

# Prashant Thakur, Ph.D.

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in Prashant Thakur

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## Permanent Address

■ Singh's House, Near Boys Hostel  
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PIN: 173212; Country: India

## RESEARCH INTERESTS

■ My research focuses on the physics of neutron stars, particularly their equations of state (EoS), interactions with dark matter, and the constraints that astrophysical observations impose on these interactions. During my Ph.D., I extensively studied dark matter-admixed neutron stars using both single-fluid and two-fluid formalisms. I also employed machine learning techniques, specifically the Random Forest classifier, to distinguish between scenarios with and without dark matter. Additionally, I investigated the neutron star EoS by modifying the sigma potential in the relativistic mean-field (RMF) approach, introducing the sigma-cut potential. Beyond the equation of state, my work has also explored neutron star oscillations and transport properties. I have studied  $r$ -mode instabilities and hyperon bulk viscosity, key factors in the rotational evolution of neutron stars. Post-Ph.D., my primary research interests extend to investigating radial and non-radial oscillations, not only in conventional neutron star matter but also in the presence of exotic phases and dark matter. I aim to analyze these oscillations throughout the evolution of proto-neutron stars to their cold, mature states. I am also studying dark matter-admixed neutron stars (DANS) in rotating configurations and examining how the presence of dark matter influences the evolution of their magnetic fields.



## Employment History

2025 – ... ■ **Post-Doctoral Fellow**, Department of Physics, Yonsei University, 50 Yonsei-ro, Seodaemun-gu, Seoul 03722, South Korea  
Research Group: **Prof. Yeunhwan Lim Group**

## Education








2020 – 2025 ■ **Ph.D., Birla Institute of Technology & Science – Pilani, K.K. Birla Goa Campus, India** (Nuclear Astrophysics).  
**Thesis title:** *Feasibility of Dark Matter in Neutron Stars: A Quantitative Analysis*  
**Supervisor:** Prof. Tarun Kumar Jha  
**Advisor:** Dr. Tuhin Malik  
**Examiner:** Prof. Ritam Mallick (IISER Bhopal)  
**Thesis Reviewed by:** Prof. Ritam Mallick (IISER Bhopal), Prof. Dr. Odilon Lourenço (Instituto Tecnológico de Aeronáutica, São José dos Campos, SP, Brazil)  
**Degree Grade Point Average:** 8.52/10.00  
**Graduation Date:** 9th July, 2025




## Education (continued)

- 2016 – 2018  **M.Sc. Physics, Shoolini University, Solan, India**  
**Year of Completion:** 2018  
**Degree Grade Point Average:** 7.77/10.00
- 2012 – 2015  **B.Sc. Physics (Hons.), Centre of Excellence, Sanjauli Degree College, Shimla, Himachal Pradesh**  
**Pass Subjects:** Physics (Hons.), Mathematics, Chemistry, English, Hindi

