

Contact Information

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Employment

- 2024–present **Weinberg Postdoctoral Fellow**, *University of Texas at Austin*, Austin, TX, USA.
- 2020–2024 **Postdoctoral Associate**, *University of Minnesota*, Minneapolis, MN, USA.
- 2018–2020 **Visiting Fellow (Research & Teaching)**, *Chennai Mathematical Institute*, Chennai, India.
- 2017–2018 **Research Associate**, *Indian Institute of Technology Bombay*, Mumbai, India.

Education

- 2012–2017 **Ph.D.**, *Indian Institute of Science Education and Research Thiruvananthapuram*, India.
Thesis: *Parameter estimation of gravitational waves from compact binaries and astrophysical implications*
Advisor: Prof. Archana Pai, Thesis defended: February 2018 Degree awarded: June 2018
- 2011 **Junior Research Fellow**, *Institute for Plasma Research (IPR)*, Gandhinagar, Gujarat, India.
- 2010–2011 **Physics Instructor**, *T.I.M.E & Advanced Institute of Mathematics*, Cochin, Kerala, India.
- 2007–2009 **M.Sc. Physics**, *St. Albert's College Ernakulam, MG University*, Kerala, India.
- 2004–2007 **B.Sc. Physics**, *MES Mampad College, University of Calicut*, Kerala, India.

Research Interests & Expertise

Gravitational-wave astronomy and strong-field gravity: tests of general relativity with compact binaries; characterization of exotic compact objects.

Multi-messenger astrophysics: connections between GW observations, short gamma-ray bursts, and r-process nucleosynthesis; modeling of binary neutron-star mergers and their EM counterparts.

GW data analysis: Bayesian parameter estimation, hierarchical inference, machine-learning applications for noise regression, and design of large-scale workflows and pipelines for GW data.

Astrophysical populations and stochastic backgrounds: detection of stochastic gravitational-wave background of binary black holes and characterization of astrophysical population models.

Teaching Experience

Courses Taught

- 2019 Jan-Apr **Graduate Elective “PGE046: Gravitational Waves”**, *Chennai Mathematical Institute*.
- 2020 Jan-Apr **Graduate Elective “PGE018: Basics of Gravitational Wave Data Analysis”**, *Chennai Mathematical Institute*.
- 2023 April **National Science Foundation’s Research Traineeship Workshop: “Introduction to Noise Regression using Machine Learning”**, *University of Minnesota*, (undergrad to grad attendees).

Teaching Assistance (TA) and Other Teaching Roles

- 2013–2016 **Undergraduate Teaching Assistant**, *IISER Thiruvananthapuram, Kerala, India*.
 - Mathematical Tools and Hands-on Training with *Mathematica* (Varsha 2013)
 - Electrodynamics I (Vasanth 2014)
 - Mathematical Tools and Hands-on Training with *MATLAB* (Vasanth 2015)
 - Mathematical Tools and Hands-on Training with *MATLAB* (Varsha 2015)
 - Mathematical Tools and Hands-on Training with *Mathematica* (Vasanth 2016)
- 2010–2011 **Instructor (Undergraduate Level Qualifying Examinations)**, *T.I.M.E., Cochin*.
- 2011 Mar-Jul **Instructor (Graduate Level Qualifying Examinations)**, *A.I.M., Cochin*.

