Curriculum Vitae - Bikram Keshari Pradhan

Inter-University Centre for Astronomy and Astrophysics (IUCAA), Pune, 411007, India

+91 8468866004 bikram.iucaa@gmail.com @Bikkramp Pradhan iNSPIRE-HEP

Education

2019 – Present **Ph.D., Inter-University Centre for Astronomy and Astrophysics (IUCAA), Pune, 411007, India .**

2017–2019 **M.Sc. Physics, Utkal University, Bhubaneswar, Odisha,751004, India.** *Specialization in Particle Physics.*

2014–2017 **B.Sc. Physics, Nayagarh Autonomous College, Utkal University, Bhubaneswar, Odisha,751004, India.**

Research Interests

Neutron Star (NS) Interior Modeling

- **Modeling the NS interior from microscopic Equation of State (EoS) to macroscopic structure. Determining the NS EoS with exotic matter, particularly hyperons, analytically (involves nuclear physics, particle physics, hypernuclear physics), and numerically.**
- **Imposing constraints from multidisciplinary Physics on nuclear and hypernuclear EoS in NSs.**

Oscillations of Compact Stars

- **Computation of stellar oscillation modes, particularly fluid modes (f-,p-,g-modes) of compact stars both in the relativistic Cowling approximation and also within the general relativistic formalism.**
- **Investigating the impact of composition of the compact star interior on the stellar oscillation modes.**
- **Constraining NS interior properties using observations of oscillation modes in compact stars.**

Gravitational Waves (GWs)

- **Looking for the signatures of NS interior composition in observations of gravitational waves emanating from isolated and binary NS systems.**
- **Investigating the effect of ignorance of additional corrections (such as multi-polar tidal correction, the dynamical corrections due to excitation of stellar oscillation modes) to GW waveform modeling of the binary system on compact star observables.**
- **Constraining the NS EOS and nuclear physics within Bayesian formalism using the current and future GW measurements associated with isolated and binary neutron stars.**

Research Experience

2021-present **Senior Research Fellow (IUCAA)**

2019-2021 **Junior Research Fellow (IUCAA)**

Graduate Project, 2020 **Project Title:** "Study of the effect of hyperons on f-mode oscillations in Neutron Stars."
Supervisor: Prof. Debarati Chatterjee, IUCAA, Pune
Developed the formalism and numerical scheme to solve the hyperonic EoSs for NS. Developed the numerical methodology for solving f-mode oscillations within Cowling approximation as well as full general relativity. The impact of uncertainty in nuclear and hypernuclear parameters on the f-mode oscillations in NS is investigated.

Research Experience (continued)

M.Sc. Project, 2019

Project Title: "Thermodynamics of Relativistic Gas And Hagedorn's Hypothesis."
Advisor: Prof. Bedangadas Mohanty, National Institute of Science Education and Research (NISER), Bhubaneswar
Solved the required statistical mechanical problems and developed numerical schemes for the thermodynamic properties of hadrons and quarks at high temperature and/or high density. Developed the numerical scheme to implement Hagedorn's hypothesis to find the chemical freeze-out temperature of the hadronic phase and compared it with the measured critical temperature from experiments and also with the value predicate by Lattice QCD.

Skills

Languages	Fluent in **English, Hindi and Odia.**
Coding	Python, C, C++, FORTRAN,
GW Packages	Bilby, Bilby-Pipe, PyCBC, LALSimulation
Bayesian Packages	Multinest, Py-Multinest
Other Packages	RNS, CompOSE, LaTeX

