Som Dev Bishoyi

Contact Information

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Education

University of Massachusetts Dartmouth

Ph.D. in Computational Science and Engineering, Specialization in Numerical PDEs, Scientific ML, Gravitational waves, GPA : 4.00/4.00 — *Sept 2022-present*

Dissertation Advisor : Professor Scott Field

IISER Kolkata

BS-MS in Physics, Minor in Mathematics, GPA : 9.05/10 — *August 2017-July 2022*

Thesis : Studies on the spacetime of slowly rotating stars

Research Interests

I develop efficient, high-order PDE solving algorithms for problems in computational general relativity, black hole perturbation theory(BHPT) and gravitational waves. I work with discontinuous Galerkin/WENO methods to solve wave equations in BHPT. Also developing exact nonreflecting boundary conditions using Boundary Kernels and perfectly matched layers/hyperboloidal slicing.

Publications & preprints

1. Som Dev Bishoyi, Subir Sabharwal, Gaurav Khanna, *Numerical Evidence for Non-Axisymmetric Gravitational "Hair" for Extremal Kerr Black Hole Spacetimes with Hyperboloidal Foliations*, 10.1007/s10714-025-03378-1.

2. Som Dev Bishoyi, Subir Sabharwal, Gaurav Khanna, *Source-Driven Tails in Kerr Spacetime : Nonlinear effects in Late-Time Behavior*, appears on arXiv on Jan 20

3. Som Dev Bishoyi, Scott Field, Stephen Lau, *Exact radiation outer boundary conditions and near-to-far field signal teleportation for the Bardeen-Press-Teukolsky equation*, in preparation.

Research Experience

ROBCs and near-to-far field teleportation for the BPT equation

- Developed boundary kernels to construct exact non-reflecting BCs to numerically solve the Bardeen-Press-Teukolsky equation in Schwarzschild spacetime.
- Developed teleportation kernels that perform near to far field teleportation of signals and extract them in the astrophysical wave zone.
- The above techniques resulted in long duration stable solutions of the BPT equation in Boyer-Lindquist coordinates, an open problem earlier.

General spin-weight time domain Teukolsky equation solver

- Discontinuous Galerkin(DG) solver for gravitational perturbations in the time domain having spectral convergence.
- Computing the Teukolsky source term for gravitational perturbations.
- Formulating a symmetric hyperbolic system of coupled PDEs using different choices of auxilliary variables and hyperboloidal coordinates.
- Implemented hyperboloidal slices (a variant of the perfectly matched layers technique) in the DG method to evolve wave equations (Bardeen-Press-Teukolksy equation).

Awards

- **UMass Dartmouth Doctoral Fellowship**, Research fellowship for a period of 1 year. *Sept 2022 to May 2023*
- **UMass Dartmouth Provost Travel Grant**, Travel grant of $500 for presenting at conferences. *APS April Meetings 2024, 2025, 2026*
- **APS DGRAV Travel Grant**, Travel grant of $300 for presenting at APS april meeting 2024. *April 3 2024 - April 6 2024*
- **IISER-K Summer Fellowship** Fellowship of 10,000 rupees for research project on Ahoronov-Bohm effect and geometric phases. *May 2019 - July 2019*
- **IIT Indore Research Internship** Internship for two months on cosmological N Body Simulations . *May 2020 - July 2020*

Invited Talks

1. Scalar and gravitational horizon hair as observable imprints of extremal black holes, *Extremal Black Holes and Black hole thermodynamics workshop, ICERM, Brown University, Jan-2026*

Contributed Talks and posters

1. Exact boundary conditions for the Teukolsky equation, *Prospects in Theoretical Physics workshop, Institute of Advanced Study, Princeton, July 2025*
2. Exact boundary conditions for the Teukolsky equation, *SciML for gravitational wave astronomy workshop, ICERM, Brown University, June 2025*
3. Long simulations of extreme mass ratio inspirals by solving the Teukolsky equation with singular source terms, *APS April meeting 2025*
4. Determining extremality of Reissner-Nordstrom BHs using late time tails at $\mathscr{I}^+$, *APS April meeting 2024*

Teaching Experience

Department of Mathematics, UMass Dartmouth

- TA for High Performance Scientific Computing *Sept 2024 to Dec 2024*

Department of Physical Sciences, IISER Kolkata

- TA for Classical Mechanics II *August 2020 to Dec 2020*
- TA for Classical Mechanics II *August 2021 to Dec 2021*
- TA for Introductory Electromagnetism *January 2021 to May 2021*

Computation and Data Sciences, IISER Kolkata

- TA for Scientific Computing in Python *January 2022 to May 2022*

Additional Expertise

Computing : C, Python(scipy, numpy, sympy, JAX), numerical PDE solvers, pseudo-spectral methods, finite difference methods, Matplotlib, Mathematica xAct, LaTeX, git

Organizing : Biweekly talks at meetings of gravity research groups of UMass Dartmouth and University of Rhode Island.

Research Mentorship :

Project : **WENO solver for the massive Klein-Gordon equation**

- Varenya Upadhaya, 2nd year PhD student at UMass Dartmouth, Spring 2025

Project : **DG solver for wave equations in modified gravity spacetimes**

- Scott Shaw, MS-Physics student at UMass Dartmouth, Spring 2023
- Ansh Gupta, MS-Physics student at IISER Mohali, 2023