

Dr. Prashant Thakur

CONTACT INFORMATION

Research Scholar

Department of Physics, BITS Pilani, K.K. Birla Goa Campus, India

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iNSpire HEP: <https://inspirehep.net/authors/2150191?ui-citation-summary=true>

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EDUCATION

- **Ph.D. (2020-2025) (Defense Completed on 11/02/2025)**
 - Birla Institute of Technology & Science – Pilani, K.K. Birla Goa Campus, India
 - 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
- **Masters of Science (M.Sc) Physics:**
 - Shoolini University, Solan, India,
 - Year of Completion : 2018
 - Degree Grade Point Average : 7.77/10.00
- **Bachelor of Science (B.Sc) Physics:**
 - Centre of Excellence, Sanjauli Degree College, Shimla, Himachal Pradesh
 - Year of Completion :2015
 - Pass Subjects : Physics(Hons.) Mathematics, Chemistry, English, Hindi

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 PhD, 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-PhD, 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 neutron stars and examining how the presence of dark matter influences the evolution of their magnetic fields.

RESEARCH VISIT

- Departamento de Física, University of Coimbra, Coimbra, Portugal, from 1st May 2023 - 30th July 2023.
Visited: Prof. Constança Providência & Dr. Tuhin Malik
- Inter-University Centre for Astronomy and Astrophysics, India, from 13th September 2024 - 30th September 2024.
Visited: Dr. Apratim Ganguly.

Articles

* In Communication

1. Non-Radial Oscillation Modes in Hybrid Stars with Hyperons and Delta Baryons: Full General Relativity Formalism vs. Cowling Approximation

Authors: *Ishfaq Ahmad Rather, Kau D. Marquez, Prashant Thakur, Odilon Lourenço*

e-Print: e-Print: 2412.12002 [astro-ph.HE]

In Communication to: Physical Review D

Date: Dec 16, 2024

* Published

1. Feasibility study of a dark matter admixed neutron star based on recent observational constraints

Authors: *Prashant Thakur, Tuhin Malik, Arpan Das, B. K. Sharma, T. K. Jha, Constança Providência*

DOI: 10.1051/0004-6361/202451879

Published in: *Astronomy & Astrophysics*

Date: 21st May, 2025

2. Hyperon Bulk Viscosity and r-Modes of Neutron Stars

Authors: *O P Jyothilakshmi, P E Sravan Krishnan, Prashant Thakur, V Sreekanth, T.K. Jha*

DOI: 10.1093/mnras/stac2360

Journal: Monthly Notices of the Royal Astronomical Society, 516 (2022) 3, 3381-3388

3. Exploring Robust Correlations Between Fermionic Dark Matter Model Parameters and Neutron Star Properties: A Two-Fluid Perspective

Authors: *Prashant Thakur, Tuhin Malik, Arpan Das, T.K. Jha, Constança Providência*

DOI: 10.1103/PhysRevD.109.043030

Journal: Physical Review D, 109 (2024) 4, 043030

4. Towards Uncovering Dark Matter Effects on Neutron Star Properties: A Machine Learning Approach

Authors: *Prashant Thakur, Tuhin Malik, T.K. Jha*

DOI: 10.3390/particles7010005

Journal: Particles, 7 (2024) 1, 80-95

5. Influence of the Symmetry Energy and σ -cut Potential on the Properties of Pure Nucleonic and Hyperon-Rich Neutron Star Matter

Authors: *Prashant Thakur, B. K. Sharma, A. Ashika, S. Srivishnu, T.K. Jha*

DOI: 10.1103/PhysRevC.109.025805

Journal: Physical Review C, 109 (2024) 2, 025805

6. Implications of the σ -cut potential on antikaon condensates in neutron stars

Authors: *Prashant Thakur, Yashmitha Kumaran, Lakshana Sudarsan, Krishna Kunnampully, B. K. Sharma, T. K. Jha*

DOI: 10.1103/PhysRevC.111.035801

Journal: Physical Review C, 111, 035801 (2025)

7. Impact of the σ -cut potential in the properties of neutron star matter

Authors: *Tamanna Iqbal, Prashant Thakur, Yashmitha Kumaran, R. Chandra, T. K. Jha, B. K. Sharma*

DOI: 10.1103/PhysRevC.111.045801

Journal: Phys.Rev.C 111 (2025) 4, 045801)

8. Supernova Remnants with Mirror Dark Matter and Hyperons

Authors: *Adamu Issifu (Espirito Santo U.), Prashant Thakur (Birla Inst. Tech. Sci.), Franciele M. da Silva (Londrina U.), Kau D. Marquez (Espirito Santo U.), Débora P. Menezes (Londrina U.) et al.*

DOI: <https://doi.org/10.1103/PhysRevD.111.083026>

Journal: Phys. Rev. D 111, 083026 – Published 17 April, 2025

*

Conference Proceedings

1. Neutron Stars with Fermionic Dark Matter: A Two-Fluid Approach

Authors: *Prashant Thakur, T.K. Jha*

Proceedings: DAE Symp.Nucl.Phys., 66 (2023) 776-777

2. Antikaon Condensates with Dark Vector Meson in Neutron Stars

Authors: *Prashant Thakur, T.K. Jha*

Proceedings: DAE Symp.Nucl.Phys., 66 (2023) 804-805

3. HESSJ1731-347 Supernova Remnant as Possible Dark Matter Admixed Candidate

Authors: *Prashant Thakur, T.K. Jha, B.K. Sharma*

Proceedings: DAE Symp.Nucl.Phys., 67 (2024) 817-818

4. Neutron Stars Anisotropic Nature: A Study of Exotic States of Matter and Cosmic Observations

Authors: *Premachand Mahapatra, Prashant Thakur*

Proceedings: DAE Symp.Nucl.Phys., 67 (2024) 819-820

5. On the Possibility of a $2.6M_{\odot}$ Neutron Star

Authors: *Tamanna Iqbal, R. Chandra, B.K. Sharma, Prashant Thakur, T.K. Jha*

Proceedings: DAE Symp.Nucl.Phys., 66 (2023) 772-773

Conferences & Workshops Attended

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

TEACHING

- Teaching Assistance (TA) at BITS-Pilani Goa (Mechanics Lab, Electrodynamics and Optics Lab)

PROGRAMMING LANGUAGES/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

**KNOWN
LANGUAGES**

- English, Hindi, Punjabi, Pahadi

**PERSONAL
DETAILS**

- Name of Father : Mr. HarKrishan Singh (Retired Government officer).
- Name of Mother : Mrs. Sangeeta (House Wife)
- Date of Birth : 19th March, 1992
- Nationality : Indian
- Marital Status : Married
- Spouse name: Prachie Sharma

REFEREES

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