Research Publications

Journal Articles

1. **B. K. Pradhan** and D. Chatterjee, "Effect of hyperons on f-mode oscillations in Neutron Stars," *Phys. Rev. C*, vol. 103, no. 3, p. 035 810, 2021. DOI: 10.1103/PhysRevC.103.035810. arXiv: 2011.02204 [astro-ph.HE].
2. **B. K. Pradhan**, D. Chatterjee, M. Lanoye, and P. Jaikumar, "General relativistic treatment of f-mode oscillations of hyperonic stars," *Phys. Rev. C*, vol. 106, no. 1, p. 015 805, 2022. DOI: 10.1103/PhysRevC.106.015805. arXiv: 2203.03141 [astro-ph.HE].
3. **B. K. Pradhan**, D. Chatterjee, R. Gandhi, and J. Schaffner-Bielich, "Role of vector self-interaction in neutron star properties," *Nucl. Phys. A*, vol. 1030, p. 122 578, 2023. DOI: 10.1016/j.nuclphysa.2022.122578. arXiv: 2209.12657 [nucl-th].
4. **B. K. Pradhan**, A. Vijaykumar, and D. Chatterjee, "Impact of updated multipole Love numbers and f-Love universal relations in the context of binary neutron stars," *Phys. Rev. D*, vol. 107, no. 2, p. 023 010, 2023. DOI: 10.1103/PhysRevD.107.023010. arXiv: 2210.09425 [astro-ph.HE].
5. **B. K. Pradhan**, D. Pathak, and D. Chatterjee, "Constraining Nuclear Parameters Using Gravitational Waves from f-mode Oscillations in Neutron Stars," *Astrophys. J.*, vol. 956, no. 1, p. 38, 2023. DOI: 10.3847/1538-4357/acef1f. arXiv: 2306.04626 [astro-ph.HE].
6. **B. K. Pradhan**, D. Chatterjee, and D. E. Alvarez-Castillo, "Probing hadron-quark phase transition in twin stars using f-modes," *Accepted for Publication in MNRAS*, Sep. 2023. arXiv: 2309.08775 [nucl-th].
7. S. Ghosh, **B. K. Pradhan**, D. Chatterjee, and J. Schaffner-Bielich, "Multi-Physics Constraints at Different Densities to Probe Nuclear Symmetry Energy in Hyperonic Neutron Stars," *Front. Astron. Space Sci.*, vol. 9, p. 864 294, 2022. DOI: 10.3389/fspas.2022.864294. arXiv: 2203.03156 [astro-ph.HE].
8. S. Ghosh, **B. K. Pradhan**, and D. Chatterjee, "Tidal heating as a direct probe of strangeness inside neutron stars," *Phys. Rev. D*, vol. 109, no. 10, p. 103 036, 2024. DOI: 10.1103/PhysRevD.109.103036. arXiv: 2306.14737 [gr-qc].
9. **B. K. Pradhan**, S. Shirke, and D. Chatterjee, "Prospects of identifying the presence of Strange Stars using Gravitational Waves from binary systems," Nov. 2023. arXiv: 2311.15745 [gr-qc].
10. **B. K. Pradhan**, T. Ghosh, D. Pathak, and D. Chatterjee, "Cost of Inferred Nuclear Parameters toward the f-mode Dynamical Tide in Binary Neutron Stars," *Astrophys. J.*, vol. 966, no. 1, p. 79, 2024. DOI: 10.3847/1538-4357/ad31a8. arXiv: 2311.16561 [gr-qc].
11. S. Shirke, **B. K. Pradhan**, D. Chatterjee, L. Sagunski, and J. Schaffner-Bielich, "Effects of Dark Matter on f-mode oscillations of Neutron Stars," Mar. 2024. arXiv: 2403.18740 [gr-qc].

Conference Proceedings

1. **B. K. Pradhan** and D. Chatterjee, "F-mode oscillations in neutron stars: impact of hyperons and nuclear parameters," in *DAE Symp. Nucl. Phys.*, vol. 66, 2023, pp. 780–781. URL: http://www.sympnp.org/proceedings/66/C29.pdf.

Teaching Experience

- Co-guided Sukrit Jaiswal from IISER Pune along with my Ph.D. supervisor Prof. Debarati Chatterjee for his Masters project, which led to the publication, Physics 2021, 3(2),302-319.
- Teaching assistant for the "Statistical Mechanics" course by Prof. Debarati Chatterjee for the IUCAA-NCRA Grad School conducted in 2022.

