Dr. ARIJIT MANNA

Curriculum Vitae

Department of Astrophysics and High Energy Physics
S. N. Bose National Centre for Basic Sciences
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Research Interest

More than 300 molecular species have been identified in the interstellar medium (ISM) through radio, millimeter, and submillimeter observations, revealing a rich and complex astrochemical environment. My research focuses on understanding the formation and evolution of complex organic molecules (COMs) in diverse astrophysical environments, particularly in active star-forming regions where these species are most abundant. Using high-sensitivity spectroscopic observations from facilities such as ALMA, GBT, IRAM, and other radio and millimeter-wave telescopes, I investigate the rotational and vibrational emission and absorption lines of COMs, including key precursors of amino acids relevant to prebiotic chemistry. To interpret these observations, I employ three-phase (gas, grain-surface, and icy-mantle) warm-up chemical models incorporating both gas-phase and grain-surface reactions to constrain viable formation and destruction pathways. This integrated observational and modelling approach provides critical insights into the chemical processes linking interstellar chemistry to the emergence of prebiotic molecules and the early chemical evolution of planetary systems, with implications for the origin of life in the Universe.

Research Expertise

Star-Forming Regions, hot molecular cores, millimeter- and radio-wavelength astronomy, astrochemistry, radiative transfer model, chemical modelling.

Education

2021–2026: **Ph.D in Science (Research Topic: Astrophysics & Astrochemistry), Title of Thesis: Detection of Complex Molecules From Millimeter Wavelength Spectra Radiating From Interstellar Medium and Planetary Objects**, *Institution: Vidyasagar University*, Midnapore, West Bengal, India, Supervisor: Dr. Sabyasachi Pal, Ph.D.

2018–2020 : **Master of Science (MSc), Physics, Specialization: Astronomy and Astrophysics**, *Vidyasagar University*, Midnapore, West Bengal, India.

2015–2018 : **Bachelor of Science (BSc), Physics**, *University of Calcutta*, Kolkata, West Bengal, India.

2015: **Higher Secondary, Science**, *West Bengal Council of Higher Secondary Education*.

2013: **Secondary**, *West Bengal Board of Secondary Education*.

Professional Appointments

2025–present : **Post Doctoral Research Associate**, *Department of Astrophysics and High Energy Physics*, S. N. Bose National Centre for Basic Sciences (SNBNCBS), Salt Lake, JD Block, Sector 3, Bidhannagar, Kolkata, West Bengal, India - 700106.

Publications

Articles in Refereed Journal:

2026 **Arijit Manna**, Sabyasachi Pal, Sekhar Sinha, and Sushanta Kumar Mondal. Organic Acid Chemistry in ISM: Detection of Formic Acid and its Prebiotic Chemistry in Hot Core G358.93-0.03 MM1. ***Research in Astronomy and Astrophysics***, volume 26, page 035019, February 2026. DOI: https://doi.org/10.1088/1674-4527/ae2f4b.

2026 **Arijit Manna** and Sabyasachi Pal. First detection of ethylene oxide and acetaldehyde in hot core G358.93–0.03 MM1: Tracing prebiotic oxygen chemistry. ***New Astronomy***, volume 122, page 102465, January 2026. DOI: 10.1016/j.newast.2025.102465.

2024 Sabyasachi Pal and **Arijit Manna**. Detection of continuum emission and atomic hydrogen from comet C/2020 F3 NEOWISE using GMRT. ***Journal of Astrophysics and Astronomy***, volume 45, page 10, March 2024. DOI: 10.1007/s12036-024-09998-4.

2024 **Arijit Manna**, Sabyasachi Pal, and Serena Viti. Detection of antifreeze molecule ethylene glycol in the hot molecular core G358.93-0.03 MM1. ***Monthly Notices of the Royal Astronomical Society***, volume 533, pages 1143–1155, September 2024. DOI: 10.1093/mnras/stae1864.

2024 **Arijit Manna**, Sabyasachi Pal, Sekhar Sinha, and Sushanta Kumar Mondal. ALMA and GMRT Studies of Dust Continuum Emission and Spectral Lines Toward Oort Cloud Comet C/2022 E3 (ZTF). ***Research in Astronomy and Astrophysics***, volume 24, page 125009, December 2024. DOI: 10.1088/1674-4527/ad8eae.

2024 **Arijit Manna**, Sabyasachi Pal, Tapas Baug, and Sougata Mondal. Study of Complex Nitrogen and Oxygen-bearing Molecules toward the High-mass Protostar IRAS 18089–1732. ***Research in Astronomy and Astrophysics***, volume 24, page 065008, June 2024. DOI: 10.1088/1674-4527/ad3b3c.

