Abhishek Hegade K R

Contact Information

E-mail: ah30@illinois.edu, abhikumbale@gmail.com
Citizenship: Indian
Profiles: Personal website, Inspires, Google scholar, github and Linkedin.

Education

PhD in Physics, University of Illinois Urbana Champaign 2020 - 2025 (Expected)
Advisor : Nicolás Yunes, GPA : 4.0/4.0.
Teaching/Research Assistant alternating semesters.

BSc (Hons.) in Mathematics and Physics, Chennai Mathematical Institute 2017 - 2020
Advisors : K.G. Arun and Alok Laddha, GPA : 9.52/10.0.
Gold medal awarded for graduating top of my class.

Research Interests

I am interested in using analytical and numerical techniques to understand the behavior of neutron stars and black holes in strongly gravitating regions of spacetime. I also utilize Markov Chain Monte Carlo (MCMC) methods to understand gravitational wave data. I am currently interested in constraining transport properties such as shear and bulk viscosity of neutron stars using gravitational waves. In the past, I have worked on understanding the breakdown of effective field theories of gravity, the mathematical properties of black holes in and outside general relativity and measuring the Hubble constant using gravitational wave observations.

Awards

Illinois Center for Advanced Studies of the Universe - Physics Fellowship	Fall 2024 - Spring 2025
Scott Anderson Award, University of Illinois Urbana Champaign	Spring 2023
University Fellowship, University of Illinois Urbana Champaign	Fall 2022
Medal of Excellence, Chennai Mathematical Institute	2020
KVPY Fellow, Department of Science and Technology of the Government of India	2017-2020
Indian Academy of Sciences, Summer Research Fellowship	Summer 2019
National Talent Search Examination - State Scholar	2015

Mentoring Experience

- Jayana Saes: Consistent modeling of dynamical tidal effects in binary neutron star events (2024-present).
- Anand Balivada: The effect of rotation in post-Newtonian theory of tidal interactions (2024-present).
- Brook Burbridge: Gravitational wave data analysis and dissipative tidal effects (2024-present).

Technical Skills

Modelling Skills

- Analytical skills: Solving partial differential equations that arise in general relativity using numerical and perturbation theory methods (post-Newtonian theory).
- Statistical skills: Bayesian analysis using MCMC methods and nested sampling methods for analyzing complex data that arise from gravitational wave detectors.

Numerical Methods
Finite difference methods and finite volume methods. Nested sampling and MCMC methods for parameter estimation.
Programming Skills
Expert : Python.
Proficient : C++ and Mathematica.
Packages: Python - numpy, scipy, pandas, sklearn, statsmodels; `C++`: gsl, Eigen; Mathematica: xPert.

Talks and workshops

Invited talks and workshops

1. Out-of-equilibrium tidal effects in gravitational wave observations of binary neutron stars, MIT GRITTS Seminar, MIT, October 2024.
2. Modeling tidal dissipation in neutron star binary systems, Prof. Emanuele Berti's group meeting, Johns Hopkins University, October 2024.
3. Probing dissipative effects in neutron stars using gravitational waves, ICTS Astrophysics Seminar, International Centre for Theoretical Sciences, January 2024.
4. Probing dissipative effects in neutron stars using gravitational waves, VandyGRAF Seminar, Vanderbilt University, November 2023.
5. Advances in Chern-Simons Classical and Quantum Gravity, ICERM, Brown University, May 2022.

Contributed talks

1. Probing internal dissipative processes of neutron stars with gravitational waves - II, APS April meeting, Sacramento, April 2024.
2. Where and why does Einstein-Scalar-Gauss-Bonnet theory breakdown? APS April meeting, Minneapolis, April 2023.
3. How Do Black Holes Grow Hair? APS April meeting, New York, April 2022.
4. How Do Black Holes Grow Hair? Midwest Relativity meeting, Urbana-Champaign, November 2021.

Publications

I have published 9 papers, with 6 as the first author and 3 as the second author. The publications can be accessed using my Inspires profile.

Highlights: One paper has been accepted for publication in Nature astronomy and one paper has been selected as an editor's suggestion in Physical Review D.

Published

1. **Abhishek Hegade K R**, Justin L. Ripley and Nicolás Yunes, "Dissipative tidal effects to next-to-leading order and constraints on the dissipative tidal deformability using gravitational wave data", Phys. Rev. D 110, 044041, arXiv:2407.02584 [gr-qc].
2. Justin L. Ripley, **Abhishek Hegade K R**, Rohit S. Chandramouli and Nicolás Yunes, "First constraint on the dissipative tidal deformability of neutron stars", Nature Astronomy (2024), arXiv:2312.11659 [gr-qc]..
3. **Abhishek Hegade K R**, Justin L. Ripley and Nicolás Yunes, "Dynamical tidal response of non-rotating relativistic stars", Phys. Rev. D 109, 104064, arXiv:2403.03254 [gr-qc]

4. Justin L. Ripley, **Abhishek Hegade K R**, and Nicolás Yunes, "Probing internal dissipative processes of neutron stars with gravitational waves during the inspiral of neutron star binaries", Phys. Rev. D 108, 103037, arXiv:2306.15633 [gr-qc].

5. **Abhishek Hegade K R**, Justin L. Ripley, and Nicolás Yunes, "The non-relativistic limit of first-order relativistic viscous fluids", Phys. Rev. D 107, 124029, arXiv:2305.09725 [gr-qc].

6. **Abhishek Hegade K R**, Elias R. Most, Jorge Noronha, Helvi Witek, and Nicolás Yunes, "How Do Axisymmetric Black Holes Grow Monopole and Dipole Hair?", Phys. Rev. D 107, 104047, arXiv:2212.02039 [gr-qc].

7. **Abhishek Hegade K R**, Justin L. Ripley, and Nicolás Yunes, "Where and why does Einstein-scalar-Gauss-Bonnet theory break down?" Phys. Rev. D 107, 044044, arXiv:2211.08477 [gr-qc].

8. **Abhishek Hegade K R**, Elias R. Most, Jorge Noronha, Helvi Witek, and Nicolás Yunes, "How do spherical black holes grow monopole hair?" Phys. Rev. D 105, 064041, arXiv:2201.055178 [gr-qc].

9. [1]Deep Chatterjee, **Abhishek Hegade K R**, Gilbert Holder, Daniel E. Holz, Scott Perkins, Kent Yagi, and Nicolás Yunes, "Cosmology with Love: Measuring the Hubble constant using neutron star universal relations," Phys. Rev. D 104, 083528, arXiv:2106.06589 [gr-qc].

[1]Editor's Suggestion