

Nihar Gupte

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EDUCATION

- **Ph.D. in Physics** 2021–
Max Planck Institute for Gravitational Physics, Potsdam, Germany; University of Maryland, College Park, MD, USA
Advisors: Prof. Alessandra Buonanno, Prof. Jonathan Gair
- **B.S. in Physics and Mathematics** 2017–2021
University of Florida, Gainesville, FL, USA
Research advisors: Prof. Imre Bartos, Prof. Stephen Hagen

RESEARCH EXPERIENCE

- **Graduate Researcher** Fall 2021–
Max Planck Institute for Gravitational Physics, Potsdam, Germany; University of Maryland, College Park, MD, USA
 - **Core developer, DINGO**: A machine-learning code that performs simulation-based inference to obtain posterior distributions for gravitational-wave events. The current architecture is a transformer encoder coupled with a normalizing flow, trained across multiple GPUs (optionally with flow-matching). The code has been adopted by independent research groups worldwide and by the LIGO-Virgo-KAGRA collaboration to produce gravitational-wave catalogs. Currently working on a project using mixture-of-experts and distillation to improve performance at high eccentricity and high SNR.
 - **Eccentricity in the population of binary black holes**: Performed eccentric binary black hole parameter inference across 150 gravitational wave events in the O1–O4a data. Found that GW200129 shows a strong preference for eccentricity, revising its earlier interpretation as a quasi-circular, spin-precessing binary with a large recoil. Assessed the effect of non-Gaussian noise and waveform systematics when doing eccentric analyses. The trained networks and results were released publicly and are used regularly by other researchers with 700+ downloads.
 - **Population inference for eccentric binaries**: Produced the first hierarchical population analysis of eccentric binary black holes that includes selection effects. Separately, developed a statistical framework for the probability that a given event is eccentric. This is a general construction that applies equally to tests of general relativity and lensing. Implemented a black hole capture model to constrain the fraction of binaries formed by gravitational-wave capture in nuclear star clusters.
- **Undergraduate Researcher** Fall 2017 – Spring 2021
University of Florida, Gainesville, FL, USA
 - **Multi-messenger astrophysics**: Developed genetic-algorithm tiling strategies for covering LIGO localization maps with telescope fields of view. Ran Monte Carlo studies to estimate joint GRB–gravitational-wave detection rates.
 - **Experimental biophysics**: Imaged amyloid formation in *S. mutans* biofilms by optical microscopy under media flow.

COLLABORATION CONTRIBUTIONS

- **DINGO review lead — O4b, O4c and IR1**: Led the LVK reviews that qualified the gravitational-wave parameter estimation code DINGO for collaboration use. Was also heavily involved in the O4a review. Review involves strict criteria and is a precursor to the collaboration accepting scientific results; DINGO is now used routinely in LVK catalogs.
- **GWTC-5 catalog pipeline lead**: Produced the DINGO portion of the GWTC-5 catalog analyzing 60 gravitational-wave events.
- **O4a and O4b online analyst**: Ran independent real-time parameter estimation on 200+ gravitational-wave events to cross-check the online LVK results with a more accurate but expensive waveform model. Released train models to public.
- **Leading eccentric binary black hole analyses**: Leading member of the LVK eccentric parameter-estimation effort: training collaboration members on parameter estimation, shaping the structure of the eccentricity paper, and developing methods to reconcile differing eccentricity definitions.

PUBLICATIONS

- [1] **Mixture-of-experts and distillation address prior training inefficiency in simulation-based inference**
Campe+ 2026 (alphabetical), in preparation.
- [2] **Eccentricity constraints disfavor single-single capture in nuclear star clusters as the origin of all LIGO-Virgo-KAGRA binary black holes**
Gupte+ 2026, *Astrophys. J.* (accepted), arXiv:2603.29019.
- [3] **Accurate and efficient simulation-based inference for massive black-hole binaries with LISA**
Spadaro+ 2026, *Phys. Rev. D* 114, p. 023038, arXiv:2603.20431.
- [4] **Flexible Gravitational-Wave Parameter Estimation with Transformers**
Kofler+ 2025, *Phys. Rev. Lett.* 136, p. 251401, arXiv:2512.02968.
- [5] **Accelerated inference of microlensed gravitational waves with machine learning**
Caldarola+ 2025, *Phys. Rev. D* 113, p. 104073, arXiv:2511.08486.
- [6] **GW200208_222617 as an eccentric black-hole binary merger: Properties and astrophysical implications**
Romero-Shaw+ 2025, *Phys. Rev. D* 112, p. 063052, arXiv:2506.17105.

