Mudit Garg

: astromuditgarg.github.io

: mg9113@nyu.edu

ORCID: 0000-0002-9032-9103

Research Interests

9 first-author papers (7 published) · SciX Library

I study how **massive black holes (MBHs) co-evolve with their host galaxies**, focusing on gas disks around MBH binaries (MBHBs) from sub-parsec scales to merger. I built the first pipeline from simulation-calibrated gas torques to Bayesian LISA inference and showed when gas and orbital eccentricity leave measurable imprints on gravitational waves (GWs). These imprints probe gas at micro-parsec scales that telescopes cannot resolve in distant binaries, and, if ignored, can mimic violations of general relativity. I now run 3D magnetohydrodynamic (MHD) simulations of turbulent circumbinary disks and have added my live post-Newtonian binary to a GPU code, to model both GW and EM signals, so LISA, Rubin, and Roman can jointly constrain the gas.

Education

08/'21 – 10/'25	Doctor of Philosophy, Faculty of Science **University of Zurich** Advisor: Prof. Lucio Mayer *Decoding the Sub-Parsec Scale Environment of LISA Massive Black Hole Binaries with Gravitational Waves*
09/'18 – 12/'20	Master of Science in Physics GPA: 5.87/6 **ETH Zurich** Thesis supervisor: Prof. Lavinia Heisenberg *Relativistic, ghost-free, and covariant hybrid model for MOND: $f(Q)$*
07/'14 – 06/'18	Bachelor of Technology in Engineering Physics GPA: 8.15/10 **IIT Delhi** Thesis supervisor: Prof. Ajit Kumar *Geodesics near a charged black hole in $(R \pm \mu^4/R)$ gravity*

Academic Experience

11/'25 – *10/'27*	SNSF Postdoc.Mobility Fellow (own grant, can end at CITA start) **New York University** Host: Prof. Andrew MacFadyen
02/'21 – 07/'21	Research Scholar **University of Zurich** Supervisor: Prof. Lucio Mayer

Fellowships & Awards

'25	SNSF Postdoc.Mobility Fellowship, CHF 136,000 (≈CAD 230,000)
'20	MSc Physics with distinction, ETH Zurich

Leadership, Service, and Teaching

'26 –	Co-organizer, Astrophysics Seminars, New York University, inviting a gender-balanced mix of early-career and senior speakers
'26 –	Mentor, LISA Early Career Scientists (LECS) mentoring program
'26	Volunteer at NYU's postdoc orientation (Office of Postdoctoral Affairs)
'25 –	Referee for ApJ, PRD

'24 –	Outreach: video interviews for the LISA Consortium ('24) and *The Minds in Motion* ('26); Three Minute Thesis talk ('25)
'22 –	Contributor, LISA Consortium projects: Disc-IMRI hydro code comparison (paper); astrophysical source parameter space for waveforms; MBHB section (§2.2) of the in-progress update of the LISA Astrophysics white paper
'21 –	LISA Consortium member, core member since '25; Astrophysics, Waveform, LISA Data Challenge, and LECS groups
'24	Informal advisor to a junior PhD student on LISA detectability, University of Zurich
'23 – '25	Sole organizer, "GWs, BHs, and Compact Binaries" Seminars, University of Zurich
'21 – '25	Teaching assistant, University of Zurich: *Theoretical Astrophysics*, *Computational Methods for Radiative Transfer*, and others

Selected Talks 9 seminars, 1 colloquium, 16 conference talks (4 invited†, 1 panel) · full list

Seminars & colloquia: GRAPPA Colloquium, Amsterdam ('26); THEA Seminar, Columbia ('26); CfA High Energy Seminar, Harvard & Smithsonian ('26); Special TAPIR Seminar, Caltech ('25); Cosmology Seminar, MPA Garching ('24); DAMTP GR Seminar, Cambridge ('24).

Conferences: DYNAMIX†, Cambridge ('25); GW Probes of BH Environments†, Trieste ('25); Frontiers of Astrophysical Black Holes†, Sexten ('25); New Ideas on the Origin of BH Mergers†, NBI Copenhagen ('24); Panelist and short talk, eccentric compact binaries, Corfu ('26); LISA Symposium, College Park ('26).

Informal: CCA SPA ('24, '26) and GW ('26) groups, and Wednesday coffee talk ('26); MIT Kavli ('24, '26); IAS-Princeton GW group ('26).

Research Visits

- CCA, Flatiron Institute: regular visitor, MHD and `Pasta` work with Y.-F. Jiang ('25–)
- Niels Bohr International Academy, Copenhagen ('25; host J. Samsing)
- Max Planck Institute for Gravitational Physics (AEI), Potsdam ('23; host J. Gair)

Codes & Computing C++ (Kokkos), Python, Mathematica

- `Pasta` (GPU radiation-MHD code by Jiang et al., in prep.): wrote the live post-Newtonian (PN) binary setup (≈1,700 lines: 1–2.5PN dynamics, gas-gravity back-reaction, standard and torque-free sink accretion, target-temperature cooling), validated against PN theory and my `Athena++` MHD runs, found the multi-GPU MHD bottleneck, and added faster POSIX output.
- `Athena++`: matched 3D MHD and α-viscosity hydrodynamic (HD) simulations of circumbinary disks (1.2M CPU core-hours); implemented a locally isothermal equation of state and α-viscosity, public on GitHub.
- `GIZMO`: HD simulations of live PN MBHBs in circumbinary disks (350k CPU core-hours).
- `lisabeta`: developed the environmental-effect waveform modules and included the eccentric TaylorF2 model (Moore et al. 2016) as `TF2Ecc`, with S. Tiwari. Full LISA response and Bayesian parameter estimation with `ptmcmc` and `Eryn` (RJMCMC).