

# Rajsekhar Mohapatra

Theoretical and Numerical Astrophysics

Humboldt Fellow, AIP Potsdam

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## Research interests

My research combines theoretical modelling and numerical fluid dynamics to investigate turbulence, magnetic fields, cooling and feedback across the interstellar medium, galactic atmospheres and galaxy clusters. I use high-resolution simulations to connect the underlying gas physics to observations and models for larger-scale simulations.

## Academic and research appointments

|                   |                                                                                                            |
|-------------------|------------------------------------------------------------------------------------------------------------|
| Oct 2026–present  | <b>Humboldt Fellow</b><br>Leibniz Institute for Astrophysics Potsdam (AIP), Germany.                       |
| Sep 2022–Sep 2026 | <b>Postdoctoral Research Associate</b><br>Department of Astrophysical Sciences, Princeton University, USA. |

## Education

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|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Oct 2018–Sep 2022 | <b>PhD in Astronomy</b> , Australian National University, Australia.<br>Thesis: <i>The Role of Stratification, Turbulence and Cooling in the Intracluster Medium</i> .<br>Supervisor: Prof. Christoph Federrath. |
| Aug 2014–Jun 2018 | <b>BSc in Physics</b> , Indian Institute of Science, Bengaluru, India.<br>Thesis: <i>Studying Turbulence in the Intracluster Medium</i> .<br>Supervisor: Prof. Prateek Sharma.                                   |

## Awards and scholarships

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|---------------|--------------------------------------------------------------------------------------------------------------------|
| From Oct 2026 | <b>Humboldt Fellowship</b> , Alexander von Humboldt Foundation, Germany.                                           |
| 2018–2022     | <b>University Research Scholarship</b> , Australian National University.                                           |
| 2019, 2022    | <b>International Travel Grant</b> , Research School of Astronomy and Astrophysics, Australian National University. |
| 2013–2018     | <b>Kishore Vaigyanik Protsahan Yojana (KVPY) Scholarship</b> , Department of Science and Technology, India.        |

## Publications

### First-author papers

- **Mohapatra, R.**, Dutta, A., and Sharma, P. “Multiphase gas in Circumgalactic cloud complexes: Insights from kiloparsec-scale Magnetohydrodynamic Turbulence Simulations”. In: *The Open Journal of Astrophysics* 9 (2026), p. 64831. doi: 10.33232/001c.164831.

- **Mohapatra, R.**, Lancaster, L., Fielding, D., Quataert, E., and Bryan, G. L. “How Magnetic Fields Regulate Cooling and Mixing in Turbulent Radiative Mixing Layers”. In: (2026). arXiv: 2609.29782 [astro-ph.GA] (**submitted**).
- **Mohapatra, R.**, Quataert, E., Fielding, D., and Guo, M. “The Type Ia Supernova and Asymptotic Giant Branch Stellar Ejecta-regulated Interstellar Medium of Massive Galaxies”. In: *ApJ* 989, 103 (2025). doi: 10.3847/1538-4357/adea6c.
- **Mohapatra, R.** and Quataert, E. “Multiphase Gas in Elliptical Galaxies: The Role of Type Ia Supernovae”. In: *ApJ* 965, 105 (2024). doi: 10.3847/1538-4357/ad2940.
- **Mohapatra, R.**, Sharma, P., Federrath, C., and Quataert, E. “Multiphase condensation in cluster haloes: interplay of cooling, buoyancy, and mixing”. In: *MNRAS* 525 (2023), pp. 3831–3848. doi: 10.1093/mnras/stad2574.
- **Mohapatra, R.**, Federrath, C., and Sharma, P. “Multiphase turbulence in galactic haloes: effect of the driving”. In: *MNRAS* 514 (2022), pp. 3139–3159. doi: 10.1093/mnras/stac1610.
- **Mohapatra, R.**, Jetty, M., Sharma, P., and Federrath, C. “Characterizing the turbulent multiphase haloes with periodic box simulations”. In: *MNRAS* 510 (2022), pp. 3778–3793. doi: 10.1093/mnras/stab3603.
- **Mohapatra, R.**, Jetty, M., Sharma, P., and Federrath, C. “Velocity structure functions in multiphase turbulence: interpreting kinematics of H $\alpha$  filaments in cool-core clusters”. In: *MNRAS* 510 (2022), pp. 2327–2343. doi: 10.1093/mnras/stab3429.
- **Mohapatra, R.**, Federrath, C., and Sharma, P. “Turbulent density and pressure fluctuations in the stratified intracluster medium”. In: *MNRAS* 500 (2021), pp. 5072–5087. doi: 10.1093/mnras/staa3564.
- **Mohapatra, R.**, Federrath, C., and Sharma, P. “Turbulence in stratified atmospheres: implications for the intracluster medium”. In: *MNRAS* 493 (2020), pp. 5838–5853. doi: 10.1093/mnras/staa711.
- **Mohapatra, R.** and Sharma, P. “Turbulence in the intracluster medium: simulations, observables, and thermodynamics”. In: *MNRAS* 484 (2019), pp. 4881–4896. doi: 10.1093/mnras/stz328.

