

Zenia Zuraig

PH.D. STUDENT AND PRIME MINISTER'S RESEARCH FELLOW, INDIAN INSTITUTE OF SCIENCE

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Education

Indian Institute of Science (IISc)

Bengaluru, India

PH.D. THEORETICAL PHYSICS [EXPECTED 2027]

2022 - present

- Advisor: Prof. Banibrata Mukhopadhyay
- Thesis: Exploring unusual observations using massive, magnetized compact stars: theory and simulation

National Institute of Technology, Tiruchirappalli (NIT-T)

Tiruchirappalli, India

M.Sc. PHYSICS

2020-2022

- Advisor: Dr. Somnath Mukhopadhyay
- Thesis: Effects of fermion mass and strong two-body interactions on the mass-radius relationship of non-rotating compact stars

Stella Maris College, University of Madras

Chennai, India

B.Sc. PHYSICS

2017-2020

- Dissertation: Investigation on the optical properties of titanium nanoparticles in the treatment of waste water

Professional Experience

2022-present **Prime Minister's Research Fellow (PMRF)**, Indian Institute of Science

2023-present **Associate Member**, Indian Pulsar Timing Array (InPTA)

Publications

* - alphabetic ordering of authors

PUBLISHED

Major contributions

Zuraig, Z., Das, M., Deb, D., Kalita, S., Weber, F., Mukhopadhyay, B. Anisotropic Compact Stars: Theory and Simulation from Microphysical Models to Macroscopic Structure and Observables. *Universe* 12 (2026) 5, 130.
DOI: <https://doi.org/10.3390/universe12050130>

Bhutani, A., Raj, N., **Zuraig, Z.***. Dark, deep, deconfining: Phase transitions in neutron stars as powerful probes of hidden sectors. *Phys.Rev.D* 113 (2026) 10, 103046. DOI: <https://doi.org/10.1103/yblk-411t>, arXiv: 2507.08076

Zuraig, Z., Mukhopadhyay, B., Weber, F. Massive neutron stars as mass gap candidates: Exploring equation of state and magnetic field. *Phys. Rev. D.* 109 (2024) 2, 023027.
DOI: <https://doi.org/10.1103/PhysRevD.109.023027>, arXiv: 2311.02169

Conference proceedings and white papers

Adhikari, P. *et al.* (61 authors including **Zuraig, Z.**), Strongly interacting matter in extreme magnetic fields. *Prog. Part. Nucl. Phys.* 146 (2026) 104199. DOI: <https://doi.org/10.1016/j.pnpnp.2025.104199>, arXiv: 2412.18632

Zuraig, Z., Kumar, A., Hackett, A. J., Mukhopadhyay, B. Simulating super-Chandrasekhar white dwarfs. *World Scientific* (2026). DOI: <https://doi.org/10.1142/14814> | *Proceedings of the Seventeenth Marcel Grossmann Meeting*

Zuraig, Z., Kumar, A., Hackett, A. J., Bhattarai, S., Tout, C. A., Mukhopadhyay, B. Simulating super-Chandrasekhar white dwarfs. *Astrophys. Space Sci. Proc.* 61 (2025) 397-407.
DOI: https://doi.org/10.1007/978-3-031-90186-7_32, arXiv: 2411.18692 | *Book chapter*

Zuraig, Z., Mukhopadhyay, B., Weber, F. Exploring massive neutron stars towards the mass gap: Constraining the high-density nuclear equation of state. *Astron. Rep.* 67 (2023) Suppl 2, S199-S206.
DOI: <https://doi.org/10.1134/S1063772923140214> | *Proceedings of the Fifth Zeldovich Meeting*

As part of InPTA collaboration

Nobleson, K. *et al.* (36 authors including **Zuraig, Z.**). The Indian Pulsar Timing Array Data Release 2: II. Customised single-pulsar noise analysis and noise budget. *JHEAp* 53 (2026).

DOI: <https://doi.org/10.1016/j.jheap.2026.100594>, arXiv: 2512.20455

Susobhanan, A. *et al.* (31 authors including **Zuraig, Z.**). Revisiting wideband pulsar timing measurements. *Mon. Not. Roy. Astron. Soc.* 547 (2026) 4, stag444. DOI: <https://doi.org/10.1093/mnras/stag444>, arXiv: <https://arxiv.org/abs/2512.01288>

Chowdhury, S. *et al.* (30 authors including **Zuraig, Z.**). Effects of coronal mass ejection on PSR J1022+1001 and possible mode change of PSR J2145 - 0750 in the InPTA DR2. *JHEAp* 51 (2026) 100547.

