Sangeet Paul

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GitHub, LinkedIn

PhD candidate working on computational astrophysics. Studying black holes and neutron stars using gravitational waves.

Education

2019 – **PhD, Physics**, *University of Oregon*, Eugene, OR, USA.

2013 – 18 **BSc-MSc, Physics**, *National Institute of Science Education and Research, HBNI*, Bhubaneswar, India.

Skills

physics	Gravitational-wave astronomy, General relativity, Quantum mechanics, Quantum field theory.
quantitative	Bayesian inference, Markov chain Monte Carlo (MCMC), Cluster analysis, Machine learning.
python astro	AstroPy, bilby, PyCBC, GWpy.
python ML	TensorFlow, keras, scikit-learn.
python GPU	JAX, CuPy (CUDA).
python misc	emcee, Pandas, SciPy, Numpy, matplotlib.
languages	Python, C, C++, Java, R.
software	Mathematica, MATLAB.

Research Experience

Jul 2021 – **Research Assistant**, *Institute of Fundamental Sciences, University of Oregon*.

Worked on parameter estimation of gravitational-wave events, and astrophysical population analysis of gravitational-wave catalogs, as part of the LIGO Scientific Collaboration.

- ⋆ **Hierarchical mergers of binary black holes in dynamical astrophysical environments**
  Built population (Bayesian) inference software to find evidence of hierarchical mergers of binary black holes in LIGO-Virgo-KAGRA's gravitational wave catalogs using the coagulation model for black hole mergers in dynamical astrophysical environments, such as globular clusters and active galactic nuclei' accretion disks.
- ⋆ **Simultaneous inference of astrophysical and noise parameters in gravitational wave data**
  Built Bayesian inference software for data from gravitational-wave interferometers to estimate astrophysical signal models and detector noise models simultaneously, without assuming any intrinsic lack of correlation.
- ⋆ **Clustering algorithms for significantly uncertain data**
  Built algorithms to cluster data with high uncertainty, such as data from gravitational-wave interferometers.

2018 – 19 **Research Fellow**, *National Institute of Science Education and Research*.

- ⋆ **Blackfolds in higher-dimensional gravity**
  Analyzed the stability of blackfolds – higher-dimensional equivalents of black holes. Verified through simulations that a perturbed black string asymptotically settles down to a black hole due to the Gregory–Laflamme instability.

2013 – 18 **Research Scholar**, *National Institute of Science Education and Research*.

- ⋆ **Membrane – gravity duality in a large number of dimensions** (Thesis)
  Demonstrated that black hole event horizons are analogous to hydrodynamic membranes.
- ⋆ **Analytical predictions of the mass function of halos**
  Analyzed the effects of varying dark matter halos' mass functions on astronomical and cosmological observations.
- ⋆ **Magneto-optic Kerr effect: experiment design**
  Constructed theory for an experiment to use the magneto-optic Kerr effect to analyse magnetized surfaces.

May–Jul 2017 **Research Scholar**, *Institute of Physics, Homi Bhabha National Institute, Department of Atomic Energy*.

- ⋆ **Superstring theory: Tree-approximation scattering amplitudes**
  Studied the foundations of superstring theory, starting with bosonic strings, moving on to supersymmetry and gauge interactions, finishing with the evaluation of tree-level scattering amplitudes.

May–Jul 2016 **Research Scholar**, *Centre for Excellence in Basic Sciences, University of Mumbai – Department of Atomic Energy*.

- ⋆ **Quantum field theory: Decays of the Higgs boson**
  Studied relativistic quantum mechanics, quantum electrodynamics, Feynman diagrams, renormalization, and gauge field theories. Analyzed the radiation of gluon jets, the Coleman-Weinberg potential, and the decays of the Higgs boson.

Teaching Experience

Sep 2019 – **Teaching Assistant**, *Department of Physics, University of Oregon*.

grad-level Scientific computation (machine learning), Design of experiments (Bayesian statistics).

undergrad Quantum mechanics, Astronomy, Fourier analysis, Algebra-based physics, Calculus-based physics.