### Second- and third-author papers

- Desire, T., Kim, C.-G., and **Mohapatra, R.** “A Comparative Study of Isothermal Turbulence Statistics: Fourier Space Driving vs. Point Source Driving”. In: (2026). doi: 10.48550/arXiv.2606.14946. arXiv: 2606.14946 [astro-ph.GA] (**submitted**).
- Lancaster, L., Fielding, D., **Mohapatra, R.**, and Bryan, G. L. “The Origin of Da Scaling: Suppressed Cooling in Fast-cooling Mixing Layers”. In: *ApJ* 1008, 13 (2026). doi: 10.3847/1538-4357/ae908e.
- Lancaster, L., **Mohapatra, R.**, Fielding, D. B., and Bryan, G. L. “Ceci n’est pas une Couche de Mélange: The Meaning of Resolved Turbulent Radiative Mixing”. In: *ApJ* 1005, 222 (2026). doi: 10.3847/1538-4357/ae7714.
- Gatuzz, E., **Mohapatra, R.**, Federrath, C., Sanders, J. S., Liu, A., Walker, S. A., and Pinto, C. “Measuring the hot ICM velocity structure function using XMM-Newton observations”. In: *MNRAS* 524 (2023), pp. 2945–2953. doi: 10.1093/mnras/stad2039.

### Other co-authored papers

- Fournier, M., Grete, P., Brüggén, M., O’Shea, B. W., Prasad, D., Wibking, B. D., Glines, F. W., and **Mohapatra, R.** “XMAGNET: Velocity structure functions of active galactic nucleus-driven turbulence in the multiphase intracluster medium”. In: *A&A* 698, A121 (2025). doi: 10.1051/0004-6361/202554278.

- Gatuazz, E., Sanders, J., Liu, A., Fabian, A., Pinto, C., Russell, H., Eckert, D., Walker, S., ZuHone, J., and **Mohapatra, R.** “Chemical enrichment of the intracluster medium within the A3266 cluster: I. Radial profiles”. In: *A&A* 698, A94 (2025). doi: 10.1051/0004-6361/202453360.
- Gatuazz, E., Sanders, J., Liu, A., Fabian, A., Pinto, C., Russell, H., Eckert, D., Walker, S., ZuHone, J., and **Mohapatra, R.** “Measuring the intracluster medium velocity structure within the A3266 galaxy cluster”. In: *A&A* 692, A108 (2024). doi: 10.1051/0004-6361/202451640.

## Competitive computing allocations

ACCESS credits are allocations redeemable for computing time across US national supercomputers. DeltaAI equivalents below use the current conversion of 7,500 H100 GPU-hours per million credits.

|      |                                                                                                                       |
|------|-----------------------------------------------------------------------------------------------------------------------|
| 2026 | <b>ACCESS — Co-principal investigator</b><br>10 million ACCESS credits; equivalent to 75,000 DeltaAI H100 GPU-hours.  |
| 2025 | <b>Frontier — Co-investigator</b><br>800,000 node-hours, Oak Ridge National Laboratory, USA.                          |
| 2025 | <b>ACCESS — Co-principal investigator</b><br>20 million ACCESS credits; equivalent to 150,000 DeltaAI H100 GPU-hours. |
| 2024 | <b>ACCESS — Co-principal investigator</b><br>13 million ACCESS credits; equivalent to 97,500 DeltaAI H100 GPU-hours.  |
| 2023 | <b>ACCESS — Principal investigator</b><br>3 million ACCESS credits (45,000 Delta A100 GPU-hours).                     |

## Research software development and numerical expertise

**Methods:** High-resolution hydrodynamic and magnetohydrodynamic simulations; driven and stratified turbulence; radiative cooling; resolved supernova heating; turbulent mixing layers; radiative shocks.

