SHASHWAT **SINGH**

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229A, Kelvin Building, University of Glasgow, G12 8QQ, Scotland

I am currently a PhD student at the University of Glasgow and working on probing massive and supermassive black holes using gravitational wave sources to be detected by LISA – a future space-based gravitational-wave detector and electromagnetic transients from ZTF & LSST.

Academic Qualifications

2023 – 2027 | **University of Glasgow, School of Physics and Astronomy, PhD**
Thesis title : Revealing the family of massive black holes with LISA
Supervisors : Dr Christopher Berry and Dr John Veitch
Gravitational Waves | LISA | Super/Massive Black Holes | Population Inference

2022 – 2023 | **l'Observatoire de Paris, Université PSL (Paris Sciences & Letters), M2 – International Research Track**
Program combined with courses and research in laboratories. Graduated with honours.
General-relativity | Data-analysis | Magneto-hydrodynamics | High-performance-computing

2021 – 2022 | **Sciences et Ingénierie, Sorbonne Université, M1 – Paris Physics Masters**
Program targeted towards fundamental courses and compulsory lab-work.
Advanced quantum mechanics | Statistical mechanics | Astrophysics & Cosmology | Numerical methods

2017 – 2021 | **Sardar Vallabhbhai National Institute of Technology, B. Tech, Mechanical Engineering**
Four-year program combined with theoretical and experimental work.
Data-analysis | Fluid mechanics & dynamics | Machines and rigid body motion

Publications and Preprints†

- LISA CosmoWG, **"Measuring cosmological parameters with LISA : extreme mass-ratio inspirals"**. *In prep.*
- Kanu, A., **Singh, S.**, Harikumar, S., **"Gravitational Wave Lensing as a Probe to Understanding Subhaloes Hosting Massive Black Holes"**, *In prep.*
- **Singh, S.**, Berry, C. P. L., Broggi, L., Veitch, J., Volonteri, M., **"Disrupted Stars and Falling Compact Objects : Combining Multi-Messenger Observations to Constrain the Population of Massive Black Holes"**, *In prep.*
- **Singh, S.**, Chapman-Bird, C. E. A., Berry, C. P. L., Veitch, J., **"Revealing Massive Black Hole Astrophysics : The Potential of Hierarchical Inference with Extreme Mass-Ratio Inspiral Observations"**, *The Astrophysical Journal*, 1005, 176 (July 2026). doi:10.3847/1538-4357/ae75dc
- Al-Shammari, S. *et al.*, **"The Early Career Workshop of GR-Amaldi 2025"**, *Journal of Physics : Conference Series*, 3177, 012001 (February 2026). doi:10.1088/1742-6596/3177/1/012001
- **Singh, S.**, Chapman-Bird, C. E. A., Berry, C. P. L., Veitch, J., **"Constraints on the Extreme Mass-Ratio Inspiral Population from LISA Data"**, *Journal of Physics : Conference Series*, 3177, 012113 (February 2026). doi:10.1088/1742-6596/3177/1/012113
- **Singh, S.**, Brando, G., Savastano, S., Zumalacárregui, M., **"Gravitational Wave Lensing : Probing Fuzzy Dark Matter with LISA"**, *Journal of Cosmology and Astroparticle Physics*, 2025, 025 (July 2025). doi:10.1088/1475-7516/2025/07/025
- Mahor, A., Reddy, J., Singh, A., **Singh, S.**, **"Estimating Dynamical Parameters of Two Interacting Galaxies Using Deep Learning"**, *Monthly Notices of the Royal Astronomical Society*, 521(3), 3441–3450 (May 2023). doi:10.1093/mnras/stad700
- **Singh, S.**, Singh, A., Prajapati, A., Pathak, K. N., **"Deep Learning for Estimating Parameters of Gravitational Waves"**, *Monthly Notices of the Royal Astronomical Society*, 508(1), 1358–1370 (November 2021). doi:10.1093/mnras/stab2417
- Singh, P. K., Sahu, S., Upadhyay, P. K., **Singh, S.**, **"Experimental and Numerical Investigation of the Thermal Performance of Impinging Synthetic Jets with Different Waveforms"**, *Experimental Heat Transfer* (September 2021). doi:10.1080/08916152.2021.1984341
- Singh, P. K., Kothari, R., Sahu, S., Upadhyay, P. K., **Singh, S.**, **"Experimental and Numerical Investigation of Thermal Performance of Synthetic Jet Impingement"**, *Proceedings of the ASME 2020 28th International Conference on Nuclear Engineering (ICONE28)*, V001T03A020 (August 2020), 6 pages. doi:10.1115/ICONE2020-16775
- Prajapati, A., **Singh, S.**, **"Lindblad Evolution and Quantum to Classical Transition of Rabi Oscillation in Single Quantum Dot"**, *AIP Conference Proceedings*, 2220, 020122 (2020). doi:10.1063/5.0001258
- Singh, P. K., Kumar, A., Shah, A., Kishor, A., Sahu, S. K., Upadhyay, P. K., **Singh, S.**, **"Flow and Heat Transfer Analysis of an Axisymmetric Impinging Synthetic Jet for Electronic Cooling"**, *Proceedings of the International Conference on Innovation and Thermo-Fluid Engineering and Science (ICITFES-2020)*, NIT Rourkela, India, 10–12 February 2020. [Paper ID : 13754]
- Prajapati, A., **Singh, S.**, **"Decoherence Control via Pumping of Electromagnetic Energy in Open Quantum System"**, presented at *The 5th International Conference on Atomic, Molecular, Nano-physics with Application* (CAMNP-2019).
- **Singh, S.**, Prajapati, A., Pathak, K. N., **"Predicting Future Astronomical Events Using Deep Learning"**, arXiv:2012.15476 (December 2020).†
- **Singh, S.** (August 2022), **"Prospects of Detection of Lensed Gravitational Wave Signals"**, *Zenodo*. doi:10.5281/zenodo.7029226.†

