

# SHASHWAT SINGH

@ shashwat98singh@gmail.com   @ Shashwat.SINGH@obspm.fr  
+33(0) 78 08 38 520  
Fondation de la Maison de l'Inde, 7 Rue Boulevard Jourdan, 75014 Paris

I am currently a doctoral candidate at the University of Glasgow and working on probing massive and supermassive black holes using LISA - future space-based gravitational-wave detector.

## ACADEMIC QUALIFICATIONS

2023 Ongoing	<b>University of Glasgow, SCHOOL OF PHYSICS AND ASTRONOMY, PhD</b> Thesis title : Revealing the family of massive black holes with LISA Supervisors : Dr. Christopher Berry and Dr. John Veitch LISA MBH SMBH
2022 2023	<b>l'Observatoire de Paris, UNIVERSITÉ PSL (PARIS SCIENCES &amp; LETTRES), M2 – International Research Track</b> Program combined with courses and research in laboratories. General-relativity Data-analysis Magneto-hydrodynamics High-performance-computing
2021 2022	<b>Sciences et Ingénierie, SORBONNE UNIVERSITÉ, M1 – Paris Physics Masters</b> Program targetted towards fundamental courses and compulsory lab-work. Advanced quantum mechanics Statistical mechanics Astrophysics & Cosmology Numerical-methods
2017 2021	<b>Sardar Vallabhbhai National Institute of Technology, B. TECH, Mechanical Engineering</b> Four year program combined with theoretical and experimental work. Data-analysis Fluids - mechanics & dynamics Machines and rigid body motion

## RESEARCH EXPERIENCE

January 2023 July 2023	<b>Max-Planck-Institut für Gravitationsphysik, (ALBERT-EINSTEIN-INSTITUT), Supervisor : Dr. M. Zumalacárregui</b> Probing Fuzzy dark matter using lensed gravitational waves detected by LISA. Internship gravitational-wave-lensing fuzzy dark-matter
September 2022 January 2023	<b>l'Observatoire de Paris, LAB INSERTION UNIT, Supervisor : Dr. A. Hees (SYRTE) &amp; Dr. N. Korsakova (APC)</b> Aimed towards waveform compression of Extreme-Mass-Ratios-Inspirals (EMRIs) using Singular Valued Decomposition. gravitational-waves EMRI waveform-modeling
April 2022 July 2022	<b>Max-Planck-Institut für Gravitationsphysik, (ALBERT-EINSTEIN-INSTITUT), Supervisor : Dr. A. H. Nitz</b> Worked on prospects of premerger detections & skylocalization of gravitational waves (GWs), extracting higher harmonics information from GW strain. This was targeted towards generating premerger alerts to observe any electromagnetic counterparts (multi-messenger astronomy). Internship gravitational-waves higher-modes premerger-detection multi-messenger astronomy PyCBC
June 2020 September 2020	<b>Max-Planck-Institut für Gravitationsphysik, (ALBERT-EINSTEIN-INSTITUT), Supervisor : Dr. A. H. Nitz</b> Build a prototype analysis for massive binary blackhole (MBH) mergers using the planned LISA space-based GW observatory. Worked on implementing the LISA orbit and the detector response to the GW signal for such sources. Internship gravitational-waves LISA PyCBC simulation
May 2019 July 2019	<b>Dept. of Mechanical Engineering, INDIAN INSTITUTE OF TECHNOLOGY INDORE, Supervisor : Dr. S. K. Sahu</b> ➢ Developed numerical method to study heat transfer effects of synthetic jet on different materials in the shape of a 2D plate. ➢ Developed C++ code for allowing mesh motion within the model in Ansys Fluent. Internship synthetic-jet Ansys Fluent computational-fluid-dynamics C++

May 2019  
August 2020

Dept. of Physics, SVNIT SURAT, Under supervision of Dr. K. N. Pathak

Worked on several projects especially targeted towards the use of deep learning

> estimating parameters of GWs (Convolutional neural networks)