**Simulation codes:** AthenaK, FLASH and PLUTO.

**AthenaK research development:** I maintain athenak-RM, my public research fork of AthenaK, with a turbulence driver and on-the-fly analysis tools.

**Simulation analysis software:** I develop AthenaResearchRM, an open-source Python package for simulation analysis and visualisation, with CPU/GPU support and MPI parallelism.

**Programming and analysis:** C, C++, Fortran, Python.

**Computing facilities:** USA: Frontier, Delta and DeltaAI; Princeton’s Della and Stellar; Australia: Gadi and Raijin; Finland/EuroHPC: LUMI.

## Mentoring and supervision

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|-----------|----------------------------------------------------------------------------------------------------------------------------------------|
| 2026      | Co-supervision and mentoring of Xiaoqi Jiang, a master’s student at the University of Chicago, USA, during a summer research project.  |
| 2026      | Supervision and mentoring of Tanya Zhou, undergraduate summer student, Princeton University, USA.                                      |
| 2025–2026 | Supervision and mentoring of Prisha Sahu, high-school student, Texas, USA.                                                             |
| 2024–2026 | Co-supervision and mentoring of Tejahni Desire, bachelor’s thesis student from Princeton University, USA; student-led paper submitted. |

- 2023–2026 Mentor, graduate student–postdoc mentoring programme, Princeton University.
- 2025 Supervision and mentoring of Yash Padaya, a master’s student at Liverpool John Moores University, UK, during a summer research project.
- 2021–2022 Co-supervision and mentoring of Mrinal Jetti, master’s thesis student from IIT Madras, Chennai, India; two papers published in MNRAS with the student as a co-author (paper 1, paper 2).
- 2019–2021 Supervision and mentoring of two high-school students through Canberra’s MSATT program, Canberra, Australia.

## Teaching

- Jan 2020–May 2021 **Tutor in Physics**, Australian National University. Physics of Materials (2020); Advanced Electromagnetism (2021).
- 2021 **Tutor, Indigenous Tuition Program**, Tjabal Indigenous Higher Education Centre, Australian National University. Provided academic tutoring for Indigenous Australian students.
- 2020 **Guest lecturer, Astrophysical Processes (ASTR6013)**, Australian National University. Guest lectures in the graduate course convened by Prof. Christoph Federrath.

## Academic service

- 2022–present **Journal refereeing**: Astronomy & Astrophysics; The Astrophysical Journal; Astronomy and Computing; Monthly Notices of the Royal Astronomical Society; The Open Journal of Astrophysics; Frontiers.
- 2024–2026 **Postdoctoral representative, Departmental Climate Committee**, Department of Astrophysical Sciences, Princeton University.
- 2024 **Proposal referee**, Hubble Space Telescope (HST) Cycle 32.
- 2024 **Workshop organising committee**, *Synergistic Approaches to Particle Transport in Magnetized Turbulence*, Princeton Center for Theoretical Science, Princeton University.
- 2022 **Volunteer, IAU General Assembly**, Busan, South Korea.
- 2020–2022 **Student representative, Inclusion, Diversity, Equity and Access Committee**, Research School of Astronomy & Astrophysics (RSAA), Australian National University.
- 2019 **Organiser, Mount Stromlo Student Seminars**, Australian National University.

## Outreach and public engagement

- 2023–2025 **Public observing team**, Department of Astrophysical Sciences, Princeton University.

- 2019–2022** **Outreach Assistant**, Mount Stromlo Observatory, Australian National University. Organised more than 50 school visits for students in Years 3–10, spanning approximately 8–16 years of age.
- Rural school outreach:** Visited schools in rural Australia to deliver astronomy outreach activities, New South Wales, Australia.
- Public talks:** Delivered astronomy talks to audiences of more than 100 people, Mount Stromlo Observatory, Australia.
- Observatory open days:** Organised ANU Open Day tours at Siding Spring Observatory, Australia.
- 2020** **Online public talks:** Delivered live astronomy talks on YouTube and Facebook during the COVID-19 pandemic.
- 2015–2018** **IISc open days:** Organised Open Day tours at the Indian Institute of Science, Bengaluru, India.

