SHASHWAT **SINGH**

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I am currently a 2^{nd} year Master's student and passionate about understanding astrophysical objects, especially compact binary systems, and their gravitational effect. I wish to specialize in understanding the behavior of matter under extreme gravity using gravitational waves as a fundamental probe.

Academic Qualifications

2022 – Ongoing | **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. Zumalacarregui & Dr. Brando**
Observing dark matter substructures imprints on Gravitational-Waves : Detectability and Inference (Master Thesis)
Internship | gravitational-wave-lensing | 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.** (submitted to *MNRAS*, final revision received) https://arxiv.org/abs/2112.12604
- "**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]

Preprints and Reports

- "**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
- "**Prospects of detection of gravitational waves using higher harmonics.**" **Singh S.** (2022). Internship report

Poster Presentation

- *Lindblad Evolution and Quantum to Classical Transition of Rabi Oscillation in Single Quantum Dot*. 3rd International Conference on Condensed Matter and Applied Physics (ICC) - Bikaner, India. (2019, October)
- *Clustering and Predicting Astrophysical events using GW.* - 9th International Conference on Gravitation and Cosmology (ICGC) - IISER Mohali, India. (2019, December)

Ongoing projects

2022
ongoing

Max-Planck-Institut für Gravitationsphysik, (Albert-Einstein-Institut), Supervisor : Dr. A. H. Nitz
Prospects of premerger detection & skylocalization of gravitational waves using higher harmonics

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

2022
ongoing

Bose.X, Triac, mentoring
Breaking degeneracies within the gravitational wave parameter space using deep learning

gravitational-waves | parameter-estimation | deep-learning | PyCBC

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 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

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

ongoing **Breaking degeneracies within the gravitational wave parameter space using deep learning** : Attempt to use the Convolutional-neural-network to break the degeneracies between the parameter space of the GWs primarily targetted towards V-shaped luminosity distance (d_L) and inclination (ι) degeneracy.

2021-2022 **Estimating dynamical parameters of two interacting galaxies using Deep Learning** : Attempt to use the regression method to predict the parameters of the galaxies. Submitted to *MNRAS*, final revision received - https://arxiv.org/abs/2112.12604

2020-2021 **Differentiating between lensed and unlensed signals using deep-learning** : Using Convolutional-neural-network 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

Dr. Nicolas Rodriguez

Assistant Professor, Sorbonne Université - Laboratoire des Biomolecules, Paris

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