Arnab Chakraborty

Trottier Chair Fellow

Contact Information

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Employment

Trottier Chair Fellow November 2021 – present

Department of Physics & Trottier Space Institute, McGill University, Montreal, Canada.

Education

Ph.D. in Astrophysics & Cosmology — July 2016 - September 2021
Department of Astronomy, Astrophysics and Space Engineering
Indian Institute of Technology, Indore
Supervisors: Abhirup Datta

Master Degree in Physics — September 2013 - August 2015
University of Burdwan, Burdwan, India
Master Thesis: Secondary Anisotropies in Cosmic Microwave Background
Supervisor: Sarbeswar Chaudhuri

Bachelor Degree in Physics — August 2010- July 2013
Asutosh College, University of Calcutta, Kolkata, India

Research Interests

Cosmology: Cosmological data analysis, HI 21cm Intensity Mapping, Baryon Accoustic Osscilation, Epoch of Reionization and Cosmic Dawn, large scale structure

Radio astronomy: Developing pipeline to calibrate and imaging of radio interferometric low-frequency data, direction-dependent calibration, radio frequency interference (RFI) flagging.

Foreground Characterization: Modelling the emission of Galactic and extragalctic foregrounds, Compact sources and diffuse synchrotron radiation, foreground suppression and avoidance techniques.

Strong Gravitational Lensing: HI 21cm emission line from distant galaxies, strongly lensed by foreground galaxies, star formation history

Interface of Astrophysics and Cosmology: Radio continuum study of deep fields at low-frequency, studying clustering properties of sources, Active Galactic Nuclei, Star-Forming Galaxies, continuum study of Galactic plane at 1.4 GHz and 5 GHz.

Honors & Awards

- Trottier Chair Fellowship, McGill University, November 2021 to present
- Young Scientist Award at URSI-GASS 2021
- DST Inspire Fellowship for Ph.D, July 2016 to September 2021
- Scholarship for Higher Education (SHE) by DST-Inspire, October 2010 to October2015

Accepted observational proposals

upgraded Giant Metrewave Radio Telescope (uGMRT):

- Characterizing Foregrounds in 21cm Cosmology Observations: Pilot Study with the uGMRT at 250-500 MHz, **ID:** 32_120
- Characterizing Foregrounds in 21cm Cosmology Observations: Pilot Study with the uGMRT at 120-240 MHz, **ID:** 34_141
- Characterizing Foregrounds in 21cm Cosmology Observations with the uGMRT at 120 - 240 MHz - Phase 1, **ID:** 41_099
- Characterizing Foregrounds in 21cm Cosmology Observations with the uGMRT at 120 - 240 MHz - Phase 2, **ID:** 43_077
- Characterizing Foregrounds in 21cm Cosmology Observations with the uGMRT at 120 - 240 MHz - Phase 3, **ID:** 46_016
- The search for redshifted HI signal in redshift range 1.8 - 3.7 with the uGMRT, **ID:** 45_124
- Towards 21-cm intensity mapping at $1.8 < z < 3.7$ with uGMRT, **ID:** 46_032

Students Advised

- Aishrila Mazumder, IIT Indore, Ph.D, December 2017 to November 2022.
  Project title: "Characterization of Foregrounds and Systematics for Sensitive Radio Observations"
  Now post-doc at the University of Manchester

- Akriti Sinha, IIT Indore, Ph.D, July 2018 to February 2024.
  Project title:"Star-formation in Radio Deep Fields: a Multi-wavelength Perspective"
  Now post-doc at Thuringer Landessternwarte Tautenburg, Germany

- Rashmi Sagar, IIT Indore, Ph.D, May 2021 to present.
  Project title: "Characterizing Foregrounds and constraint on HI 21cm signal from Epoch of Reionization with uGMRT."

- Kyle Miller, McGill University, Master student, Fall 2023 to present.
  project title: "OH megamaser search with CHIME"

Teaching Experience

- Teaching Assistant, Radio Astronomy, IIT Indore, 2017-2019
  Taught basics of Radio Astronomy and Radiative Transfer to the Master Students and first-year Ph.D students in their course-work.

- Computer lab assistant, Radio data analysis and astrostatistics, IIT Indore, 2018-2019
  Take computational lab course and taught radio data analysis: Calibration, RFI flagging and imaging using CASA.

- Tutorial on data analysis in school "Frontiers in 21 cm Cosmology" held at Kodaikanal Solar Observatory, December 2018
  Take a tutorial on calibration and imaging of radio data and power spectrum estimation from it.

- Take tutorial on radio astronomy data analysis in school "First billion years" held at Indian Institute of Technology, Indore, January 2020.