2024 **Arijit Manna** and Sabyasachi Pal. Observation of Complex Organic Molecules Containing Peptide-like Bonds Toward Hot Core G358.93–0.03 MM1. ***Research in Astronomy and Astrophysics***, volume 24, page 075014, July 2024. DOI: 10.1088/1674-4527/ad539b.

2024 **Arijit Manna** and Sabyasachi Pal. First Identification and Chemical Modeling of New Thiol (−SH) Bearing Molecule in the Interstellar Medium: Dithioformic Acid. ***ACS Earth and Space Chemistry***, volume 8, pages 2401–2410, December 2024. DOI: 10.1021/acsearthspacechem.4c00142.

2024 **Arijit Manna** and Sabyasachi Pal. Detection of possible glycine precursor molecule methylamine towards the hot molecular core G358.93-0.03 MM1. ***New Astronomy***, volume 109, page 102199, July 2024. DOI: 10.1016/j.newast.2024.102199.

2024 **Arijit Manna** and Sabyasachi Pal. Detection and prebiotic chemistry of possible glycine precursor molecule methylenimine towards the hot molecular core G10.47+0.03. ***International Journal of Astrobiology***, volume 23, page e14, May 2024. DOI: 10.1017/S1473550424000107.

2024 **Arijit Manna** and Sabyasachi Pal. Detection and Chemical Modeling of Complex Prebiotic Molecule Cyanamide in the Hot Molecular Core G31.41+0.31. ***ACS Earth and Space Chemistry***, volume 8, page 665. ACS Publications, February 2024. DOI: 10.1021/acsearthspacechem.3c00245.

2024 **Arijit Manna** and Sabyasachi Pal. Confirmation of interstellar phosphine towards asymptotic giant branch star IRC+10216. ***Journal of Astrophysics and Astronomy***, volume 45, page 36, December 2024. DOI: 10.1007/s12036-024-10027-7.

2024 **Arijit Manna** and Sabyasachi Pal. ALMA detection of hydrogen cyanide in the atmosphere of Saturn. ***Journal of Astrophysics and Astronomy***, volume 45, page 31, October 2024. DOI: 10.1007/s12036-024-10024-w.

2024 Manoj Mandal, Debasish Saha, Sabyasachi Pal, and **Arijit Manna**. Multi-wavelength observation of MAXI J1348-630 during the outburst in 2019. ***Astrophysics and Space Science***, volume 369, page 18, February 2024. DOI: 10.1007/s10509-024-04280-z.

2023 Payel Nandi, CS Stalin, DJ Saikia, Rogemar A Riffel, **Arijit Manna**, Sabyasachi Pal, OL Dors, Dominika Wylezalek, Vaidehi S Paliya, Payaswini Saikia, et al. Evidence for low-power radio jet–ism interaction at 10 pc in the dwarf agn host ngc 4395. ***The Astrophysical Journal***, volume 959, page 116. IOP Publishing, 2023. DOI: 10.3847/1538-4357/ad0c57.

2023 **Arijit Manna**, Sabyasachi Pal, Serena Viti, and Sekhar Sinha. Identification of the simplest sugar-like molecule glycolaldehyde towards the hot molecular core G358.93-0.03 MM1. ***Monthly Notices of the Royal Astronomical Society***, volume 525, pages 2229–2240, October 2023. DOI: 10.1093/mnras/stad2185.

2023 **Arijit Manna** and Sabyasachi Pal. Identification of interstellar cyanamide towards the hot molecular core G358.93-0.03 MM1. ***Astrophysics and Space Science***, volume 368, page 33. Springer, April 2023. DOI: 10.1007/s10509-023-04192-4.

2023 **Arijit Manna** and Sabyasachi Pal. Detection of monothioformic acid towards the solar-type protostar IRAS 16293-2422. ***Journal of Astrophysics and Astronomy***, volume 44, page 69, December 2023. DOI: 10.1007/s12036-023-09961-9.

2023 **Arijit Manna** and Sabyasachi Pal. Detection of complex nitrogen-bearing molecule ethyl cyanide towards the hot molecular core G10.47 + 0.03. ***Astrophysics and Space Science***, volume 368, page 44, May 2023. DOI: 10.1007/s10509-023-04202-5.

2023 **Arijit Manna** and Sabyasachi Pal. ACA observation and chemical modeling of phosphorus nitride towards hot molecular cores G10.47+ 0.03 and G31.41+ 0.31. ***Journal of Astrophysics and Astronomy***, volume 45, page 3, December 2023. DOI: 10.1007/s12036-023-09989-x.