Science Outreach

2020 **Volunteered in the Nation Science Day (NSD) celebration from 28th February to 29th February 2020, held at the Inter-University Centre for Astronomy and Astrophysics (IUCAA). My role consisted of preparing a poster and encouraging a large audience (citizens, school students, college, and university students) on the topic "career in Astronomy and Astrophysics".**

2022 **Volunteered in the Nation Science Day, 2022 (NSD) at IUCAA. Conducted the school-level "drawing competition" for students to popularize the science. Additionally, created an introduction video explaining the "gravitational wave" to a larger audience attending in online mode.**

Volunteered for LIGO-India EPO (Education and Public Outreach) in setting up a LIGO-India booth at the IISER Bhopal Tech fest "Singularity" from 15th to 18th October 2022.

2023 **Volunteered in the Nation Science Day, 2023 (NSD) at IUCAA. There I have extensively contributed by explaining the role of gravitational wave detectors, the current status of the GW detections along with a basic introduction to the existence of other electromagnetic telescopes and their role.**

Awards and Achievements

2019 **University Gold Medal 2019, Utkal University, for securing the highest CGPA in the Postgraduate examination of 2019 in M.Sc. physics.**

Lalit Kumar Panda memorial Gold medal 2019 from Utkal University.

Dr. Indumati Sheshadri Memorial Gold Medal 2019, Utkal University

Ashok Kumar Mishra Memorial Gold medal 2019, Utkal University

Secured all India rank (AIR)of 126 on the GATE Physics entrance-2019.

2018 **Secured AIR of 22 in the National Examination Test (NET-Physics), India held on December 2018.**

Conferences Attended with an Oral Presentation

Presentations Given

2022 **Attended the conference Young Astronomers' Meet (2022) in person, held on November 6-13, 2022, at ARIES, Nainital. I gave an oral presentation titled "F-mode oscillations in Neutron Stars: role of interior composition and impact on Gravitational Waves".**

Attended the XXV DAE Symposium on High Energy Physics in person at IISER Mohali from December 12 to 16, 2022. I have given an oral presentation on "General Relativistic treatment of f-mode Oscillation of Neutron Star: Impact of NS composition and Nuclear parameter."

Participated in the 32nd meeting of the Indian Association for General Relativity and Gravitation (IAGRG 32) at IISER Kolkata from 19th December to 21st December. I gave an oral presentation titled "Impact of updated Multipole Love and f-Love Universal Relations in the Context of Binary Neutron Stars."

Conferences Attended with an Oral Presentation (continued)

2023

- **Attended the conference "Bridging the Gaps: Interdisciplinary Collaborations in Constraining the Physics of Finite Nuclei, Neutron Stars, and Dark Matter." I gave an oral presentation titled "Constraining nuclear parameters using f-modes from the glitching pulsar."**

- **Attended the international conference on "Multi-Messenger Continuous Gravitational-Wave Workshop" held from 11-13 July 2023 at Nikhef/ University of Amsterdam in online mode. I gave an oral presentation on "The importance of neutron star oscillation modes in constraining the neutron star EoS and nuclear parameters from GW observations of binary and isolated neutron stars."**
- **Attended the international conference "Amaldi15: Premier International Conference on Gravitational Waves" from 17th July to 21st July 2023 virtually. At the conference, I presented the work titled "Constraining nuclear parameters using f-modes from glitching pulsar".**

- **Attended the 63rd Cracow School of Theoretical Physics: Nuclear Matter at Extreme Densities and High Temperatures in person held from 17th September to 23rd September 2023 at Zakopane, Poland. Gave an oral presentation on titled "Probing hadron-quark phase transition in twin stars using f-modes".**

- **Attended ROCKSTAR: Towards a ROadmap of the Crucial measurements of Key observables in Strangeness reactions for neutron sTARs equation of state held from 9th October to 13th October 2023 at ECT*, Trento, Italy. Gave an oral presentation on titled "Probing hadron-quark phase transition in twin stars using f-modes".**

References

Available on request.