DOI: <https://doi.org/10.1016/j.jheap.2025.100547>, arXiv: 2510.26594

Rana, P. *et al.* (47 authors including **Zuraig, Z.**). The Indian Pulsar Timing Array Data Release 2: I. Dataset and Timing Analysis. *Publ. Astron. Soc. Aust.* 42 (2025). p.e108, DOI: <https://doi.org/10.1017/pasa.2025.10066>, arXiv: 2506.16769

SUBMITTED

Zuraig, Z., Mukhopadhyay, B., Kumar, A., Sarkar, A., Hackett, A. J., Banerjee, P., Tout, C. A. Evolution of magnetized main-sequence stars to super-Chandrasekhar white dwarfs by STARS simulation.

Zuraig, Z., Mukhopadhyay, B. Anisotropic hybrid stars: Interplay of superconductivity and magnetic field leading to gravitational waves. arXiv: 2604.06308

Zuraig, Z., Susobhanan, A. Improving Pulsar Timing Array sensitivity using VLBI Astrometry.

Tahbilda, H. *et al.* (31 authors including **Zuraig, Z.**). The Indian Pulsar Timing Array Data Release 2: III. Search for a Stochastic Gravitational Wave Background. arXiv: 2608.02808

Chowdhury, S. *et al.* (29 authors incl. **Zuraig, Z.**). Profile Reconstruction from Temporally Stable Emission Components for Timing PSR J1713+0747. arXiv: 2608.04108

IN PREP (NEAR SUBMISSION)

Mukhopadhyay, B., Roy, N., **Zuraig, Z.**, Chakraborty, C., Rao, A. R. Is PSR J0901-4046 truly an ultra-slowly rotating neutron star or a white dwarf?

Zuraig, Z., Mukhopadhyay, B. Exploring the slow-rotating pulsar parameter space: Emission from STARS simulated white dwarfs.

Awards, Fellowships, & Grants

- 2022 **Prime Minister's Research Fellowship**, Government of India
- 2022 **All India Rank 36 (out of 28135 candidates), awarded Junior Research Fellowship**, National Eligibility Test, Council of Scientific and Industrial Research, India
- 2022 **All India Rank 51 (out of 19375 candidates)**, Graduate Aptitude Test in Engineering
- 2022 **All India Rank 198 (96.12 Percentile)**, Joint Entrance Screening Test
- 2022 **Gold Medalist**, M.Sc. Physics, National Institute of Technology, Tiruchirappalli
- 2020 **All India Rank 669 (out of 16379 candidates)**, Joint Admission Test for Masters
- 2020 **Silver Medalist**, B.Sc. Physics, Stella Maris College
- 2020 **Outgoing student of the year**, Department of Physics, Stella Maris College

Presentations

TALKS

Anisotropic hybrid stars: Interplay of superconductivity and magnetic field leading to gravitational waves
6th Zeldovich Meeting, Pescara, Italy | 07/25

Simulating magnetized white dwarfs: Chandrasekhar limit and beyond
Workshop: Magnetism in low-mass stars and their compact remnants, IIT Bombay, Mumbai, India | 12/25

Anisotropic neutron stars as mass gap candidates

Brainstorming workshop on neutron stars, Institute of Mathematical Sciences, Chennai, India | 08/25

Explaining unusual observations using magnetized white dwarfs

International Pulsar Timing Array (IPTA) Meeting 2025, California Institute of Technology, Pasadena, USA | 06/25

Addressing fundamental puzzles with the neutron star EOS

University of California, Riverside, USA | 06/25

Simulating magnetized white dwarfs: Chandrasekhar limit and beyond

GW Paleontology group meeting, University of California San Diego, USA | 06/25

Explaining unusual observations using magnetized white dwarfs

43rd Meeting of the Astronomical Society of India, NIT Rourkela, Odisha, India | 02/25

Simulating magnetized white dwarfs by time evolution: Chandrasekhar limit and beyond **[invited]**

4th Symposium of the BRICS Association on Gravity, Astrophysics and Cosmology, SGT University, Gurugram, India | 12/24

Anisotropic neutron stars as mass gap candidates

Conference on Classical and Quantum Gravity, CUSAT, Cochin, India | 11/24

A journey towards compact star physics... and beyond! **[invited]**

Stella Maris College Research Day talk, Chennai, India | 09/24

Massive, magnetized neutron stars as mass gap objects

Parallel session: Galactic and extragalactic magnetars: recent observations and theoretical progress