2022 **Arijit Manna** and Sabyasachi Pal. Identification of interstellar amino acetonitrile in the hot molecular core G10.47+0.03: Possible glycine survey candidate for the future. ***Life Sciences in Space Research***, volume 34, pages 9–15, August 2022. DOI: 10.1016/j.lssr.2022.04.002.

2022 **Arijit Manna** and Sabyasachi Pal. First detection of methyl formate in the hot molecular core IRAS 18566+0408. ***Astrophysics and Space Science***, volume 367, page 94, September 2022. DOI: 10.1007/s10509-022-04132-8.

2022 **Arijit Manna** and Sabyasachi Pal. Detection of interstellar cyanamide (NH_2CN) towards the hot molecular core G10.47+0.03. ***Journal of Astrophysics and Astronomy***, volume 43, page 83, December 2022. DOI: 10.1007/s12036-022-09868-x.

Publication in The Astronomer's Telegram:

2022 Shobha Kumari, Sabyasachi Pal, Manoj Mandal,, *and* ***Arijit Manna***., VLA observation of LSV + 4417 during the giant outburst of 2022–2023, The Astronomer's Telegram, ATel #15913.

2026 **Arijit Manna**, Sabyasachi Pal, and Tapas Baug., Detection of comet 3I/ATLAS in radio wavelength during closest approach to Earth using uGMRT, The Astronomer's Telegram, ATel #17571.

Book Chapter:

2022 **Arijit Manna**, *and Sabyasachi Pal.*, Millimeter wavelength studies of complex nitrile species in the atmosphere of Saturn's moon titan, **Advances in Modern and Applied Sciences**, ISBN: 978-1-64997-436-5, page 90-101, Scientific Research Publishing, Inc. USA, November 2022.

Publication in Conference Proceedings:

2024 **Arijit Manna**, *Sabyasachi Pal, and Tapas Baug.*, Detection of phosphorus nitride and other complex organic molecules towards the high-mass protostar IRAS 18089–1732, *4^{th} meeting on Star Formation Studies in India* in S. N. Bose National Centre for Basic Sciences, Kolkata, 8–11 January, 2024.

2023 **Arijit Manna**, *Sabyasachi Pal, and Sekhar Sinha*, Identification of molecular outflows towards the hot molecular core G34.43+00.24 MM1, *A National Workshop on Galactic inflows and outflows on all Scales (GALFLOWS 2023)* in IUCAA, Pune, 2–5 February, 2023.

2022 **Arijit Manna**, *and Sabyasachi Pal*, ALMA detection of the glycine precursor amino acetonitrile towards the hot molecular core G10.47+0.03, *The 21st National Space Science Symposium (NSSS)* in IISER Kolkata, 31 January – 4 February, 2022.

2020 **Arijit Manna**, *and Sabyasachi Pal*, Millimeter-wavelength study of Galactic micro-quasar SS433 using the Atacama Large Millimeter Array (ALMA), *27th West Bengal State Science & Technology in University of Burdwan, West Bengal, 13–18 December, 2020.*

2019 **Arijit Manna**, *and Sabyasachi Pal*, Study of emission from low mass X-ray binaries in millimetre wavelength, *4th National Conference on Recent Trends in the Study of Compact Objects: Theory and Observation (RETCO-IV) in IUCAA, Pune, 17–20 April 2019.*

Major observing proposal awards as principal investigator/co-principal investigator

GMRT: ddtC267 (2023) – GMRT observation of comet C/2022 E3 (ZTF).

GMRT: Cycle 46: 46_073 (2024) – Observation of radio continuum emission and atomic hydrogen from comet 12P/Pons-Brooks (2024) and C/2023 A3 (Tsuchinshan-ATLAS).

GMRT: Cycle 49: 49_160 (2025) – Observation of Radio Continuum Emission and HI from the Interstellar Comet 3I/ATLAS.

GMRT: Cycle 50: 50_116 (2026) – Study of Continuum Emission and Atomic HI from Comet C/2025 R3 (PANSTARRS).

Honors, Awards, and Fellowships

• Post-doctoral Fellowship, S. N. Bose National Centre for Basic Sciences (SNBNCBS), Kolkata, India, 2025-2027.

• A graphical abstract illustrating the first detection of t-HC(S)SH in the hot corino NGC 1333 IRAS 4A, including its presence in the ISM, was featured on the cover of **ACS Earth and Space Chemistry**. This recognition is featured in the December (2024), Volume 8, Issue 12.