Publications

First-author or equally-contributed second-author papers

- 2025 **M. Saleem**, Hsin-Yu Chen, Daniel M. Siegel, Philippe Landry, Jocelyn S. Read, Kaile Wang. "Mergers Fall Short: Non-merger Channels Required for Galactic Heavy Element Production". arXiv pre-print:2508.06020 (currently under review with Journal)
- 2025 Xiao-Xiao Kou, **M. Saleem**, Vuk Mandic, Colm Talbot, Eric Thrane. "Progress toward the detection of the gravitational-wave background from stellar-mass binary black holes: a mock data challenge". *Phys. Rev. D* 112, 084064 (2025), arXiv:2506.14179
- 2025 R. W. Kiendrebeogo, **M. Saleem**, M. Bizouard, Andy H. Y. Chen, N. Christensen, Chia-Jui Chou, M. W. Coughlin, K. Janssens, S. Zacharie Kam, J. Koulidiati, Shu-Wei Yeh. "Application of Non-Linear Noise Regression in the Virgo Detector". *Phys. Rev. D* 112, 083053 (2025), arXiv:2410.06220
- 2024 **M. Saleem**, A. Gunny, C. Chou, L. Yang, S. Yeh, Andy Chen, R. Magee, W. Benoit, T. Nguyen, P. Fan, D. Chatterjee, E. Marx, E. Moreno, R. Omer, R. Raikman, D. Rankin, R. Sharma, M. Coughlin, P. Harris, E. Katsavounidis. "Demonstration of Machine Learning-assisted real-time noise regression in gravitational wave detectors". *Class. Quantum Grav.* 41, 195024 (2024), arXiv:2306.11366
- 2022 **M. Saleem**, N. V. Krishnendu, Abhirup Ghosh, Anuradha Gupta, W. Del Pozzo, Archisman Ghosh, K. G. Arun. "Population inference of spin-induced quadrupole moments as a probe for nonblack hole compact binaries". *Phys. Rev. D* 105, 104066 (2022), arXiv:2111.04135
- 2022 **M. Saleem**, Sayantani Datta, K. G. Arun, B. S. Sathyaprakash. "Parametrized tests of post-Newtonian theory using principal component analysis". *Phys. Rev. D* 105, 084062 (2022), arXiv:2110.10147
- 2022 **M. Saleem**, Javed Rana, V. Gayathri, Aditya Vijaykumar, Srashti Goyal, Surabhi Sachdev, Jishnu Suresh, S. Sudhagar, Arunava Mukherjee, Gurudatt Gaur, Bangalore Sathyaprakash, Archana Pai, Rana X. Adhikari, P. Ajith, Sukanta Bose. "The Science Case for LIGO-India". *Class. Quantum Grav.* 39, 025004 (2022), arXiv:2105.01716
- 2022 S. Mohan, **M. Saleem**, L. Resmi. "Detectability of Electromagnetic counterparts from Neutron Star mergers: prompt emission vs afterglow". *MNRAS* 511, 2356–2366 (2022), arXiv:1912.09436
- 2020 **M. Saleem**. "Prospects of joint detections of neutron star mergers and short-GRBs with Gaussian structured jets". *MNRAS* 493 (2), 1633–1639 (2020), arXiv:1905.00314
- 2020 **M. Saleem**, L. Resmi, K. G. Arun, S. Mohan. "On the energetics of a possible relativistic jet associated with the binary neutron star merger candidate S190425z". *ApJ* 891 (2), 130 (2020), arXiv:1905.00337
- 2019 N. V. Krishnendu, **M. Saleem**, A. Samajdar, K. G. Arun, W. Del Pozzo, Chandra Kant Mishra. "Constraints on the binary black hole nature of GW151226 and GW170608 from spin-induced quadrupole moments". *Phys. Rev. D* 100, 104019 (2019), arXiv:1908.02247
- 2018 **M. Saleem**, L. Resmi, Kuntal Misra, Archana Pai, K. G. Arun. "Exploring short-GRB afterglow parameter space for observations in coincidence with gravitational waves". *MNRAS* 474(4), 5340–5350 (2018), arXiv:1710.06102
- 2018 **M. Saleem**, Archana Pai, Kuntal Misra, L. Resmi, K. G. Arun. "Rates of Short-GRB afterglows in association with Binary Neutron Star mergers". *MNRAS* 475(1), 699–707 (2018), arXiv:1710.06111

Other Short Author-list Papers

- 2025 P. Mahapatra, S. Datta, Ish Gupta, Poulami D. Roy, **M. Saleem**, P. Narayan, S. Roy, Jan Steinhoff, D. Shoemaker, Alan J. Weinstein, A. Gupta, B. S. Sathyaprakash, K. G. Arun. "Confronting General Relativity with Principal Component Analysis: Simulations and Results from GWTC-3 Events". *Phys. Rev. D* 112, 104007 (2025), arXiv:2508.06862