Invited Talks

- Physik-Institut, Universität Zürich, January 2026. *Revealing MBH astrophysics using EMRIs*.
- Institute for Gravitational Research, University of Glasgow, January 2026. *Revealing the population of massive black holes*.

- LISA Working Group, January 2026. *Constraints on EMRI Populations from LISA data*.
- PyCBC Telecon, April 2025. *Gravitational wave lensing : probing Fuzzy Dark Matter with LISA*.
- LISA Cosmology Working Group, April 2025. *Gravitational wave lensing : probing Fuzzy Dark Matter with LISA*.

Conferences, Seminars & Workshops Organisation

- GR24 & Amaldi16, University of Glasgow, UK, July 2025
- Student Seminar, University of Glasgow, UK, 2024–2025

Conferences, Seminars & Workshops‡ Contributions

- National Astronomy Meeting 2026, University of Birmingham, July 2026. *Inferring MBH's origin and growth with multimessenger observation from EMRI and TDE observations*.
- European Astronomical Society Annual Meeting, SwissTech Convention Centre Lausanne, Switzerland, July 2026. *Probing massive black hole population with combined EMRI and TDE observations*.
- Massive Black Hole Spin Workshop, University of Edinburgh, UK, April 2026. *Disrupted stars and falling compact objects : Combining multi-messenger observations to constrain the population of MBH*.
- GW:UK@Nottingham, University of Nottingham, January 2026. *The potential of hierarchical inference with extreme mass-ratio inspiral observations*.
- Reunion populations de sources GDR ondes gravitationnelles, Institut d'Astrophysique de Paris, September 2025. *Revealing the massive black hole population with LISA*.
- GR24 & Amaldi16, University of Glasgow, UK, July 2025. *Constraints on EMRI Populations from LISA data*.
- EMRI Search & Inference within the LISA Global Fit - Part I, APC Paris, France, June 2025. *Accelerated MBH population estimation from EMRI detections*.
- SUPA Cormack, University of Dundee, UK, December 2024. *Constraining Massive Black Hole population from LISA observations*.
- LISA Astrophysics Working Group Meeting, MPA Garching, Germany, November 2024. *Constraining EMRI Population using Hierarchical Bayesian Inference*.
- Cosmology from Home, July 2023. *Probing Fuzzy dark matter with lensed Gravitational waves.*
- Python for HPC Workshop by Max Planck Computing and Data Facility (MPCDF)‡, July 2023
- 2^{nd} MaNiTou Summer School on Gravitational Waves : A new window to the Universe‡ - Nice, France, July 2023.
- 9th International Conference on Gravitation and Cosmology (ICGC) - IISER Mohali, India, December 2019. *Clustering and Predicting Astrophysical events using GW.*
- 3rd International Conference on Condensed Matter and Applied Physics (ICC) - Bikaner, India, October 2019. *Lindblad Evolution and Quantum to Classical Transition of Rabi Oscillation in Single Quantum Dot*.

Awards and Recognition

2025	Lord Kelvin and Charles Lindie Mitchell Scholar
2023	University of Glasgow Graduate School Mobility Grant
2023	University of Glasgow Graduate School Scholarship
2023	Erasmus+ funding (EU's program to support education, training, youth and sport in Europe)
2022	Université PSL fellowship for higher education (M2)
2022	IPIASMUS grant (IPI « Physique des Infinis ») for an internship at Max-Planck-Institut für Gravitationsphysik (AEI)
2020	Honorarium from the Max-Planck-Institut für Gravitationsphysik (Albert-Einstein-Institut)

Research Experience

Oct 2025 – Sep 2025 | **Visiting researcher, Institut d'Astrophysique de Paris, France**
Supervisor : Prof. Marta Volonteri
Project on combining tidal disruption event (TDE) and EMRI observations to constrain the massive black hole population.