• Visiting Researcher Fellowship, S. N. Bose National Centre for Basic Sciences (SNBNCBS), Kolkata, India, February 2024.

• Awarded the Swami Vivekananda Merit Cum Means Fellowship by the Government of West Bengal, including research funding from 2022-2025, in recognition of exceptional academic achievements and research potential.

• Received the Rajya Puruskar Award for Scouting in 2015 from Keshari Nath Tripathi, the Honourable Governor of West Bengal.

Research highlights and media coverage

• Featured in Nature (Research Highlight, 2026) for the study on the detection of key interstellar organic molecules (ethylene oxide and acetaldehyde) in a Milky Way star-forming region G358.93–0.03 using the Atacama Large Millimetre/Submillimeter Array.

• GMRT observations of radio emission from the interstellar comet 3I/ATLAS received media coverage on R Plus News. The study investigates radio diagnostics of rare interstellar visitors to the Solar System.

• Research highlighted in Anandabazar Patrika on the discovery of low-frequency radio emission from the extrasolar comet 3I/ATLAS (4 January 2026, Link).

• Article selected for inclusion in the ACS Earth and Space Chemistry special collection "The Year of Quantum: Advances in Astrochemistry and Molecular Astrophysics" (International Year of Quantum Science and Technology, 2025).

• Featured in NEWS 18 Bangla, Sangbad Pratidin, and Ajkal Patrika for the discovery of dithioformic acid (HC(S)SH) in hot corino object NGC 1333 IRAS 4A2 (Link1, Link2).

• Research on the discovery of the simplest sugar-like molecule, Glycolaldehyde (CH_2OHCHO), in the high-mass star-forming region G358.93–0.03 was covered by Astrobiology Web (Link).

• First discovery of the simplest sugar alcohol molecule, ethylene glycol ($(CH_2OH)_2$), in hot molecular core G358.93–0.03 MM1 was covered by AstroChemical Newsletter (#105).

Technical Skills

Programming Languages :	Python, Latex.
Astronomical Software:	CASA, AIPS, GBT IDL, CASSIS, XCLASS, MADCUBA, GILDAS, RADEX, ULCHEM, GGCEHMPY, CARTA, RADTRAN, NEMESIS, PSG.
Radio Telescope Data Analysis :	Atacama Large Millimeter/submillimeter Array (ALMA), Green Bank Telescope (GBT), Giant Metrewave Radio Telescope (GMRT), Very Large Array (VLA), Australia Telescope Compact Array (ATCA), Institut de Radioastronomie Millimétrique (IRAM) 30 m, Submillimeter Array (SMA).
Spectroscopic and Astrochemical Databases :	Cologne Database for Molecular Spectroscopy (CDMS), Jet Propulsion Laboratory (JPL), Leiden Ice Database for Astrochemistry (LIDA), Kinetic Database for Astrochemistry (KIDA), The UMIST Database for Astrochemistry.

Referee for peer-review journals

- The Astrophysical Journal (IOP Science)
- The Astronomical Journal (IOP Science)
- The Planetary Science Journal (IOP Science)
- Chemical Papers (Springer Nature)
- Journal of Instrumentation (IOP Science)

Collaborators

- Dr. Sabyasachi Pal (Midnapore City College, Paschim Medinipur, India).
- Dr. Tapas Baug (S. N. Bose National Centre for Basic Sciences, Kolkata, India).
- Dr. Avdhoot Datar (University of Dayton, Dayton, OH 45469, United States.)
- Dr. Somnath Dutta (Academia Sinica Institute of Astronomy and Astrophysics, Taiwan).
- Dr. Manash Samal (Physical Research Laboratory, Ahmedabad, Gujarat).
- Prof. Serena Viti (Leiden Observatory, The Netherlands).
- Prof. C. S. Stalin (Indian Institute of Astrophysics, Bangalore, India).
- Dr. Susanta Kumar Mondal (Sidhu-Kanhu-Birsha University, Purulia, West Bengal).
- Dr. Sandip Dutta (Dinabandhu Andrews Institute of Technology and Management, Kolkata).

References

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   Purulia, West Bengal, India - 723104
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4. **Dr. Manash Samal**
   Associate Professor,
   Astronmy & Astrophysics Divison,
   Physical Research Laboratory,
   Ahmedabad 380009, Gujarat, India
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5. **Dr. Sandip Dutta**
   Assistant Professor,
   Department of Applied Mathematics,
   Dinabandhu Andrews Institute of Technology and Management (DAITM),
   Block-S, 1/406A, Patuli, Kolkata, West Bengal, India - 700094
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