- 2025 Christina Reissel, Siddharth Soni, [M. Saleem](#), Michael Coughlin, Philip Harris, Erik Katsavounidis. "Coherence DeepClean: Toward autonomous denoising of gravitational-wave detector data". arXiv:2501.04883
 - 2025 E. Marx, Will Benoit, Alec Gunny, Rafia Omer, Deep Chatterjee, Ricco C. Venterea, L. Wills, [M. Saleem](#), Eric Moreno, R. Raikman, E. Govorkova, D. Rankin, M. W. Coughlin, P. Harris, E. Katsavounidis. "A machine-learning pipeline for real-time detection of gravitational waves from compact binary coalescences". Phys. Rev. D 111, 042010 (2025), arXiv:2403.18661
 - 2024 D. Chatterjee, E. Marx, W. Benoit, R. Kumar, M. Desai, E. Govorkova, A. Gunny, E. Moreno, R. Omer, R. Raikman, [M. Saleem](#), S. Aggarwal, M. W. Coughlin, P. Harris, E. Katsavounidis. "Rapid likelihood free inference of compact binary coalescences using accelerated hardware". Mach. Learn.: Sci. Technol. 5, 045030 (2024), arXiv:2407.19048
 - 2024 Soumyadeep Bhattacharjee, Smaranika Banerjee, Varun Bhalerao, Paz Beniamini, Sukanta Bose, Kenta Hotokezaka, Archana Pai, [M. Saleem](#), Gaurav Waratkar. "Joint gravitational wave-short GRB detection of Binary Neutron Star mergers with existing and future facilities". MNRAS 528, 4255–4263 (2024), arXiv:2401.13636
 - 2024 Divyajyoti, N. V. Krishnendu, [M. Saleem](#), Marta Colleoni, Aditya Vijaykumar, K. G. Arun, Chandra Kant Mishra. "Effect of double spin-precession and higher harmonics on spin-induced quadrupole moment measurements". Phys. Rev. D 109, 023016 (2024), arXiv:2311.05506
 - 2024 Sayantani Datta, [M. Saleem](#), K. G. Arun, B. S. Sathyaprakash. "Multiparameter tests of general relativity using principal component analysis with next-generation gravitational wave detectors". Phys. Rev. D 109, 044036 (2024), arXiv:2208.07757
 - 2022 N. K. Johnson-McDaniel, A. Ghosh, S. Ghonge, [M. Saleem](#), N. V. Krishnendu, J. A. Clark et al. *Investigating the relation between gravitational wave tests of general relativity*. Phys. Rev. D 105, 044020 (2022), arXiv:2109.06988
 - 2022 Alec Gunny, Dylan Rankin, Jeffrey Krupa, [M. Saleem](#), Tri Nguyen et al. *Hardware-accelerated Inference for Real-Time Gravitational-Wave Astronomy*. Nature Astronomy 6, 529–536 (2022), arXiv:2108.12430
 - 2022 Siddharth R. Mohite, Priyadarshini Rajkumar, Shreya Anand, David L. Kaplan, Michael W. Coughlin, Ana Sagués-Carracedo, [M. Saleem](#) et al. "Inferring kilonova population properties with a hierarchical Bayesian framework I: Non-detection methodology and single-event analyses". Astrophys. J. 925, 58 (2022), arXiv:2107.07129
 - 2020 Shilpa Kastha, [M. Saleem](#), K. G. Arun. "Imprints of the redshift evolution of double neutron star merger rate on the SNR distribution". MNRAS 496, 523–531 (2020), arXiv:1801.05942
- [Large author-list Collaboration papers with significant contributions](#)
- 2024 Varun Bhalerao et al. "Science with the Daksha High Energy Transients Mission". Exp Astron 57, 23 (2024), arXiv:2211.12052. ([M. Saleem](#): Computed Daksha's projected GRB detection rates)
 - 2021 Abbott et al. "Tests of general relativity with binary black holes from the second LIGO–Virgo gravitational-wave transient catalog". Phys. Rev. D 103, 122002 (2021), arXiv:2010.14529. ([M. Saleem](#): Analysis and writing of section V.B on spin-induced deformations)
 - 2017 Abbott et al. "GW170817: Observation of gravitational waves from a binary neutron star inspiral". Phys. Rev. Lett. 119, 161101 (2017). ([M. Saleem](#): GRB-associated and multimessenger analysis)
 - 2017 Abbott et al. "Gravitational waves and gamma-rays from a binary neutron star merger: GW170817 and GRB 170817A". ApJL 848, L13 (2017). ([M. Saleem](#): Jet structure interpretation)
 - 2016 Abbott et al. "Binary black hole mergers in the first Advanced LIGO observing run". Phys. Rev. X 6, 041015 (2016). ([M. Saleem](#): Parametrized tests of GR)
 - 2016 Abbott et al. "Tests of general relativity with GW150914". Phys. Rev. Lett. 116, 221101 (2016). ([M. Saleem](#): Parametrized GR tests)