## Research Publications

### Journal Articles

- 1 H. Chandrakar, A. Taridalu, A. Issifu, T. K. Jha, and P. Thakur, “Magnetized Proto-Neutron Stars: Structure and Stability,” Aug. 2025. arXiv: 2508.04264 [astro-ph.HE].
- 2 T. Iqbal, P. Thakur, Y. Kumaran, R. Chandra, T. K. Jha, and B. K. Sharma, “Impact of the  $\sigma$ -cut potential in the properties of neutron star matter,” *Phys. Rev. C*, vol. 111, no. 4, p. 045801, 2025.  DOI: 10.1103/PhysRevC.111.045801.
- 3 A. Issifu, A. Konstantinou, P. Thakur, and T. Frederico, “Rotating Proto-Neutron Stars Admixed with Mirror Dark Matter: A two fluid approach,” Jul. 2025. arXiv: 2507.20823 [astro-ph.HE].
- 4 A. Issifu, P. Thakur, F. M. da Silva, *et al.*, “Supernova remnants with mirror dark matter and hyperons,” *Phys. Rev. D*, vol. 111, no. 8, p. 083026, 2025.  DOI: 10.1103/PhysRevD.111.083026. arXiv: 2412.17946 [hep-ph].
- 5 I. A. Rather, K. D. Marquez, P. Thakur, and O. Lourenço, “Nonradial oscillation modes in hybrid stars with hyperons and delta baryons,” *Phys. Rev. D*, vol. 112, no. 2, p. 023013, 2025.  DOI: 10.1103/PhysRevD.112.023013. arXiv: 2412.12002 [astro-ph.HE].
- 6 P. Thakur, A. Issifu, I. A. Rather, Y. Lim, and T. Frederico, “Radial and Non-Radial Oscillations of Protoneutron Stars with Hyperonic Composition,” May 2025. arXiv: 2505.24104 [nucl-th].
- 7 P. Thakur, Y. Kumaran, L. Sudarsan, K. Kunnampully, B. K. Sharma, and T. K. Jha, “Implications of the  $\sigma$ -cut potential on antikaon condensates in neutron stars,” *Phys. Rev. C*, vol. 111, no. 3, p. 035801, 2025.  DOI: 10.1103/PhysRevC.111.035801. arXiv: 2502.18882 [astro-ph.HE].
- 8 P. Thakur, T. Malik, A. Das, T. K. Jha, B. K. Sharma, and C. Providência, “Feasibility study of a dark matter admixed neutron star based on recent observational constraints,” *Astron. Astrophys.*, vol. 697, A220, 2025.  DOI: 10.1051/0004-6361/202451879. arXiv: 2408.03780 [nucl-th].
- 9 P. Thakur, I. A. Rather, and Y. Lim, “Effect of dark matter and  $\sigma$ -cut potential on radial and nonradial oscillation modes in neutron stars,” *Phys. Rev. D*, vol. 112, no. 4, p. 043017, 2025.  DOI: 10.1103/PhysRevD.112.043017. arXiv: 2507.13227 [astro-ph.HE].
- 10 P. Thakur, A. Taridalu, I. A. Rather, T. Klangburam, and C. Pongkitivanichkul, “Constraining Axion-Like Particle mediated Dark Matter with Observational Constraints: A Statistical and Machine Learning Approach,” Sep. 2025. arXiv: 2509.18863 [astro-ph.HE].
- 11 P. Thakur, T. Malik, A. Das, T. K. Jha, and C. Providência, “Exploring robust correlations between fermionic dark matter model parameters and neutron star properties: A two-fluid perspective,” *Phys. Rev. D*, vol. 109, no. 4, p. 043030, 2024.  DOI: 10.1103/PhysRevD.109.043030. arXiv: 2308.00650 [hep-ph].

- 12 P. Thakur, T. Malik, and T. K. Jha, "Towards Uncovering Dark Matter Effects on Neutron Star Properties: A Machine Learning Approach," *Particles*, vol. 7, pp. 80–95, 2024.  DOI: 10.3390/particles7010005. arXiv: 2401.07773 [hep-ph].
- 13 P. Thakur, B. K. Sharma, A. Ashika, S. Srivishnu, and T. K. Jha, "Influence of the symmetry energy and  $\sigma$ -cut potential on the properties of pure nucleonic and hyperon-rich neutron star matter," *Phys. Rev. C*, vol. 109, no. 2, p. 025 805, 2024.  DOI: 10.1103/PhysRevC.109.025805.
- 14 O. P. Jyothilakshmi, P. E. S. Krishnan, P. Thakur, V. Sreekanth, and T. K. Jha, "Hyperon bulk viscosity and r-modes of neutron stars," *Mon. Not. Roy. Astron. Soc.*, vol. 516, no. 3, pp. 3381–3388, 2022.  DOI: 10.1093/mnras/stac2360. arXiv: 2208.14436 [astro-ph.HE].


## Conference Proceedings

- 1 H. Chandrakar, T. Malik, P. Thakur, and T. K. Jha, "Non-radial oscillation in neutron stars with dark matter core," in *Proceedings of the DAE Symposium on Nuclear Physics*, vol. 68, India: Department of Atomic Energy (DAE), 2025, pp. 733–734.
- 2 P. Thakur, "Feasibility of dark matter in neutron stars: A quantitative analysis," in *Proceedings of the DAE Symposium on Nuclear Physics*, vol. 68, India: Department of Atomic Energy (DAE), 2025, pp. 1281–1282.
- 3 P. Mahapatra and P. Thakur, "Neutron stars anisotropic nature: A study of exotic states of matter and cosmic observations," in *Proceedings of the DAE Symposium on Nuclear Physics*, vol. 67, India: Department of Atomic Energy (DAE), 2024, pp. 819–820.
- 4 P. Thakur, T. K. Jha, and B. K. Sharma, "Hess j1731-347 supernova remnant as a possible dark matter-admixed candidate," in *Proceedings of the DAE Symposium on Nuclear Physics*, vol. 67, India: Department of Atomic Energy (DAE), 2024, pp. 817–818.
- 5 T. Iqbal, R. Chandra, B. K. Sharma, P. Thakur, and T. K. Jha, "On the possibility of a  $2.6 M_{\odot}$  neutron star," in *Proceedings of the DAE Symposium on Nuclear Physics*, vol. 66, India: Department of Atomic Energy (DAE), 2023, pp. 772–773.
- 6 O. P. Jyothilakshmi, P. E. S. Krishnan, P. Thakur, V. Sreekanth, and T. K. Jha, "Bulk viscosities and r-mode of massive neutron stars," in *Proceedings of the DAE Symposium on Nuclear Physics*, vol. 66, India: Department of Atomic Energy (DAE), 2023, pp. 732–733.