17th Marcel Grossmann meeting, Pescara, Italy | 07/24

Simulating magnetized white dwarfs by time evolution: Chandrasekhar limit and beyond

Parallel session: Massive white dwarfs and related phenomena

17th Marcel Grossmann meeting, Pescara, Italy | 07/24

Simulating super-Chandrasekhar white dwarfs

International Symposium on Recent Development in Relativistic Astrophysics, SRM Sikkim, Gangtok, India | 12/23

Massive, magnetized compact stars: Theory and Simulation

10th International Conference on Gravitation and Cosmology, IIT Guwahati, Assam, India | 12/23

Massive neutron stars: Effect of EOS vs magnetic field **[invited]**

Online: London-Oldenburg Relativity Seminar | 10/23

Massive neutron stars: effects of EOSs and magnetic field

Online: Strongly interacting matter in extreme magnetic fields, ECT* workshop | 09/23

Exploring massive neutron stars towards the mass gap: Constraining the high density nuclear equation of state

5th Zeldovich Meeting, Yerevan, Armenia | 06/23

POSTERS

Simulating magnetized white dwarfs by time evolution: Chandrasekhar limit and beyond

24th European Workshop on White Dwarfs, ISTA Klosterneuburg, Austria | 08/26

Simulating magnetized white dwarfs by time evolution: Chandrasekhar limit and beyond

In-House Symposium 2025, Department of Physics, Indian Institute of Science, Bengaluru, India | 11/25

Explaining unusual observations using magnetized white dwarfs

In-House Symposium 2024, Department of Physics, Indian Institute of Science, Bengaluru, India | 11/24

Massive neutron stars as mass gap candidates **[invited]**

PMRF Annual Symposium 2024, IIT Indore, Indore, India | 03/24

Simulating super-Chandrasekhar white dwarf from main sequence star: Exploring stellar evolution codes STARS and MESA

Parallel session: Stars, Interstellar Medium, and Astrochemistry in Milky Way

42nd annual meeting of the Astronomical Society of India, Indian Institute of Science, Bengaluru, India | 02/24

Massive neutron stars as mass gap candidates **[Best poster award]**

In-House Symposium, Department of Physics, Indian Institute of Science, Bengaluru, India | 11/23

Simulating magnetised super-Chandrasekhar white dwarfs using STARS

3rd Conference on Plasma Simulations, Raman Science Center, Leh, India | 07/23

Conferences and other visits

CONFERENCES ATTENDED

- 24th European Workshop on White Dwarfs, ISTA Klosterneuburg, Austria | 08/26
- 6th Zeldovich Meeting, Pescara, Italy | 07/26
- Workshop: Magnetism in low-mass stars and their compact remnants, IIT Bombay, Mumbai, India | 12/25
- Brainstorming workshop on neutron stars, IMSc, Chennai, India | 08/25
- International Pulsar Timing Array (IPTA) Meeting 2025, California Institute of Technology, Pasadena, USA | 06/25
- 43rd annual meeting of the Astronomical Society of India (ASI), NIT Rourkela, Rourkela, India | 02/25
- 4th Symposium of the BRICS Association on Gravity, Astrophysics and Cosmology, SGT University, Gurgaon, India | 12/24
- Conference on Classical and Quantum Gravity, CUSAT, Cochin, India | 11/24
- 17th Marcel Grossmann meeting, Pescara, Italy | 07/24
- PMRF Annual Symposium 2024, IIT Indore, Indore, India | 03/24
- Meeting on Pulsar Timing Array Experiments: Present and Future of Indian Collaboration, IMSc, Chennai, India | 02/24
- 42nd annual meeting of the Astronomical Society of India (ASI), Indian Institute of Science, Bengaluru, India | 02/24
- International Symposium on Recent Developments in Relativistic Astrophysics, SRM Sikkim, Gangtok, India | 12/23
- 10th International Conference on Gravitation and Cosmology (ICGC), IIT Guwahati, Guwahati, India | 12/23
- 3rd Conference on Plasma Simulations, Raman Science Center, IIA, Leh, India | 07/23
- 5th Zeldovich meeting, Yerevan, Armenia | 06/23