- 2016 Abbott et al. "Observation of gravitational waves from a binary black hole merger". Phys. Rev. Lett. 116, 061102 (2016). (**M. Saleem**: GR tests analysis)
[In Conference Proceedings](#)
- 2022 Alec Gunny, Dylan Rankin, Philip Harris, Erik Katsavounidis, Ethan Marx, **M. Saleem**, Michael Coughlin, William Benoit. "A Software Ecosystem for Deploying Deep Learning in Gravitational Wave Physics", FlexScience 22: Proceedings of the 12th Workshop on AI and Scientific Computing at Scale using Flexible Computing Infrastructures. <https://doi.org/10.1145/3526058.3535454>

Computational Expertise

Expertise in developing large-scale gravitational-wave data-analysis pipelines, Bayesian-inference frameworks, and machine-learning-based detector-noise mitigation tools.

Extensive experience with scientific programming in Python/C++, HPC environments, workflow automation, and reproducible research software.

As a Referee in Peer-Reviewed Journals (More than 10 articles reviewed)

- 2022–present **Physical Review Letters and Physical Review D**, *American Physical Society*.
- 2024–present **Classical and Quantum Gravity**, *IOP Publishing*.
- 2024–present **Monthly Notices of the Royal Astronomical Society (MNRAS)**, *Oxford University Press / Royal Astronomical Society*.

Awards and Achievements

- 2016 **Special Breakthrough Prize in Fundamental Physics**, *Co-recipient (shared with members of the LIGO Scientific Collaboration) for the discovery of gravitational waves..*
[Link to prize announcement](#)
- 2016 **Gruber Cosmology Prize**, *Co-recipient (shared with members of the LIGO Scientific Collaboration) – Awarded by the Gruber Foundation..*
- 2017 **Bruno Rossi Prize**, *Co-recipient (shared with the LIGO Scientific Collaboration).*
 "For the first direct detections of gravitational waves, for the discovery of merging black hole binaries, and for beginning the new era of gravitational-wave astronomy."

Memberships in Professional Collaborations

- 2013–present **LIGO Scientific Collaboration (LSC)**.
- 2013–2020 **IndIGO–LSC (now LIGO–India Science Collaboration)**.
- 2019–2023 **Daksha Science Team**, *Actively involved in the science study of "Daksha", a proposed space-based gamma-ray mission dedicated to follow-up of gravitational-wave triggers.*

Specific Contributions to the LIGO Scientific Collaboration (LSC)

- 2025–present Analysis of data from 4th observing run with *Templated Background Search (TBS)* pipeline
- 2023–2025 Development of a new method named *Templated Background Search (TBS)* and pipeline for detection of stochastic background from sub-threshold binary blackholes
- 2024–present Chairing a committee that reviews the software infrastructures and results produced for real-time noise subtraction in the fourth observing run of the LIGO–Virgo–KAGRA detectors.
- 2023–2025 Development of a novel Testing GR infrastructure named "PCA-based multi-parameter tests of GR", review, and application on GW events
- 2019–2021 Development of a new infrastructure named "Spin-induced quadrupole moment tests of compact objects", to test the black-hole nature compact objects, review, and application on GW events
- 2019–present Served as LIGO Internal reviewer for the review of several articles

- 2019-2020 Member of the parameter-estimation team for GW triggers during the O3 observing run.
- 2019-2020 Advocate for signing off public alerts for electromagnetic follow-up of gravitational-wave triggers.
- 2017 Assessment of GW170817 of jet properties using multimessenger (GW+EM) observations.
- 2015-2016 Parametrized tests of General Relativity with GW events GW150914 and GW151226.
- 2015 Estimation of background distributions of NSBH systems for parametrized tests of GR.
- 2015 Study of waveform systematics affecting parametrized tests of GR.

