SHASHWAT **SINGH**

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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 | **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
LISA | MBH | SMBH

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

2021 – 2022 | **Sciences et Ingénierie, Sorbonne Université, M1 – Paris Physics Masters**
Program targetted towards fundamental courses and compulsary 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 | Fluids - mechanics &dynamics | Machines and rigid body motion

Research Experience

January 2023 – July 2023 | **Max-Planck-Institut für Gravitationsphysik, (Albert-Einstein-Institut), Supervisor : Dr. M. Zumalacárregui**
Probing Fuzzy dark matter using lensed gravitational waves detected by LISA.
Internship | gravitational-wave-lensing | fuzzy dark-matter

September 2022 – January 2023 | **l'Observatoire de Paris, Lab Insertion Unit, Supervisor : Dr. A. Hees (SYRTE) & Dr. N. Korsakova (APC)**
Aimed towards waveform compression of Extreme-Mass-Ratios-Inspirals (EMRIs) using Singular Valued Decomposition.
gravitational-waves | EMRI | waveform-modeling

April 2022 – July 2022 | **Max-Planck-Institut für Gravitationsphysik, (Albert-Einstein-Institut), Supervisor : Dr. A. H. Nitz**
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 | **Max-Planck-Institut für Gravitationsphysik, (Albert-Einstein-Institut), Supervisor : Dr. A. H. Nitz**
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 | **Dept. of Mechanical Engineering, Indian Institute of Technology Indore, Supervisor : Dr. S. K. Sahu**
- 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**" Proce 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

- Python for HPC Workshop by Max Planck Computing and Data Facility (MPCDF) - July 2023.
- Cosmology from Home - July 2023. Talk : *Probing Fuzzy dark matter with lensed Gravitational waves*
- 2^{nd} 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

AEI - lensing library 2023

Code not yet public
Contributed to the GW lensing library

Internship | gravitational-waves | lensed-gravitational-waves | PyCBC

Inclusion of higher-modes for Parameter estimation of Gravitational waves in PyCBC 2022

github.com/SSingh087/pycbc/tree/conmodel
A recovery model that allows extracting mode-by-mode information while performing parameter estimation.

Internship | gravitational-waves | higher-modes | premerger-detection | multi-messenger astronomy | PyCBC

LensGW for generating gravitationally lensed signals 2021

github.com/SSingh087/lensGW
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.

gravitational-waves | lensed-gravitational-waves | PyCBC

lensGW-PyCBC-plugin 2021

github.com/SSingh087/lensGW-PyCBC-plugin
Plugin for allowing waveforms to be recognized by PyCBC and perform parameter estimation

gravitational-waves | lensed-gravitational-waves | PyCBC

LISA - Module 2020

github.com/gwastro/pycbc/commits/master/pycbc/detector.py?author=SSingh087
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.

Internship | gravitational-waves | LISA | PyCBC

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 "6thINTERNATIONAL 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

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

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
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