## Research Visits

-  **Departamento de Física, University of Coimbra, Coimbra, Portugal** 1st May 2023 – 30th July 2023  
Visited: Prof. Constança Providência & Dr. Tuhin Malik (*Invited*)
- Inter-University Centre for Astronomy and Astrophysics (IUCAA), Pune, India** 13th September 2024 – 30th September 2024  
Visited: Dr. Apratim Ganguly (*Invited*)
- Department of Physics, Yonsei University, Seoul, South Korea** 21st June 2025 – 5th July 2025  
Visited: Prof. Yeunhwan Lim (*Invited*)

## Teaching Assistance

-  **BITS Pilani, K.K. Birla Goa Campus**  
Teaching Assistant (TA)  
Mechanics Laboratory  
Electrodynamics and Optics Laboratory  
Quantum Mechanics

## Conferences & Workshops Attended

- **Gravitational-Wave Astronomy Summer School (Online)** *July 5–16, 2021*  
Organized by ICTS-TIFR, Bengaluru, India
- ICTS Summer School on Gravitational-Wave Astronomy 2022** *May 30–June 10, 2022*  
Hosted offline at ICTS-TIFR, Bengaluru, India
- Workshop on Lunar Gravitational-Wave Detection** *April 17–20, 2023*  
ICTS-TIFR, Bengaluru, India
- DAE Symposium on Nuclear Physics 2022** *December 1–5, 2022*  
Cotton University, Guwahati, Assam, India  
*Presented Poster*
- Dark Matter and Stars: Multi-Messenger Probes of Dark Matter and Modified Gravity** *May 3–5, 2023*  
Centro de Congressos, CENTRA, IST, University of Lisbon, Portugal  
*Presented Poster*
- DAE Symposium on Nuclear Physics 2023** *December 9–13, 2023*  
IIT Indore, Madhya Pradesh, India  
*Presented Poster*
- NEOSGrav2024: International Conference on Neutron Star Equation of State and Gravitational Waves** *October 1–4, 2024*  
Kenilworth Hotel, Goa, India  
*Invited Talk*
- 3rd International Conference on Neutrinos and Dark Matter** *December 11–14, 2024*  
Cairo, Egypt  
*Invited Talk*
- Department of Physics, Yonsei University** *July 2, 2025*  
Seoul, South Korea  
*Invited Talk*

## Skills

- **Coding Skills:**  
Python, FORTRAN 90, Linux Shell scripting,  $\LaTeX$

### Software:

**RNS** – Computes equilibrium configurations of rapidly rotating neutron stars in General Relativity.

**LORENE** – A spectral numerical library for solving Einstein's equations in astrophysical settings, widely used for binary neutron star mergers and relativistic stellar models.

**NMMA** – A fully featured Bayesian pipeline for multi-messenger astrophysics, designed for joint analyses of gravitational-wave and electromagnetic data, with a focus on optical counterparts.

**XNS** – Solves for the axisymmetric equilibrium of neutron stars in General Relativity, modeling differential rotation and magnetic fields (toroidal, poloidal, or mixed twisted torus). Uses the XCFC approximation for Einstein's equations in spherical coordinates.

### Gravitational Wave Analysis:

BILBY

### Neutron Star Related Codes:

Equation of States (Relativistic Mean Field Theory); Dark Matter Modeling (Fermionic and Bosonic); Tolman–Oppenheimer–Volkoff (TOV) Equation Solver; Two-Fluid TOV Solver; Non-Radial Oscillations of Neutron Stars ( $f$ ,  $p$ , and  $g$  modes) using both Cowling Approximation and Full GR Framework; Modified Theory of Gravity  $f(R, T)$ ; Anisotropic Neutron Stars.

## Miscellaneous Experience

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- **Grant Secured:** Yonsei University Frontier Fellowship for Postdoctoral Researchers  
**Date:** September 2025  
**Amount:** 55 million KRW

## Referees

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## Collaborators

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