Muhammad Zeeshan

Fulbright Ph.D. Scholar | Astrophysical Science and Technology | LIGO Scientific Collaboration Member
Gravitational Waves | Compact Binary Populations | Eccentric Binaries | Bayesian Inference

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Education

Rochester Institute of Technology — *Rochester, NY, USA*
Ph.D. Astrophysical Science and Technology — ***August 2023 - Present***
- Advisor: Dr. Richard O'Shaughnessy
- Dissertation: Population Inference of Compact Binaries with Eccentricity

Rochester Institute of Technology — *Rochester, NY, USA*
MS Astrophysical Science and Technology — ***August 2021 - August 2023***
- Advisor: Dr. Richard O'Shaughnessy
- Thesis: Population Inference of Non-spinning Eccentric Binary Black Holes. PDF

COMSATS University Islamabad — *Lahore, Punjab, Pakistan*
MS Mathematics — ***August 2016 - August 2018***
- Advisor: Dr. Muhammad Zubair
- Thesis : Cosmological Evolution in the Background of Non-Minimally Coupled Gravity. PDF

University of Education — *Lahore, Punjab, Pakistan*
BS Mathematics — ***August 2012 - August 2016***
- Advisor: Dr. Abdul Rauf Nizami

Teaching and Research Experience

Member, LIGO Scientific Collaboration — *USA*
Rates and Population (R&P) Group — ***August, 2021 - present***
- Conduct research on population inference of compact binaries using gravitational-wave observations within the LIGO Scientific Collaboration Rates and Populations working group.
- Contribute to internal collaboration reviews by evaluating analysis methods, providing feedback on manuscripts, and coordinating reviews of our research.

Graduate Teaching Assistant — *Rochester, NY, USA*
Rochester Institute of Technology — ***January 2022 - August 2025***
- College Physics (1-2), Modern Physics, Stellar Astrophysics

Lecturer (Full-Time) — *Lahore, Punjab, Pakistan*
University of Central Punjab — ***March 2020 - August 2021***
- Calculus and Analytical Geometry, Pre-Calculus, General Relativity, Special Relativity

Visiting Lecturer — *Lahore, Punjab, Pakistan*
University of Education — ***August 2019 - January 2020***
- Calculus-1

Visiting Lecturer — *Lahore, Punjab, Pakistan*
University of Central Punjab — ***March 2019 - March 2020***
- Calculus and Analytical Geometry

Research Assistant — *Lahore, Punjab, Pakistan*
COMSATS University Islamabad, Lahore Campus — ***August 2017 - August 2018***
- Cosmological Studies in Modified Theories of Gravity

Supervision and Mentoring

Co-Mentor: NSF Research Experience for Undergraduates (REU)
Sophiya Mehra (Rochester Institute of Technology) — *Rochester, NY, USA.* Summer 2025
• Project: Population Inference Enhanced by Analytical Likelihood (This Project Led to a Publication.)

Co-Advisor: Undergraduate Final Year Project (FYP)
Meesum Qazalbash, Safi Haider, Abbas, Maham (Habib University of Karachi) — *Rochester, NY, USA.* 2023-2024
• Project: Population Inference using Bayesian Neural Networks

Advisor: Undergraduate Final Year Project
Eiman Maqsood, Amna Iftikhar, Iqra Nadeem (University of Central Punjab) — *Lahore, Pakistan.* 2020-2021
• Project: Contribution of Collisional Matter in Modified Theories of Gravity

Co-Advisor: Undergraduate Final Year Project
Hafsa Jameel (University of Central Punjab) — *Lahore, Pakistan.* 2020-2021
• Project: Comparison of energy conditions in general relativity and modified theories of gravity. (Published)

Publications

Muhammad Zeeshan, Richard O'Shaughnessy, Natalie Malagon. "Population Properties of Binary Black Holes with Eccentricity." Under review at *Physical Review D*, arXiv:2602.11030 (2026).

Meesum Qazalbash, **Muhammad Zeeshan**, Richard O'Shaughnessy. "An Implementation to Identify the Properties of Multiple Population of Gravitational Wave Sources." Under review at *Physical Review D*, arXiv:2509.13638 (2025).

