>
2022	<b>Astronomy Club, IISER Mohali: Outreach talk</b> on the "Epoch of Reionization".	<i>SAS Nagar, IN</i>

2022	<b>Aakashganga, IISER Pune:</b> Outreach talk on the “Epoch of Reionization”.	Online
2022	<b>Luminosity Podcast series:</b> <a href="#">Interview</a> on applying for an astrophysics PhD.	Online
2021	<b>Student Development Council, IISER Bhopal:</b> Panelist to advise undergraduate students applying for the DAAD WISE fellowship.	Online
2021	<b>Citizens of Science:</b> <a href="#">Interviewed</a> astronomer Dr. Mayuri S. Rao (RRI) about transitioning from engineering to astronomy.	Online
2021	<b>Sigma Xi Research Society, VIT:</b> <a href="#">Outreach talk and Q&amp;A</a> on “Pursuing a career in Research” to undergraduates.	Online
2021	<b>DAAD (German Academic Exchange Service) India:</b> Panelist for the WISE Virtual Summer Academy’s panel discussion.	Online
2021	<b>Astronomy Club, IISER Mohali:</b> <a href="#">Outreach talk</a> on my Master’s thesis research and X-ray Astronomy.	SAS Nagar, IN
2021	<b>Heel Foundation:</b> 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	<b>Astronomy Club, IISER Mohali:</b> <a href="#">Outreach talk</a> at the <i>Internship Webinar Series</i> on CV design and networking.	Online
2020	<b>Physics After Engineering (PAE) Astro Wing:</b> Panelist in a panel discussion addressing engineering graduates switching to astronomy research.	Online
2019	<b>Astronomy Club, IISER Mohali:</b> Outreach talk on the DAAD WISE program and my internship at the Universität Heidelberg.	SAS Nagar, IN
2017	<b>IIT Kharagpur, Bhubaneswar Extension Centre:</b> Invited by Subhadhra Educational and Charitable Trust to give a <a href="#">talk</a> on “Basic Science Research and Why It Matters”, at Science Movement 2017 to high school students.	Bhubaneswar, IN
	<b>Long-term Outreach</b> .....	
	<b>SciAstra:</b> Mentor for astronomy.	2023-Present
	<b>Citizens of Science:</b> Mentor for PhD applications.	2020-Present
	<b>Quora:</b> One of the Top Writers of 2018, with 9 million+ views, and 4000+ followers on the topic of natural sciences undergraduate education in India.	2016-Present
	<b>Other social media:</b> Providing direct consultation to 4500+ Indian high-school students on college applications and academia.	2016-Present
	<b>Science Working Group memberships</b> _____	
	<b>German LOW frequency (GLOW):</b> “Short-Wavelength Radio Astronomy & New Initiatives”.	2024-Present
	<b>Square Kilometre Array Observatory (SKAO):</b> “Epoch of Reionization”.	2022-Present
	<b>Low Frequency ARray (LOFAR):</b> “Epoch of Reionization” Key Science Project.	2021-Present
	<b>Conferences/Meetings Leadership</b> _____	
2024	<b>Hackathon organizer:</b> “Generative AI for super-resolving cosmological simulations” at the AstroAI workshop, CfA, Harvard.	Cambridge, USA
2022	<b>LOC:</b> 13th IMPRS Student Symposium.	Garching, DE
2021	<b>LOC:</b> Radio 2021 and GLOW Symposium.	Garching, DE
2019	<b>Volunteer:</b> 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, 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 and conference 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 1-week workshop**

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, 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.