## Seminars

### Invited seminars

- Apr 2026 *KICP Seminar*, University of Chicago, USA.
- Mar 2026 University of Massachusetts Amherst, USA.
- Feb 2026 Australian National University, Canberra, Australia.
- Mar 2024 *Galaxy Talk*, Center for Computational Astrophysics, Flatiron Institute, New York, USA.
- Apr 2023 *Monday Science Seminar*, Department of Astronomy, University of Wisconsin–Madison, USA.

### Other seminars

- Sep 2026 *Oxford Simulators Meeting*, University of Oxford, UK.
- Apr 2026 *CIERA Seminar*, Northwestern University, Evanston, USA.
- Feb 2026 *Seminar*, Swinburne University of Technology, Melbourne, Australia.
- Feb 2026 University of Western Australia, Perth, Australia.
- Dec 2025 Cardiff University, UK.
- Dec 2025 *Plasma group meeting*, University of Oxford, UK.
- Nov 2025 *Cosmology Lunch*, Max Planck Institute for Astrophysics, Garching, Germany.
- May 2025 Yonsei University, Seoul, South Korea.
- Nov 2024 *Galaxy Clusters Meeting*, Center for Astrophysics, Harvard University, Cambridge, USA.
- Oct 2024 *Cosmology Lunch*, Max Planck Institute for Astrophysics, Garching, Germany.
- Oct 2024 *Galaxy Lunch*, Leiden University, Netherlands.
- Sep 2024 *Galaxy Coffee*, Max Planck Institute for Astronomy, Heidelberg, Germany.
- May 2024 *Galaxy Discussion*, Institute of Astronomy, University of Cambridge, UK.
- May 2024 *Galaxy Lunch Talk*, Department of Physics, University of Oxford, UK.

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| Feb 2024 | <i>KIPAC XOC Group Talk, Stanford University, USA.</i>                                 |
| Feb 2024 | <i>Tea Talk, Caltech, Pasadena, USA.</i>                                               |
| Apr 2023 | <i>Galaxy Lunch Seminar, Department of Astronomy, Yale University, New Haven, USA.</i> |

## Conferences, workshops and research programmes

### Invited talks

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|----------|-----------------------------------------------------------------------------------------|
| Jul 2026 | <i>8th ICM Theory and Computation Workshop, Brno, Czech Republic.</i>                   |
| Jun 2024 | <i>7th ICM Theory and Computation Workshop, University of Michigan, Ann Arbor, USA.</i> |

### Contributed talks

|              |                                                                                                                             |
|--------------|-----------------------------------------------------------------------------------------------------------------------------|
| Jul 2026     | <i>The Many Scales of Galaxy Environments (GalScale26), Ascona, Switzerland.</i>                                            |
| Nov 2025     | <i>Modelling of Multiphase Astrophysical Media, Schloss Ringberg, Germany.</i>                                              |
| Jul 2025     | <i>National Astronomy Meeting, Durham, UK.</i>                                                                              |
| Dec 2024     | <i>Baryons Beyond Galactic Boundaries, IUCAA, Pune, India.</i>                                                              |
| Aug–Sep 2024 | <i>Toward a Holistic Understanding of the Multi-scale, Multiphase Circumgalactic Medium, Aspen Center for Physics, USA.</i> |
| Feb 2024     | <i>Turbulence in the Universe, KITP conference, Santa Barbara, USA.</i>                                                     |
| Jan–Mar 2024 | <i>Turbulence in Astrophysical Environments, KITP research programme, Santa Barbara, USA.</i>                               |
| Feb 2023     | <i>Oasis in the Cosmic Desert, Arizona State University, USA.</i>                                                           |
| Nov 2022     | <i>Exploring the Hot and Energetic Universe, Barcelona, Spain.</i>                                                          |
| Aug 2022     | <i>XXXI IAU General Assembly, BEXCO, Busan, South Korea.</i>                                                                |