> sequence-prediction of galaxy mergers (Long-short term memory neural networks)

lab-work

gravitational-waves

sequence-prediction

deep-learning

neural-networks

## PUBLICATIONS

- “Estimating dynamical parameters of two interacting galaxies using Deep Learning”, Mahor, A., Reddy, J., Singh, A., **Singh, S.**, Monthly Notices of the Royal Astronomical Society, Volume 521, Issue 3, May 2023, Pages 3441–3450, <https://doi.org/10.1093/mnras/stad700>
- “Deep learning for estimating parameters of gravitational waves”, **Singh, S.**, Singh, A., Prajapati, A., Pathak, K. N., Monthly Notices of the Royal Astronomical Society, Volume 508, Issue 1, November 2021, Pages 1358–1370, <https://doi.org/10.1093/mnras/stab2417>
- “Lindblad Evolution and Quantum to Classical Transition of Rabi Oscillation in Single Quantum Dot” Prajapati, A., **Singh, S.** AIP Conference Proceedings 2220, 020122 (2020); <https://doi.org/10.1063/5.0001258>
- “Experimental and Numerical Investigation of Thermal Performance of Synthetic Jet Impingement” Singh, P. K., Kothar, R., Sahu, S., Upadhyay, P.K., **Singh, S.**, ICONE2020-16775, V001T03A020; 6 pages, <https://doi.org/10.1115/ICONE2020-16775>
- “Experimental and numerical investigation of the thermal performance of impinging synthetic jets with different waveforms” Singh, P. K., Sahu, S., Upadhyay, P.K., **Singh, S.**, Experimental Heat Transfer, 10.1080/08916152.2021.1984341
- “Decoherence Control via Pumping of Electromagnetic Energy in Open Quantum System” Prajapati, A., **Singh, S.** presented at The 5th International Conference on Atomic, Molecular, Nano-physics with Application (CAMNP-2019).
- P. K. Singh, A. Kumar, A. Shah, A. Kishor, S. K. Sahu, P. K. Upadhyay, **S. Singh**, “Flow and Heat Transfer analysis of an axisymmetric Impinging Synthetic Jet for Electronic Cooling” Proc of Int Conf on Innovation and Thermo-Fluid Eng and Sci [ICITFES – 2020] NIT Rourkela, India, 10-12 February [Paper ID : 13754]

## SEMINARS AND TALKS

- Cosmology from Home - July 2023. Talk : *Probing Fuzzy dark matter with lensed Gravitational waves*
- 2<sup>nd</sup> MaNiTou Summer School on Gravitational Waves : A new window to the Universe - Nice, France, July 2023.
- 3rd International Conference on Condensed Matter and Applied Physics (ICC) - Bikaner, India, October 2019. Poster : *Lindblad Evolution and Quantum to Classical Transition of Rabi Oscillation in Single Quantum Dot*.
- 9th International Conference on Gravitation and Cosmology (ICGC) - IISER Mohali, India, December 2019. Poster : *Clustering and Predicting Astrophysical events using GW*.

## PREPRINTS AND REPORTS

- “Unveiling the Hidden Cosmos : Lensing of Gravitational Waves by Fuzzy Dark Matter with LISA.” Singh S. (2023). Master (M2) thesis; supervisor Dr. Miguel Zumalacárregui
- “Prospects of detection of gravitational waves using higher harmonics.” Singh S. (2022). Internship report. Supervisor : Dr. Alexander H. Nitz
- “Predicting future astronomical events using deep learning” Singh, S., Prajapati, A., Pathak, K.N. - <https://arxiv.org/abs/2012.15476>
- “Prospects of detection of lensed gravitational wave signals.” Singh S. (2022). Zenodo. <https://doi.org/10.5281/zenodo.7029226>

## TECHNICAL SKILLS

Python	● ● ● ● ●
C++/C	● ● ● ● ○
MATLAB	● ● ● ○ ○
Mathematica	● ● ● ○ ○
LaTeX, Pack Office	● ● ● ● ●
JS, HTML, CSS	● ● ● ○ ○

## LIBRARIES WORKED ON

- > Astropy, GWpy, PyCBC, IBM Quiskit - Python
- > Scikit, Pytorch, Keras - Python
- > Managing HDF5, FITS files

## AWARDS AND RECOGNITION

- 2023 University of Glasgow Graduate School scholarship.
- 2023 Received Erasmus+ funding (EU's program to support education, training, youth and sport in Europe)
- 2022 Université PSL fellowship for higher education (M2).
- 2022 Received IPIASMUS grant (IPI Initiative « Physique des Infinis ») towards carrying out an internship at Max-Planck-Institut für Gravitationsphysik (Albert-Einstein-Institut).
- 2020 Received honorarium by the Max-Planck-Institut für Gravitationsphysik (Albert-Einstein-Institut) for a three-month internship.