Muhammad Zeeshan, Richard O'Shaughnessy. "Eccentricity matters: Impact of eccentricity on inferred binary black hole populations." *Physical Review D*, 110, 063009 (2024).
`https://journals.aps.org/prd/abstract/10.1103/PhysRevD.110.063009`

Muhammad Zeeshan. "Population Inference of Non-Spinning Eccentric Binary Black Holes." M.S. Thesis, Rochester Institute of Technology (2023).
`https://repository.rit.edu/theses/11574/`

Muhammad Zeeshan. "Cosmic evolution in the presence of collisional matter in modified gravity." *International Journal of Modern Physics D*, 29 (2020).
`https://www.worldscientific.com/doi/10.1142/S0218271820500996`

M. Zubair, **Muhammad Zeeshan**. "Evolution of Collisional Matter in Modified Teleparallel Theories." *Journal of Physics: Conference Series*, 1557, 012007 (2020).
`https://iopscience.iop.org/article/10.1088/1742-6596/1557/1/012007`

M. Zubair, **Muhammad Zeeshan**, Saira Waheed. "Cosmic evolution in the background of $(R(1+\alpha Q))$ gravity." *Modern Physics Letters A*, 34, 1950253 (2019).
`https://www.worldscientific.com/doi/10.1142/S0217732319502535`

M. Zubair, **Muhammad Zeeshan**, "Cosmic Evolution in the Background of Non-minimal Coupling in $f(R,T,R_{uv}T^{uv})$ Gravity". Astrophys Space Sci. **363**, 248 (2018).
`https://www.worldscientific.com/doi/10.1142/S0217732319502535`

M. Zubair, **Muhammad Zeeshan**, S. S. Hasan, V. K. Oikonomou. "Cosmic Evolution with Modified Gravity in the Presence of Collisional Matter." *Symmetry*, **10**, 463 (2018). `https://www.mdpi.com/2073-8994/10/10/463`

Awards, Fellowships, and Grants

Fully Funded Fulbright Ph.D. Scholarship for Five Years
Fulbright, Institute of International Education (IIE). — *United States* 2021-2026
• Prestigious international scholarship providing financial support and opportunities to collaborate with a global network of scholars.

Punjab Educational Endowment Fund (PEEF) for MS Mathematics
Government of Punjab — *Pakistan* 2016-2018
• Provided full funding support for Master Studies.

Seminar, Conference, and Workshop

2026 **Oral Presentation: American Physical Society (APS) Global Physics Summit, Denver, Colorado, USA.**

2026 **Oral Presentation: American Astronomical Society**, Arizona, USA.

2025 **Poster Presentation: Institute for Advanced Study (IAS)**, Princeton, NJ USA.

2024 **Poster Presentation: American Physical Society (APS) Global Physics Summit**, California, USA.

2024 **Invited Speaker: International Conference on Relativistic Astrophysics and Cosmology**, Lahore, Pakistan.

2023 **Participant: LIGO-VIRGO-KAGRA March Meeting**, at Louisiana State University, USA.

2019 **Participant: 1st PU International Conference on Gravitation and Cosmology**, at the Punjab University, Lahore, Pakistan.

2018 **Participant: Fully Funded Summer School on Cosmology (smr3213)** at the ICTP, Trieste, Italy.

2018 **Participant: Workshop on Information, Black Holes and Quantum Theory: Theoretical physics crossroads** at the Abdus Salam School of Mathematical Sciences (ASSMS), Lahore, Pakistan.

2017 **Participant: International workshop on Astrophysics and Cosmology**, at National Center for Physics, Islamabad, Pakistan.

2016 **Participant: 1st international workshop on relativistic astrophysics and cosmology**, at COMSATS University Islamabad, Lahore, Pakistan.

Technical Skills

Programming	Python, JAX, NumPy, SciPy, Matplotlib, Linux, zsh/Bash
Statistical Methods	Bayesian Inference, MCMC, Hierarchical Bayesian Modeling, Normalizing Flows
Gravitational Waves	Population Inference, Selection Effects, Parameter Estimation
Scientific Software	GWKokab, RIFT, FlowMC
Version Control	Git, GitHub
High Performance Computing	GPU Computing, Parallel Computing, Cluster Workflows

References

Dr. Richard O'Shaughnessy
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School of Mathematical Sciences
Rochester Institute of Technology, NY, USA.
Email: rossma@rit.edu

Dr. Muhammad Zubair
Assistant Professor
Department of Mathematics
COMSATS University Islamabad, Lahore Campus, Pakistan.
Email: drmzubair@cuilahore.edu.pk

Dr. Jason Nordhaus
Associate Professor
School of Mathematical Sciences
Rochester Institute of Technology, NY, USA.
Email: jtnsma@rit.edu