Collaboration Member

The Canadian Hydrogen Intensity Mapping Experiment (CHIME): HI intensity mapping group

The Canadian Hydrogen Observatory and Radio-transient Detector (CHORD): Intensity mapping and HI galaxy survey group

Service

To the Astrophysics Community:

- Referee, Monthly Notices of the Royal Astronomical Society

- Referee, GMRT time allocation committee

Publications

Led or Co-led

1. **Chakraborty A.**, Datta A., Choudhuri S., Roy N., Intema H., Choudhury M., Datta K.K., Pal S., Bharadwaj S., Dutta P., Choudhury T.R. (2019), *Detailed study of the ELAIS N1 field with the uGMRT - I. Characterizing the 325 MHz foreground for redshifted 21 cm observations* , MNRAS , 487(3), 4102–4113, doi:10.1093/mnras/stz1580, [arXiv:1906.01655]
2. **Chakraborty A.**, Roy N., Datta A., Choudhuri S., Datta K.K., Dutta P.,Bharadwaj S., Intema H., Choudhury M., Pal S., Choudhury T.R. (2019), *Detailed study of ELAIS N1 field with the uGMRT - II. Source properties and spectral variation of foreground power spectrum from 300-500 MHz observations, MNRAS*, 490(1), 243–259, doi:10.1093/mnras/stz2533, [arXiv:1908.10380]
3. **Chakraborty A.**, Dutta P., Datta A., Roy N. (2020), *The study of the angular and spatial distribution of radio-selected AGNs and star-forming galaxies in the ELAIS N1 field*, MNRAS, 494(3), 3392–3404, doi:10.1093/mnras/staa945, [arXiv:2001.02358]

4. **Chakraborty A.**, Datta A., Roy N., Bharadwaj S., Choudhury T.R., DattaK.K., Pal S., Choudhury M., Choudhuri S., Dutta P., Sarkar D. (2021), *First Multi-redshift Limits on Post-Epoch of Reionization 21 cm Signal from z =1.96-3.58 Using uGMRT*, APJL, 907(1), L7, doi:10.3847/2041-8213/abd17a, [arXiv:2012.04674]
5. **Chakraborty A.**, Roy N., Wang Y., Datta A., Beuther H., Medina S.N.X.,Menten K.M., Urquhart J.S., Brunthaler A., Dzib S.A. (2020), *Characterization of unresolved and unclassified sources detected in radio continuum surveys of the Galactic plane*, MNRAS, 492(2), 2236–2240, doi:10.1093/mnras/stz3621, [arXiv:2001.02358]
6. **Chakraborty A.**, Datta A, Mazumder A, 2021, *A Comparative Analysis To Deal With Missing Spectral Information Caused By RFI In Cosmological HI 21CM Observations*, The Astrophysical Journal, Volume 929, Issue 1, id.104, 13 pp., doi:10.3847/1538-4357/ac5cc5, [arXiv:2203.04994]
7. Shaw A, **Chakraborty A** and other, *Probing early universe through redshifted 21-cm signal: Modelling and observational challenges*, 2022, Review article, Accepted for publication in the Special Issue of Journal of Astrophysics and Astronomy on "Indian Participation in the SKA", [arxiv:2211.05512]
8. **Chakraborty A** and Roy N, *Detection of HI 21cm emission from a strongly lensed galaxy at z=1.3,* MNRAS, Volume 519, Issue 3, pp.4074-4081, doi: 10.1093/mnras/stac3696 , [arxiv:2301.05987]
9. Shaw A, Jagannath M, Mazumder A, **Chakraborty A**, Patra N, Mondal R, Choudhuri S, *Detecting galaxies in a large HI spectral cube*, Journal of Astrophysics and Astronomy, Volume 43, Issue 2, article id.99, [arxiv:2211.02041]

Publications Led by a Supervised Student

1. Mazumder A, **Chakraborty A**, Datta A, *Characterizing EoR foregrounds: A study of the Lockman Hole Region at 325 MHz*, MNRAS, Volume 495, Issue 4, pp.4071-4084, doi:10.1093/mnras/staa1317, [arxiv:2005.05205]
2. Mazumder A, **Chakraborty A**, Datta A, *A study on the clustering properties of radio-selected sources in the Lockman Hole region at 325 MHz*, MNRAS, Volume 517, Issue 3, pp.3407-3422, doi:10.1093/mnras/stac2801, [arxiv:2208.00992]
3. Mazumder A,Datta A, **Chakraborty A**, Majumder S, *Observing the reionization: effect of calibration and position errors on realistic observation conditions*, MNRAS, Volume 515, Issue 3, pp.4020-4037, doi: 10.1093/mnras/stac1994, [arxiv:2207.06169]
4. Sinha, A, Basu A; Datta A, **Chakraborty A**, *Deep uGMRT observations of the ELAIS-North 1 field: statistical properties of radio-infrared relations up to $z \sim 2$*, 2022, MNRAS, Volume 514, Issue 3, pp.4343-4362, doi: 10.1093/mnras/stac1504 , arxiv:2111.08336