Achievements

2020 **Weiser Award for Excellence in Teaching**, *Department of Physics, University of Oregon*

2018 – 2019 **Junior Research Fellow**, *Council of Scientific and Industrial Research, Ministry of S&T, Govt. of India*

2013 – 2018 **INSPIRE Scholar**, *Department of Science and Technology, Ministry of S&T, Govt. of India*

2008 – 2018 **NTSE Scholar**, *Department of Science and Technology, Ministry of S&T, Govt. of India*

2013 *3rd prize* in **NASA Ames Space Settlement Contest** conducted by NASA Ames Research Center, San Jose State University, and National Space Society, USA

Conferences

Jan 2024 **American Astronomical Society Meeting**, *New Orleans, LA*.

Jun 2023 **Gravitational-Wave Astronomy North-West**, *Hanford, WA*.

Jan 2023 **American Astronomical Society Meeting**, *Seattle, WA*.

Jun 2022 **Gravitational-Wave Astronomy North-West**, *Hanford, WA*.

May 2022 **Astronomical Software Development**, *New York, NY*.

Apr 2022 **Intermediate-Mass Black Holes**, *San Juan, PR*.

Service Experience

2023 – 24 Graduate Support Group, Dept of Physics, U Oregon

2022 – 23 PhD Admissions Committee, Dept of Physics, U Oregon

2021 – 22 Vice-President, Graduate Student Council, Dept of Physics, U Oregon

Dec 2016 Organizer, International Olympiad of Astronomy and Astrophysics

2014 – 18 Organizer, NISER's Open Science Day

2013 – 15 Treasurer, Student Council, NISER

Languages

English, Hindi, Odia, Bengali, Gahaḷā.

I maintain a language documentation project for my native language Gahaḷā here.

Publications

1 LSC, Virgo, and KAGRA. Observation of Gravitational Waves from the Coalescence of a 2.5-4.5 $M_\odot$ Compact Object and a Neutron Star. *Accepted by ApJL*, Apr 2024.

2 LSC, Virgo, and KAGRA. Ultralight vector dark matter search using data from the KAGRA O3GK run. *Submitted to PRD*, Mar 2024.

3 Fermi-GBM, Swift-BAT, LSC, Virgo, and KAGRA. A Joint Fermi-GBM and Swift-BAT Analysis of Gravitational-Wave Events from the GWTC-3 Catalog. *Astrophys. J. 964, 149*, Aug 2023.

4 LSC, Virgo, and KAGRA. Search for Eccentric Black Hole Coalescences During the Third Observing Run of LIGO and Virgo. *Submitted to ApJ*, Aug 2023.

5 LSC, Virgo, and KAGRA. Search for gravitational-lensing signatures in the full third observing run of the LIGO-Virgo network. *Accepted by ApJ*, Apr 2023.

6 LSC, Virgo, and KAGRA. Open data from the third observing run of LIGO, Virgo, KAGRA and GEO. *Astrophys. J. Supp. 267, 29*, Feb 2023.

7 LSC, Virgo, KAGRA, S. Shandera, and D. Jeong. Search for subsolar-mass black hole binaries in the second part of Advanced LIGO and Virgo's third observing run. *Monthly Notices of the Royal Astronomical Society 524, 5984*, Dec 2022.

8 LSC, Virgo, and KAGRA. Search for gravitational-wave transients associated with magnetar bursts in Advanced LIGO and Advanced Virgo data from the third observing run. *Astrophys. J. 966, 137*, Oct 2022.

9 LSC, Virgo, and KAGRA. Model-based cross-correlation search for gravitational waves from the low-mass X-ray binary Scorpius X-1 in LIGO O3 data. *Astrophys. J. Lett. 941, L30*, Sep 2022.

10 LSC, Virgo, and KAGRA. Search for continuous gravitational wave emission from the Milky Way center in O3 LIGO-Virgo data. *Phys. Rev. D 106, 042003*, Apr 2022.

11 LSC, Virgo, and KAGRA. Search for gravitational waves associated with Fast Radio Bursts Detected by CHIME/FRB During the LIGO-Virgo Observing Run O3a. *Astrophys. J. 955, 155*, Mar 2022.

12 LSC, Virgo, and KAGRA. First joint observation by the underground gravitational-wave detector KAGRA with GEO 600. *Progress of Theor. and Exp. Phys. 2022, 063F01*, Mar 2022.

13 LSC, Virgo, and KAGRA. Search for gravitational waves from Scorpius X-1 with a hidden Markov model in O3 LIGO data. *Phys. Rev. D 106, 062002*, Jan 2022.