Jul 2023 – Jan 2023 | **Master Thesis, Max-Planck-Institut für Gravitationsphysik (Albert-Einstein-Institut), Germany**
Supervisor : Dr M. Zumalacárregui
Probing Fuzzy dark matter using lensed gravitational waves detected by LISA. Resulted in the JCAP paper "Gravitational Wave Lensing : Probing Fuzzy Dark Matter with LISA" (2025).

Jan 2023 – Sep 2022 | **Lab Insertion Unit, l'Observatoire de Paris, France**
Supervisors : Dr A. Hees (SYRTE) & Dr N. Korsakova (APC)
Waveform compression of Extreme-Mass-Ratio-Inspirals (EMRIs) using Singular Value Decomposition (SVD).

Jul 2022 – Apr 2022 | **Internship, Max-Planck-Institut für Gravitationsphysik (Albert-Einstein-Institut), Germany**
Supervisor : Dr A. H. Nitz
Prospects of premerger detections & sky-localization of gravitational waves (GWs), using higher modes.

Sep 2020 – Jun 2020 | **Internship, Max-Planck-Institut für Gravitationsphysik (Albert-Einstein-Institut), Germany**
Supervisor : Dr A. H. Nitz
Built a prototype analysis for massive binary black hole (MBH) mergers using LISA.

Aug 2020 – May 2019 | **Research project, Dept. of Physics, SVNIT Surat, India**
Supervisor : Dr K. N. Pathak
Deep learning for estimating parameters of GWs (CNNs) and sequence-prediction of galaxy mergers (LSTM networks).

Jul 2019 – May 2019 | **Internship, Dept. of Mechanical Engineering, Indian Institute of Technology Indore, India**
Supervisor : Dr S. K. Sahu
Developed a numerical method to study heat transfer effects of a synthetic jet on different materials, and C++ code allowing mesh motion within the model in Ansys Fluent.

</> Programming & Technical Skills

Languages & Tools : Python, C++/C, Mathematica, SQL
Scientific Computing : ML / DL, HPC
Cloud Technologies : AWS S3, CDN, λ
Front-End & Back-End : React + JS, HTML, CSS

Public Libraries

MBHpopulation : Unveiling the population of massive black holes — GitHub, 2024-Present
Bayesian inference | astrophysical population synthesis | selection bias modelling

Poplar : Augmenting selection bias modelling with machine learning for big speedups — GitHub, 2024-2025
machine learning | deep learning | multi-layer perceptron | detection-probability modelling

GLoW : Contributed to the GW lensing library — GitHub, 2023
contour integration (ODE) | FFT with singular-part regularisation | analytic point-lens & SIS

PyCBC higher modes : Recovery model extracting mode-by-mode information during GW parameter estimation — GitHub, 2022
per-mode waveform evaluation | likelihood-based Bayesian inference

lensGW : Python library generating lensed GW signals, built on PyCBC waveform generation — GitHub, 2021
geometrical-optics magnification & time delay | lens-equation solver

lensGW-PyCBC-plugin : Plugin letting PyCBC recognise lensed waveforms for parameter estimation — GitHub, 2021
PyCBC waveform plugin | geometrical-optics lensed waveforms

LISA Module : Prototype analysis of MBH GW signals with LISA : simplified orbit and detector response — GitHub, 2020
simplified LISA orbit | analytic detector response

Teaching[‡] and Mentorship[*,°]

- 2024, Physics Lab, P2.[‡]

Undergraduate[°] and master's[*] students (via Bose.X)

- 2025, Ankita Chaudhary[*], Osmania University.
- 2025, Ansal Kanu[°], University of Delhi, *Co-authored a paper; GW lensing*.
- 2025, Ananthu K Lali[*], University of Alabama, Huntsville.
- 2025, Shravan Kunnavakkam Vinjamur[*], University of Glasgow.
- 2024, Nancy Sharma[°] & Sree Suswara[*], SVNIT, Surat, *Gravitational-Wave Lensing + Machine Learning*.
- 2023, Nancy Sharma[°] & Nancy Jikarda[°], SVNIT, Surat, *Gravitational-Wave Lensing*.
- 2021, Adarsh Mahor[°] & Janvita Reddy[°], SVNIT, Surat, *Co-authored a paper; Application of ML in astronomy*.

Extracurricular & Outreach activities

BOSE.X, Co-Founder : Independent research organization for undergraduate research ; since 2019. (bosex.org)
GRA-WITTY, Founder : Outreach program ; since 2023. (gra-witty)
Glasgow Science Festival : Outreach activity, 2024
Worldcon : Outreach activity, 2024