Ritesh Bachhar

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Google Scholar ⧉ GitHub

Research Interests

General relativity (GR), Surrogate modeling of gravitational waves, Gravitational wave parameter estimation, Black hole merger phenomenology, Black hole perturbation theory

Education

Ph.D.	University of Rhode Island, Kingston, RI, USA	September 2021 - Present
	• Advisor: Dr. Gaurav Khanna	
M.Sc. Physics	Indian Institute of Technology Bombay, Mumbai, India	July 2018 - June, 2020
	• Advisor: Dr. Varun Bhalerao	
	• Thesis: Phase resolved analysis of Centaurus X-3	
B.Sc. Physics	Scottish Church College, Kolkata, India	July 2014 - April 2017

Awards

- **Dean's Fellowship**, University of Rhode Island - Recognized for academic achievements and scholarly potential.
- **NASA Travel Grant** ($1500) - Funded travel to the 15th LISA Symposium, Dublin, Ireland (2024) for presenting research on gravitational wave modeling.
- **Bhavesh Gandhi Memorial Prize** (2019-20), IIT Bombay - Best M.Sc. thesis award for research on *Phase-resolved analysis of Centaurus X-3*.
- **CSIR NET** (June 2019) - Secured All India Rank **66**, qualifying for Junior Research Fellowship (JRF) in Physical Sciences.

Employment

- **Dean's Fellow**, University of Rhode Island, Fall 2024 - Summer 2025
- **Research Assistant**, University of Rhode Island, Fall 2022 - Spring 2024
- **Teaching Assistant**, University of Rhode Island, Fall 2021 - Spring 2022

Publications

1. **Incorporating waveform calibration error in gravitational-wave modeling and inference for SEOBNRv4**
   Ritesh Bachhar, Michael Pürrer, Stephen R. Green
   arXiv:2410.17168, October 2024
   DOI: https://arxiv.org/abs/2410.17168 ⧉

2. **Gravitational wave surrogate model for spinning, intermediate mass ratio binaries based on perturbation theory and numerical relativity**
   *Katie Rink, **Ritesh Bachhar**, Tousif Islam et al.*
   PRD 110,124069
   DOI: https://journals.aps.org/prd/abstract/10.1103/PhysRevD.110.124069 ⧉

3. **Binary Black Hole Coalescence Phenomenology from Numerical Relativity**
   *Richard Price, **Ritesh Bachhar**, Gaurav Khanna*
   arXiv:2312.15885; December 2023
   DOI: https://arxiv.org/abs/2312.15885 ⧉

4. **Angular Momentum for Black Hole Binaries in Numerical Relativity**
   ***Ritesh Bachhar**, Richard Price, Gaurav Khanna*

PRD 108,064019; September 2023
DOI: https://journals.aps.org/prd/abstract/10.1103/PhysRevD.108.064019 ↗

5. **Timing and spectral studies of Cen X-3 in multiple luminosity states using AstroSat**
   Ritesh Bachhar, Gayathri Raman, Varun Bhalerao et al.
   MNRAS, 517, 4138; October 2022
   DOI: https://academic.oup.com/mnras/article/517/3/4138/6760011 ↗

Research Experience

Surrogate modeling of gravitational waves
September 2021 - Present

- Developing reduced-order surrogate models for gravitational waves from binary black hole mergers
- Integrating numerical relativity and perturbation theory to model gravitational waves from binary black holes (BBHs) across a wide range of mass ratios and spin configurations
- Modeling gravitational waveforms for intermediate-mass-ratio inspirals (IMRIs)

Systematics in gravitational wave modeling
July 2023 - Present

- Investigated the impact of waveform systematic on gravitational wave parameter estimation
- Developing a method to mitigate systematic biases in parameter estimations by incorporating waveform uncertainties into gravitational wave models
- Incorporated the waveform calibration error into the gravitational wave modeling within the `SEOBNRv4` framework

Black hole merger phenomenology
August 2022 - January 2024

- Studied the phenomenology of binary black hole mergers
- Integrating approximate methods to complement numerical studies
- Investigated the role of orbital angular momentum in the dynamics of binary black hole mergers

Timing and spectral analysis of X-ray pulsar: Centaurus X-3
July 2019 - January 2022

- Studied the process of X-ray emission of High Mass X-ray Binaries (HMXBs), particularly for Cen X-3
- Analyzed the phase resolved X-ray spectra of Cen X-3 using AstroSat data

Teaching Experience

- TA for Elementary Physics II (Fall 2023), with Dr. Rob Coyne
  - Assisted students with homework assignments and exam preparation by providing guidance and support to strengthen their understanding of the subject matter.
- TA for AST 108 and AST 118H, introduction to astronomy (Fall 2021 - Spring 2022) with Prof. Douglas Gobeille
  - Conducted interactive sessions to clarify doubts and reinforce understanding of the course material.
  - Organized both telescope-assisted and unaided observation sessions to guide students in identifying celestial objects, including planets, stars, and constellations.

Talks and Conferences

- University of Glasgow, Student Seminar, Online
  Incorporating Waveform Uncertainties in Effective-One-Body Models for Accurate Gravitational Wave Parameter Estimation
  November 2024
- American Physical Society (APS) April Meeting
  April 2024

Gravitational wave inference with marginalization over waveform uncertainty
- InterDisciplinary made EAsy (IDEA), Brown University   January 2024
  Gravitational waveform models for intermediate mass ratio binary black hole systems: Extending the reach of black hole perturbation theory with numerical relativity
- 23rd Eastern Gravity Meeting   June 2023
  Building surrogate model of spinning binary black hole coalescence using perturbation theory waveforms
- American Physical Society (APS) April Meeting   April 2023
  Surrogate model for gravitational waveforms from spinning binary black hole coalescence using perturbation theory

Programming Skills

Gravitational Wave Software Developer: SEOBNRv4CE

Gravitational Wave Software: GWtools, gwsurrogate

Programming: Python(NumPy, SciPy, SymPy, AstroPy and Pandas), C, Fortran

Software: Matlab, Mathematica, HEASOFT, XSPEC, and LaTeX