14 LSC, Virgo, and KAGRA. All-sky search for continuous gravitational waves from isolated neutron stars using Advanced LIGO and Advanced Virgo O3 data. *Phys. Rev. D 106, 102008*, Jan 2022.

15 LSC, Virgo, KAGRA, 28 radio astronomers, and NICER science team members. Narrowband searches for continuous and long-duration transient gravitational waves from known pulsars in the LIGO-Virgo third observing run. *Astrophys. J. 932, 133*, Dec 2021.

16 LSC, Virgo, and KAGRA. Tests of General Relativity with GWTC-3. *Accepted by PRD*, Dec 2021.

17 LSC and Virgo. Search of the Early O3 LIGO Data for Continuous Gravitational Waves from the Cassiopeia A and Vela Jr. Supernova Remnants. *Phys. Rev. D 105, 082005*, Nov 2021.

18 LSC, Virgo, and KAGRA. All-sky search for gravitational wave emission from scalar boson clouds around spinning black holes in LIGO O3 data. *Phys. Rev. D 105, 102001*, Nov 2021.

19 LSC, Virgo, and KAGRA. Searches for Gravitational Waves from Known Pulsars at Two Harmonics in the Second and Third LIGO-Virgo Observing Runs. *Astrophys. J. 935, 1*, Nov 2021.

20 LSC, Virgo, and KAGRA. Constraints on the cosmic expansion history from the third LIGO-Virgo-KAGRA Gravitational-Wave Transient Catalog. *Astrophys. J. 949, 76*, Nov 2021.

21 LSC, Virgo, and KAGRA. GWTC-3: Compact Binary Coalescences Observed by LIGO and Virgo During the Second Part of the Third Observing Run. *Phys. Rev. X 13, 041039*, Nov 2021.

22 LSC, Virgo, and KAGRA. Search for Gravitational Waves Associated with Gamma-Ray Bursts detected by Fermi and Swift during the O3b LIGO-Virgo Run. *Astrophys. J. 928, 186*, Nov 2021.

23 LSC, Virgo, and KAGRA. Population of merging compact binaries inferred using gravitational waves through GWTC-3. *Phys. Rev. X 13, 011048*, Nov 2021.

24 LSC, Virgo, and KAGRA. All-sky, all-frequency directional search for persistent gravitational waves from Advanced LIGO's and Advanced Virgo's first three observing runs. *Phys. Rev. D 105, 122002*, Oct 2021.

25 LSC, Virgo, KAGRA, D. Jeong, and S. Shandera. Search for subsolar-mass binaries in the first half of Advanced LIGO and Virgo's third observing run. *Phys. Rev. Lett. 129, 061104*, Sep 2021.

26 LSC, Virgo, KAGRA, A. C. Albayati, D. Altamirano, P. Bult, D. Chakrabarty, M. Ng, P. S. Ray, A. Sanna, and T. E. Strohmayer. Search for continuous gravitational waves from 20 accreting millisecond X-ray pulsars in O3 LIGO data. *Phys. Rev. D 105, 022002*, Sep 2021.

27 LSC and Virgo. GWTC-2.1: Deep Extended Catalog of Compact Binary Coalescences Observed by LIGO and Virgo During the First Half of the Third Observing Run. *Phys. Rev. D 109, 022001*, Jul 2021.

28 LSC, Virgo, and KAGRA. All-sky search for long-duration gravitational-wave transients in the third Advanced LIGO observing run. *Phys. Rev. D 104, 102001*, Jul 2021.

29 LSC, Virgo, and KAGRA. All-sky search for short gravitational-wave bursts in the third Advanced LIGO and Advanced Virgo run. *Phys. Rev. D 104, 122004*, Jul 2021.

30 LSC and Virgo. All-sky search for continuous gravitational waves from isolated neutron stars in the Early O3 LIGO Data. *Phys. Rev. D 104, 082004*, Jul 2021.

31 LSC, Virgo, and KAGRA. Observation of gravitational waves from two neutron star-black hole coalescences. *Astrophys. J. Lett. 915, L5*, Jun 2021.

32 LSC, Virgo, and KAGRA. Search for intermediate mass black hole binaries in the third observing run of Advanced LIGO and Advanced Virgo. *Astronomy & Astrophysics 659, A84*, May 2021.

33 LSC, Virgo, and KAGRA. Constraints on dark photon dark matter using data from LIGO's and Virgo's third observing run. *Phys. Rev. D 105, 063030*, May 2021.