## PUBLIC LIBRARIES

<b>AEI - LENSING LIBRARY</b> Code not yet public Contributed to the GW lensing library <a href="#">Internship</a> <a href="#">gravitational-waves</a> <a href="#">lensed-gravitational-waves</a> <a href="#">PyCBC</a>	2023
<b>INCLUSION OF HIGHER-MODES FOR PARAMETER ESTIMATION OF GRAVITATIONAL WAVES IN PyCBC</b> <a href="#">github.com/SSingh087/pycbc/tree/conmodel</a> A recovery model that allows extracting mode-by-mode information while performing parameter estimation. <a href="#">Internship</a> <a href="#">gravitational-waves</a> <a href="#">higher-modes</a> <a href="#">premerger-detection</a> <a href="#">multi-messenger astronomy</a> <a href="#">PyCBC</a>	2022
<b>LENSGW FOR GENERATING GRAVITATIONALLY LENSED SIGNALS</b> <a href="#">github.com/SSingh087/lensGW</a> Python library for generating lensed gravitational waves and uses PyCBC for waveform generation so that all analysis can be done using tools provided by PyCBC. <a href="#">gravitational-waves</a> <a href="#">lensed-gravitational-waves</a> <a href="#">PyCBC</a>	2021
<b>LENSGW-PYCBC-PLUGIN</b> <a href="#">github.com/SSingh087/lensGW-PyCBC-plugin</a> Plugin for allowing waveforms to be recognized by PyCBC and perform parameter estimation <a href="#">gravitational-waves</a> <a href="#">lensed-gravitational-waves</a> <a href="#">PyCBC</a>	2021
<b>LISA - MODULE</b> <a href="#">github.com/gwastro/pycbc/commits/master/pycbc/detector.py?author=SSingh087</a> Prototype for analysis of MBH GWs signals using LISA space-based GW observatory. The module consists of a simplified LISA orbit and detector response towards a GW signal. <a href="#">Internship</a> <a href="#">gravitational-waves</a> <a href="#">LISA</a> <a href="#">PyCBC</a>	2020

## MENTORED PROJECTS

- 2021 **Estimating dynamical parameters of two interacting galaxies using Deep Learning** : Attempt to use the regression method to predict the parameters of the galaxies. (<https://doi.org/10.1093/mnras/stad700>)1
- 2021 **Differentiating between lensed and unlensed signals using deep-learning** : Using Convolutional neural network (CNN) to classify between the lensed and unlensed signals (Classification problem).

## CERTIFICATIONS

- 2018 Secured top 4th candidate from all over India in “DECOHERENCE - Pravega” held at Indian Institute of Sciences (IISc), Bangalore.
- 2013 Participated in “10th INTERNATIONAL COMPUTER OLYMPIAD 2013”; achieved rank 118 in state; international rank 919.
- 2013 Participated in “5th INTERNATIONAL OLYMPIAD OF SCIENCE 2013”; achieved state rank within 500; international rank under 5000
- 2013 Participated in “6th INTERNATIONAL MATHEMATICS OLYMPIAD 2013”; achieved state rank within 500; international rank under 5000.
- 2010 Participated in “INTERNATIONAL OLYMPIAD OF SCIENCE 2010”; achieved rank 421 in state; international rank under 5000.

## 💡 EXTRACURRICULAR ACTIVITIES

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- BOSE.X, Co-FOUNDER : Independent research organization targeted to promote multidisciplinary research; since 2019. (bosex.org).
- CHRD CLUB, SVNIT : Ex-member of the Centre of Human Resource Development (CHRD, SVNIT) Music and Photography club.
- ASTRONOMY : Successfully completed “Asteroid Data Challenge 2020” - organized by IASC supported by NASA.
- SPORT : Basketball (professional), Badminton & Cycling (leisure)
- 2018 - Silver medal in Inter Year Basketball Tournament.
- 2018 - Gold medal in IGNIS SVNIT's Annual Sports Meet 2018.
- 2019 - Participated in Dhirubhai Ambani Institute of Information and Communication Technology Sports Tournament.

## “ REFERENCES

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**Prof. Alexander H. Nitz**

*Assistant Professor*, SYRACUSE UNIVERSITY - COLLEGE OF ARTS AND SCIENCE, NY, USA

@ ahnitz@syr.edu

**Dr. Miguel Zumalacárregui**

*Group Leader - Astrophysical and Cosmological Relativity*, MAX-PLANCK-INSTITUT FÜR GRAVITATIONSPHYSIK, POTSDAM, GERMANY

@ miguel.zumalacarregui@aei.mpg.de