RESEARCH VISITS

- University of Warsaw | 08/26, 07/24
- ICRANet-Ferrara, University of Ferrara | 07/26, 06/24
- University of California, Riverside | 06/25
- University of California, San Diego | 06/25
- Department of Physics, San Diego State University | 06/25
- Instytut Fizyki Teoretycznej, Uniwersytet Wroclawski (University of Wroclaw) | 07/24

INTERNSHIPS AND SUMMER SCHOOLS

- IIA Summer Programme, Indian Institute of Astrophysics, Bengaluru, India | 07/21
- Vigyan Vidushi, TIFR, Mumbai, India | 05-06/2021
- Introductory Summer School in Astronomy and Astrophysics, IUCAA, Pune, India | 05/21
- National Institute on Undergraduate Sciences (NIUS) Camp (15.1), TIFR, Mumbai, India | 06/18
- Summer Intern, IIUCNN, Mahatma Gandhi University, Kottayam, India | 05/18

Teaching Experience

- 08/26 - present **Mechanics and Waves II**, Teaching Assistant | Undergraduate course at Azim Premji University, Bengaluru, India
- 01-04/26 **Particle Physics and the Standard Model**, PMRF Teaching Assistant | NPTEL online course
- 08-12/25 **Quantum Mechanics I**, Teaching Assistant | Undergraduate course at IISc
- 08-10/25 **Mechanics and Waves II**, Teaching Assistant | Undergraduate course at Azim Premji University, Bengaluru, India
- 07-10/25 **The Joy of Computing using Python**, PMRF Teaching Assistant | NPTEL online course
- 01-04/25 **Intermediate Mechanics (Lab)**, Teaching Assistant | Undergraduate course at IISc
- 01-03/25 **Programming, Data Structures And Algorithms Using Python**, PMRF Teaching Assistant | NPTEL online course
- 07-10/24 **The Joy of Computing using Python**, PMRF Teaching Assistant | NPTEL online course
- 04-06/24 **Introductory Astronomy and Astrophysics**, Instructor, value added course at M.S. Ramaiah University of Applied Sciences, Bengaluru, India
- 01-03/24 **Nuclear Astrophysics**, PMRF Teaching Assistant | NPTEL online course
- 08-12/23 **Introductory Mechanics**, Teaching Assistant | Undergraduate course at IISc [Best TA award]
- 08-12/23 **Introductory Astronomy**, Instructor to Classes VI-X, SPARC Public School, Bengaluru, India
- 01-06/23 **High school physics**, PMRF Teaching Assistant for Class XI, Kendriya Vidyalaya, IISc Bengaluru, India

Mentoring

- 2023 **Surendra Bhattacharai**, Masters thesis student, IISER Kolkata, India
2023 **Ashmita Acharya**, Undergraduate student, M.S. Ramaiah University of Applied Sciences, Bengaluru, India

Skills

Programming Languages: Python, C++, MATLAB, Mathematica

Tools/Codes: LaTeX, MS Office, MESA, Cambridge STARS

OS: Linux, Windows, macOS

Service & Outreach

Peer review: Reviewer for European Physical Journal C, Astrophysics and Space Science Proceedings

Public talk: *The Life and Death of Stars: Stellar Physics and Evolution*
IISc PRAVEGA Astrophysics Workshop, Bengaluru, India | 01/26, 05/26

Volunteer: IISc Open Day

Public Talk: *The Sun and our Solar System* (2023), Conducted quizzes (2024, 2026)

Public talk [**invited**]: *Looking out at the Universe in Radio Waves: From Communication to Astronomy*
IEEE ComSoc SCT SBC: ComConnect 1.0, SCT College of Engineering, Thiruvananthapuram, India | 09/25

Outreach talk: *Looking out at the universe: multi-wavelength astronomy*
SERB outreach program for class X students, IISc, Bengaluru, India | 10/24

Volunteer: 42nd annual meeting of the Astronomical Society of India, IISc, Bengaluru, India | 02/24

External expert: *National Workshop on physical sciences for CSIR-UGC NET and GATE aspirants*, NIT-T, India | 05/23

Outreach talks: *Overview of fermionic compact stars*

Talk I: Non-interacting stars and white dwarfs, Talk II: Introducing interactions

PMRF outreach talk series: Christ University, Bengaluru, India | 02-04/23

Talk: *Equation of motion of double pendulum using different mechanics and MATLAB*
NIT-T weekly colloquium | 06/21

Talk: *Exoplanet detection by transit method*
NIT-T weekly colloquium | 10/20

Public Talk: *Space Debris*
Loyola Astronomy and Rocketry Club, Chennai, India | 02/19