Conference Presentations and Talks

- 2023 **Invited Talk**, Center for Gravitation, Cosmology & Astrophysics, University of Wisconsin–Milwaukee, 28 April, *Denosing gravitational wave data using Deep Learning* .
- 2020 **Invited Talk**, *Chennai Symposium on Gravitation and Cosmology, IIT Madras, India*, January. *"Multi-messenger astronomy with gravitational waves"*
- 2018 **Invited Panelist**, *PAX4 Meeting, IUCAA, Pune, India*, 7–10 August. Discussion on "Analysis challenges in gravitational wave astronomy"
- 2023 **Talk**, *2023 APS April Meeting*, *"DeepClean: Machine Learning-Assisted Noise Regression in Gravitational Wave Detectors"* .
- 2023 **Talk**, *AcceleratingPhysicsWithML@MIT, Massachusetts Institute of Technology*, January, *"De-noising gravitational wave data using Machine Learning"* .
- 2022 **Talk**, *A3D3 Fast ML Meeting, Southern Methodist University, Dallas, Texas*, October, *"DeepClean: Machine Learning-assisted data de-noising in LIGO"* .
- 2021 Dec **Poster**, *The Gravitational Wave Physics and Astronomy Workshop, Hannover, Germany*. *"An Optimal Search for the gravitational wave background of unresolved binary black-hole mergers"*
- 2021 July **Talk**, *14th Amaldi Conference on Gravitational Waves*, *"The Science case for LIGO India"*.
- 2019 **Talk**, *International Conference in Gravitation and Cosmology, IISER Mohali, India*, December. *"Constraining the properties of electromagnetic counterparts of Binary Neutron Star mergers"*
- 2019 Jan **Talk**, *IAGRG, BITS Pilani, Hyderabad, India*, January. *"Stealth biases in gravitational wave parameter estimation due to exotic nature of compact binaries"*
- 2018 **Talk**, *Astronomical Society of India Meeting, Osmania University, Hyderabad, India*, February. *"Short-GRB afterglows in coincidence with gravitational waves from Binary Neutron Star mergers"*
- 2017 **Poster**, *Astronomical Society of India Meeting, Jaipur, India*, March. *"Prospects of LIGO-India in probing masses, spins and source location of compact binaries"*
- 2015 **Poster**, *International Conference on Gravitation and Cosmology, IISER Mohali, India*, December. *"Measuring Binary inclination angle: connection to short GRB jet opening angle"*
- 2015 March **Talk**, *Indian Association for General Relativity and Gravitation Conference, RRI Bangalore, India*. *"Improving GW parameter estimation accuracy of inclination angle using short GRB observations"*

Workshops, Meetings, Schools and Visits

- 2025 Sept. **LIGO-Virgo-KAGRA Collaboration Meeting** , *Collorado State University*.
- 2023 March **LIGO-Virgo-KAGRA Collaboration Meeting Meeting**, *Northwestern University, Chicago*.
- 2021 Dec. **GWPAW Meeting**, *Albert Einstein Institute, Hannover*.
- 2021 July **14th Edoardo Amaldi Conference on Gravitational Waves**, 19–23 July.
- 2019 Aug. **Future of GW Astronomy Meeting**, *ICTS Bangalore*, 19–22 August.
- 2018 Aug. **ICTS School on GW Astronomy**, *ICTS Bangalore*, 13–24 August.
- 2016 April **ICTS Discussion Meeting: Future of GW Astronomy**, *ICTS Bangalore*, 4–8 April.
- 2015 March **Workshop on Astronomy, Cosmology and Fundamental Physics with Gravitational Waves**, *Chennai Mathematical Institute*, 2–4 March.

- 2014 Dec. **Visit to Cardiff University**, 1–4 December.
- 2014 Nov. **Visit to University of Birmingham**, *Collaboration work on tests of GR*, 6–30 November.
- 2013 Dec. **ICTS School on Experimental Gravitational-Wave Physics**, *RRCAT Indore*, 23–28 December.
- 2013 Dec. **Gravitational Wave Physics and Astronomy Workshop**, *IUCAA, Pune*, 17–20 December.
- 2013 June **ICTS School on Numerical Relativity**, *ICTS Bangalore*, 10–21 June.
- 2012 Dec. **Workshop on GW Data Analysis**, *BITS Pilani Goa Campus*, 17–21 December.
- 2012 July **Astrod 5 Meeting**, *Raman Research Institute, Bangalore*, 11–13 July.