DEEPEN GARG
Postdoctoral Researcher, University of Bonn

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Research Interests

Early Universe cosmology (main theme) | Cosmological magnetic fields | Parity (a)symmetry in the early Universe | Vorticity production | Gravitational wave cosmology | Chiral anomaly | Axion inflation | Cosmological phase transitions | MHD turbulence

Education

Ph.D. & M.A. in Astrophysical Sciences (plasma physics)	Princeton University	2023
B. Tech. in Mechanical Engg.	Indian Inst. of Technology (IIT) Bombay	2011

Employment History

Postdoctoral Researcher	University of Bonn	Feb '25 – present
Visiting Researcher	University of Geneva	Sep '23 – Jan '25
PhD Candidate	Princeton University	Jul '18 – Jul '23
Graduate Student	Princeton University	Jul '16 – Jul '18
Visiting Scientist	Inst. for Plasma Research Ahmedabad	Jan '15 – Apr '16
Project Associate	IIT Delhi (Dept. of Computer Sciences)	Apr '14 – Dec '14
Senior Analyst	Fractal Analytics (non-academic)	Jul '11 – Mar '14

Technical Skills

Python | FORTRAN | Mathematica | C++ | Bash | HPC & Git | GPU coding (CUDA) | Pencil Code

Past and Ongoing Major Research Projects

Macroscopic chiral effects in the early Universe [Aug '24 – present]

- Skills required: Chiral anomaly theory, Quantum statistical mechanics, MHD dynamo theory, Pencil Code

Vorticity production for perfect fluids [Sep '23 – present]

- Skills: Relativistic fluid dynamics, First-order cosmological phase transitions theory, GPU-coding (CuPy)

Scalar perturbations from inflationary magnetogenesis [2] [Sep '23 – Jul '24]

- Skills: Inflationary scalar perturbation theory, Tachyonic instability of U(1) gauge field for axion inflation, Asymptotics of special functions, Python (NumPy, SciPy, mpmath), Mathematica

Dispersive gravitational waves (GWs) in gases and plasmas [3 - 7] [May '18 – Jul '23]

- Skills: Higher-order perturbation theory for GR, Dispersive wave mechanics, Variational formalisms

Tokamak Design, SST-2 [8] [Jan '15 – Apr '16]

Visiting Scientist, Institute for Plasma Research, Gandhinagar, India

- Skills: 3D MHD equilibrium in tokamaks, Grad-Shafranov solver, FORTRAN

Teaching Experience

Lecturer, Pencil Code workshop, CERN [Oct '25]

- Invited to give a lecture on chiral MHD and co-organize the daily exercise sessions on the Pencil Code

Head Tutor, Undergraduate course, Electrodynamics, Bonn [Fall semester '25]

- Prepared the weekly exercises and solutions, and managed the communication with the tutors

Teaching Assistant, Master's course, Astrophysical fluids and plasmas, Bonn [Spring semester '25]

- Graded the weekly exercises and organized the weekly exercise sessions and discussion groups

Teaching Assistant, Graduate course, Plasma waves and instabilities, Princeton [Fall semester '20]

- Graded the weekly exercises and organized the weekly exercise sessions and discussion groups

High School Teacher, Physics [May '09 – Jul '11]

- Taught high-school physics to IIT-JEE aspirants as a college part-time job at Pace Academy, Mumbai

Community Service

Public Outreach

- Public talk on "Cosmological magnetic fields" at Pint of Science event, Bonn, May 2025
- Volunteered for multiple outreach events at Princeton Plasma Physics Lab over the years
  - Open House for prospective students, 2020-2022; APS-DPP Plasma Science Expo, 2018
- Campus tour leader for new graduate student orientation, Princeton University, 2022
- Managed a booth with a Van der Graff generator for Community & Staff Day, Princeton University, 2018

Refereeing work

- I have refereed papers for the following journals
  - Classical and Quantum Gravity
  - Astrophysical Journal

DEI initiatives

- Physics instructor and part of the initial team of volunteers for a non-profit organization, Maadhyam, aimed to bridge the gender gap in rural India, since 2018
  - Goal is to help the underprivileged women and children by various initiatives like building a library, providing self-defense and personal hygiene lessons, & mentoring rural children for STEM careers
- Volunteered for multiple Women in Plasma Physics events at Princeton Plasma Physics Lab over the years
- As a member of Princeton Citizen Scientist, visited senators and representatives in 2019 to lobby for paid parental leave and healthcare in the US with evidence-based policymaking
- Gave free private high school physics lessons to underprivileged students in Mumbai during 2009-11