Collaboration Equivalent as a contributor to the work

1. **CHIME collaboration including Chakraborty A**, *A Detection of Cosmological 21 cm Emission from CHIME in Cross-correlation with eBOSS Measurements of the Ly-alpha Forest*, The Astrophysical Journal, Volume 963, Issue 1, id.23, 11 pp., [arxiv:2309.04404]
2. **CHIME Collaboration, including Chakraborty A**, *Characterization of the John A. Galt Telescope for radio holography with CHIME*, Proceedings of the SPIE, Volume 12190, id. 121902V 16 pp. (2022), arxiv:2207.13876
3. Pal S, Elahi A, Bharadwaj A, Ali S, Choudhuri S, Ghosh A, **Chakraborty A**, Datta A, Roy N, Choudhury M, Dutta P, *Towards 21-cm Intensity Mapping at z=2.28 with uGMRT using the Tapered Gridded Estimator I: Foreground Avoidance*, MNRAS Volume 516, Issue 2, pp.2851-2863, [arxiv:2208.11063]
4. Elahi A, Bharadwaj A, Ghosh A, Pal S, Ali S, Choudhuri S, **Chakraborty A**, Datta A, Roy N, Choudhury M, Dutta P, *Towards 21-cm intensity mapping at z=2.28 with uGMRT using the tapered gridded estimator II: Cross-polarization power spectrum*, MNRAS Volume 520, Issue 2, pp.2094-2108, [arxiv:2301.06677]
5. Elahi A, Bharadwaj A, Ghosh A, Pal S, Ali S, Choudhuri S, **Chakraborty A**, Datta A, Roy N, Choudhury M, Dutta P, *Towards 21-cm intensity mapping at z=2.28 with uGMRT using the tapered gridded estimator III: Foreground removal*, MNRAS Volume 525, Issue 3, pp.3439-3454, [arxiv:2308.08284]
6. Elahi A, Bharadwaj A, Ghosh A, Pal S, Ali S, Choudhuri S, **Chakraborty A**, Datta A, Roy N, Choudhury M, Dutta P, *Towards 21-cm intensity mapping at z=2.28 with uGMRT using the tapered gridded estimator – IV. Wideband analysis*, MNRAS Volume 529, Issue 4, pp.3372-3386, arxiv:2403.06736
7. Gayen S, Sagar R, Mangla S, Dutta P, Roy N, **Chakraborty A**, Kumar J, Datta A, Choudhuri S, *Calibration requirement for Epoch of Reionization 21-cm signal observation. Part III. Bias and variance in uGMRT ELAIS-N1 field power spectrum*, JCAP, Volume 2024, Issue 05, id.068, 24 pp. arxiv:2402.18306
8. Dzib S.A, ... **Chakraborty A**, 2022, *A global view on star formation: The GLOSTAR Galactic plane survey. VI. Radio Source Catalog II:* $28^\circ < l < 36^\circ$ *and* $|b| < 1^\circ$ *, VLA B-configuration*, [arxiv:2210.00560]
9. Mazumder A, Datta A, Sathyanarayana Rao M, **Chakraborty A** and others, 2022, *Synthetic Observations with the Square Kilometre Array (SKA) – development towards an end-to-end pipeline*, Journal of Astrophysics and Astronomy on "Indian Participation in the SKA', [arxiv:2211.04302]

Contributed Talks

December 2017	"Characterizing Foregrounds in 21 cm Cosmology Observation with the uGMRT at 300-500 MHz", "Universe after the first 200 million years Cosmic Dawn, Reionization and Post reionization with 21cm" held at Presidency University from 11-13 December, 2017
December 2018	"Detailed study of ELAIS N1 field using uGMRT observation at 300-500 MHz", Frontiers in 21 cm Cosmology" held at Kodaikanal Solar Observatory from 10-18th December, 2018
January 2020	"Detail study of foregrounds in ELAIS N1 field", "First Billion Years" at Indian Institute of Technology, Indore, 2020
March 2021	"Characterizing Low-frequency Foregrounds for Cosmological HI studies with the uGMRT - Indian SKA pathfinder" in AAS 236 virtual meeting held at USA
January 2021	"First multi-redshift limits on HI 21 cm signal from z = 1.96 - 3.58 using uGMRT" in SAZERAC SIP (on 29th Jan 2021) on the 21-cm Signal from Cosmic Dawn and the Epoch of Reionisation
June 2023	"Progress towards measuring HI auto power spectrum using CHIME data" in TomFest: Frontiers in Radio Science and Engineering with Tom Landecker, at DRAO.
March 2024	"Progress towards measuring HI auto power spectrum using CHIME data" in Cosmology in the Alps conference, Switzerland