

Dr. Muhammed Shafeeque

Ph.D. in Physics | Relativistic Astrophysics
Assistant Professor (Contractual)
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Research Interests

- General relativity and Gravitation.
- Modified theories of gravity.
- Gravitational waves.
- Numerical relativity.
- Binary coalescence.
- Compact objects: Neutron stars and Black holes.
- Stellar structure.
- Neutron star equation of state.
- Black hole hair.
- Scalarized black holes.

Areas of Expertise and Key Contributions

- Current research investigates the spontaneous scalarization of black holes in Eddington inspired Born-Infeld (EiBI) gravity. Motivated by scalarized solutions in scalar-Gauss-Bonnet and scalar-tensor theories, this work investigates whether the nonlinear curvature structure of EiBI gravity can trigger scalarization without requiring a scalar potential. In this model, the scalar field couples non-minimally to the electromagnetic field through a scalar-dependent coupling function. By analysing the dynamical stability of these scalarized black holes, the physical viability of the solution is confirmed.
- PhD research examined neutron stars and black holes in general relativity and modified gravity. This work showed that hybrid neutron stars with deconfined quark cores remain causal and can reach masses up to $1.98M_{\odot}$, and that Starobinsky $f(R) = R + \alpha R^2$ gravity allows even heavier stable configurations.
For black holes, charged solutions in Eddington-inspired Born-Infeld gravity and studied electrically charged scalar fields in Einstein-Maxwell theory was investigated. This work established the existence of stable, charged, hairy black hole solutions through complementary perturbative analyses.
- Author of *five* research articles.[Link](#)
- Extensive teaching experience as a teaching assistant and tutor, providing tutorials and laboratory sessions in general and computational physics, and instructing several core physics courses to senior higher secondary, undergraduate, and postgraduate students.

Education

Degree/Certificate	Institute/Board	Year
Ph.D. Physics	Indian Institute of Technology Guwahati	2019-2026 Viva-voce: 09-02-2026
M.Sc. Physics	Indian Institute of Technology Guwahati	2017-2019
B.Sc. Physics (Honours)	Jamia Millia Islamia (Central University), New Delhi	2008-2011
Senior Secondary	CBSE Board	2008
Secondary	CBSE Board	2006

Publications.

1. **Charged black holes in Eddington-inspired Born-Infeld gravity: An in-depth analysis of the structure of spacetime geometry**
Authors: **Muhammed Shafeeque** and Malay K. Nandy
Journal : *European Physical Journal Plus* **140**,1147(2025)
DOI:10.1140/epjp/s13360-025-07073-7.
2. **Stability of charged scalar hair on a charged black hole**
Authors: **Muhammed Shafeeque** and Malay K. Nandy
Journal: *General Relativity and Gravitation* **56**, 115 (2024).
DOI: 10.1007/s10714-024-03311-y.
3. **Maximal mass of the neutron star with a deconfined quark core**
Authors: **Muhammed Shafeeque**, Arun Mathew and Malay K. Nandy
Journal: *Journal of Astrophysics and Astronomy* **44**, 63 (2023)
DOI: 10.1007/s12036-023-09957-5
4. **Stellar structure of quark stars in a modified starobinsky gravity.**
Authors: Arun Mathew, **Muhammed Shafeeque**, and Malay K. Nandy.
Journal: *The European Physical Journal C* 80(7):615, Jul 2020.
DOI: 10.1140/epjc/s10052-020-8130-4.

Forthcoming Publication

1. **Supermassive Neutron Stars in Starobinsky Gravity with Causal Hybrid Stellar Matter**(*Under review*)
Authors: **Muhammed Shafeeque**, Arun Mathew and Malay K. Nandy
href <https://arxiv.org/abs/2508.09861> arXiv:2508.09861.

Current and Future Works

1. Spontaneous scalarization of black holes in modified theories of gravity.
2. Effect of gravitational halos in $f(R)$ gravity on binary neutron star mergers.
3. Constraining the coupling parameter α in $f(R)$ gravity using gravitational wave observations.

Conferences.

1. **32nd Meeting of Indian Association for General Relativity and Gravitation (2022)**, held at IISER Kolkata , from 19th to 22th December 2022.
Presented talk entitled: *Effect of quark deconfinement in a few neutron star models*
2. **10th International Conference on Gravitation and Cosmology: New Horizons and Singularities in Gravity-2023**, held at IIT Guwahati, from 6th to 9th December 2023.
Presented talk entitled: *Charged Scalar Hair on Reissner-Nordström Black Holes*

Teaching Experience

- **Department of Physics, University of Calicut**
Assistant Professor (Adhoc)
Subjects Taught:
 - Quantum Mechanics I
 - Data Science and Visualization in Python
 - Basic Computational Tools
 - Computational Physics Lab
 - General Physics Lab

September 2026 - Present
Thenhipalama, Keralam, India
- **Indian Institute of Technology Guwahati**
Undergraduate Teaching Assistant
 - PH102 *Physics II - Electromagnetism* *January 2020 - November 2023*
 - PH407 *Computer Programming & Numerical Methods* *Guwahati, Assam, India*
 - PH101 *Physics I - Mechanics (Classical and Quantum)* *January - May 2020*
 - PH102 *Physics II - Electromagnetism* *September-November 2020*
 - PH101 *Physics I - Mechanics (Classical and Quantum)* *November 2020-February 2021*
 - PH102 *Physics II - Electromagnetism* *March-June 2021*
 - PH101 *Physics I - Mechanics (Classical and Quantum)* *July-November 2021*
 - PH516 *Advanced Physics laboratory -* *January-May 2022*
 - PH101 *Physics I - Mechanics (Classical and Quantum)* *July-November 2022*
 - PH102 *Physics II - Electromagnetism* *January-May 2023*
 - PH307 *Atomic and Molecular Physics* *July-November 2023*
 - Mid- and End-Semester duties *Invigilation and Evaluation* *January 2020 - December 2023*
- **Colonel Satsangi's Kiran Memorial Public School.**
Physics Instructor
 - Core faculty for PCES(Preparation for Competitive Examination Section)
 - Physics instructor for classes IX, X, XI and XII.

July 2014 - December 2015
Sat Bari, New Delhi, India

Technical Skills

- **Programming:** C/C++, Python, and Fortran 90/95
- **Languages Known:** English, Malayalam, Tamil, Hindi, and Urdu
- **Utility packages:** Mathematica, Maxima, Gnu Plot, and Xmgrace
- **Operating System:** Linux/Unix, and Windows
- **Productivity Packages:** L^AT_EX, LyX, and MS Office

Competitive Fellowships and Academic Achievements

- Senior Research Fellowship awarded by MHRD, Government of India 2021-2024
 - Junior Research Fellowship awarded by MHRD, Government of India 2019-2021
 - Graduate Aptitude Test in Engineering-Physics (All India Rank: 1662) 2019
 - Joint Admission Test for M.Sc.-Physics (All India Rank: 481) 2017
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