Roles in student bodies

- Twice elected as the President of the residential student body, Lawrence Apartments Committee at Princeton, in 2021 & 2022
  - Initiated and oversaw a total overhaul of the constitution, the website and the social event landscape
- Served as the Secretary of the Lawrence Apartments Committee, 2020
  - Set up and managed all the pandemic communication, activities, and protocols for our community
- Served in various student body positions at IIT Bombay
  - Department Secretary, Mechanical Engg. Department, IIT Bombay, 2009-10
  - Sports Secretary, Hostel 13, IIT Bombay, 2008-09
  - Commander, 2MER company of National Cadet Corps (NCC) at IIT Bombay, 2007-08

Talks and Seminars

- Oct 2025 and Sep 2023, University of Geneva, Cosmology and Astroparticle Physics seminar
- Aug 2025, Nordita Stockholm, Numerical Simulations of Early Universe Sources of GWs
- Apr 2025, Benasque Science Center, The Dawn of Gravitational Wave Cosmology (*a talk and a panel*)
- Nov 2024, Majorana-Raychaudhuri Seminar (***invited***)
- Oct 2024, Laboratoire Astroparticule & Cosmologie (APC Paris), Theory group seminar
- Sep 2024, Institut D'Astrophysique de Paris (IAP), Gravitational and Cosmology (GReCO) Seminar
- Sep 2024, Geneva Observatory, Tea-time seminar
- Sep 2024, University of Münster, Schmitz working group seminar
- Jun 2024, SISSA Trieste, Astroparticle Physics Seminar
- Jun 2024, University of Southern Denmark, CP-3 Seminar
- May 2024, EPFL, Bernoulli Workshop on Cosmological Magnetic fields (***invited***)
- 2018 – 2022, presentations at the annual meetings of APS Division of Plasma Physics
- Nov 2021, University of Illinois Urbana Champaign, Midwest Relativity Meeting
- Apr 2019, APS April Meeting

Other Awards

- Won APS DGRAV student travel grant 2019

Non-Academic Professional Experience

Senior Analyst, Fractal Analytics Ltd., Mumbai [Oct '12 – Mar '14]
Analyst [Jul '11 – Sep '12]

- Led a team of 5 analysts to optimize marketing budgets of clients
- Pioneered a new technique using log-linear regression in marketing analytics [9]
- Awarded Best Overall Performance in Consumer Analytics, and a fast-tracked promotion cycle
- Conducted many formal and informal training sessions and seminars on MMM and related topics

List of Publications

1. D. Garg, J. Schober, and R. Durrer, *Are magnetic fields in cosmic voids primordial?*, arXiv:2505.14774
2. R. Durrer, R. von Eckardstein, D. Garg, K. Schmitz, O. Sobol, and S. Vilchinskii, *Scalar perturbations from inflation in the presence of gauge fields*, Phys. Rev. D **110**, 043533 (2024)
3. D. Garg and I. Y. Dodin, *Self-consistent interaction of linear gravitational and electromagnetic waves in non-magnetized plasma*, J. Cosmol. Astropart. Phys. **02** (2024) 045
4. D. Garg and I. Y. Dodin, *Gauge-invariant gravitational waves in matter beyond linearized gravity*, Class. Quantum Gravity **40**, 215002 (2023)
5. D. Garg and I. Y. Dodin, *Gauge invariants of linearized gravity with a general background metric*, Class. Quantum Gravity **39**, 245003 (2022)
6. D. Garg and I. Y. Dodin, *Gravitational wave modes in matter*, J. Cosmol. Astropart. Phys. **08** (2022) 017
7. D. Garg and I. Y. Dodin, *Average nonlinear dynamics of particles in gravitational pulses: Effective Hamiltonian, secular acceleration, and gravitational susceptibility*, Phys. Rev. D **102**, 064012 (2020)
8. U. Prasad *et al.*, *Preliminary Design of Central Solenoid of SST-2 and Demo*, IEEE Trans. Appl. Supercond. **26**, no. 4, 4200904 (2016)
9. D. Garg *et al.*, *Multiplicative Marketing Mix Modeling simplified* (2014) [non-academic white paper]