- [7] **Fast and accurate parameter estimation of high-redshift sources with the Einstein Telescope**
Santoliquido+ 2025, *Phys. Rev. D* 112, p. 103015, arXiv:2504.21087.
- [8] **Real-time inference for binary neutron star mergers using machine learning**
Dax+ 2025, *Nature* 639, pp. 49–53, arXiv:2407.09602.
- [9] **Evidence for eccentricity in the population of binary black holes observed by LIGO-Virgo-KAGRA**
Gupte+ 2025, *Phys. Rev. D* 112, p. 104045, arXiv:2404.14286.
- [10] **EinsteinPy: A Community Python Package for General Relativity**
Bapat+ 2020, arXiv:2005.11288.
- [11] **Optimal Gravitational-wave Follow-up Tiling Strategies Using a Genetic Algorithm**
Gupte+ 2020, *Phys. Rev. D* 101, p. 123008, arXiv:2003.04839.
- [12] **Gravitational-wave follow-up with CTA after the detection of GRBs in the TeV energy domain**
Bartos+ 2019, *Mon. Not. Roy. Astron. Soc.* 490, pp. 3476–3482, arXiv:1908.09832.
- [13] **How would a nearby kilonova look on camera?**
Gupte+ 2020, *Am. J. Phys.* 88, p. 568, arXiv:1905.01594.
- [14] **Observational consequences of structured jets from neutron star mergers in the local Universe**
Gupte+ 2018, arXiv:1808.06238.

SELECTED COLLABORATION PUBLICATIONS

- [15] **GWTC-6e: Population Properties of Eccentric Merging Compact Binaries**
LIGO-Virgo-KAGRA Collaboration 2026, in preparation.
- [16] **GWTC-5.0: Observations from the Second Part of the Fourth LIGO-Virgo-KAGRA Observing Run and Updates to the Gravitational-Wave Transient Catalog**
LIGO-Virgo-KAGRA Collaboration 2026, arXiv:2605.27225.

PRESENTATIONS

INVITED TALKS

“**What does eccentricity tell us about formation channels**” Niels Bohr Institute, Copenhagen, Denmark, *Oct. 2026*

“**Detecting eccentricity: what are our current prospects?**” Corfu Workshop, Greece (plenary), *Sep. 2026*

“**ML methods in the era of GW astronomy**” Sun Yat-Sen University, online, *Mar. 2025*

“**GW analysis in the era of machine learning**” Royal Astronomical Society, UK (panelist), *Jan. 2025*

“**Evidence for eccentricity in BBHs**” Korean Gravitational Waves Group, online, *Jul. 2024*

“**Evidence for eccentricity in BBHs**” University of Nottingham, UK, *Apr. 2024*

TALKS

“**Population properties of eccentric BBHs**” IUCAA, Pune, India, *Nov. 2025*

“**Population properties of eccentric BBHs**” GR-Amaldi, Glasgow, UK, *Jul. 2025*

“**Evidence for eccentricity in BBHs**” AILands Workshop, Isle of Arran, UK, *Apr. 2024*

“**Evidence for eccentricity in BBHs**” LVK Conference, LSU, Baton Rouge, USA, *Mar. 2024*

POSTERS

“**Accurate parameter inference of BNSs in one second**” LVK Meeting, Barcelona, Spain, *Sep. 2024*

“**Evidence for eccentricity in the BBH population**” LVK Meeting, Baton Rouge, USA, *Mar. 2024*

“**Lightning data for real-time wildfire detection**” AGU Fall Meeting, *Dec. 2020*

“**How would a nearby kilonova look on the sky**” AAPT Conference, Orlando, USA, *Jan. 2020*

“**NS mergers, GWs, and the origin of heavy elements**” UF Physics Graduate Research Symposium, *Dec. 2019*

TEACHING AND MENTORING

- **Mentoring:** Trained Marienza Caldarola, Srashti Goyal and Alice Spadaro (PhD students and postdocs) in machine-learning methods for gravitational-wave data analysis, leading to publications on gravitational wave lensing and simulation-based inference for LISA.
- **IMPRS lecture week:** tutorial on machine learning for gravitational-wave data analysis.
- **Teaching assistant,** General Physics, University of Maryland, Fall 2021 – Fall 2022.

SERVICE AND OUTREACH

- **Chair,** LIGO meetings at the Max Planck Institute for Gravitational Physics, Fall 2025–.
- **Organizer,** ACR division social committee (AEI).
- Long Night of Astronomy public outreach event.

HONORS

- University of Maryland Graduate School Fellowship
- Goldwater Scholarship Nomination (University of Florida)
- Florida Bright Futures Scholarship (4-year merit-based full tuition)
- Wentworth Travel Scholarship; UF Honors Program; UF Dean’s List

ENGINEERING EXPERIENCE

- **Co-founder and Machine-Learning Lead**

Spring 2020 – Spring 2021

Fire Neural Network, Gainesville, FL, USA

- **Detecting fires from satellite data using neural networks and cross referencing with lightning databases:** One of three founders of a startup to predict where fires will occur in California. We worked with time-series infrared data to extract potential hotspots. I wrote the machine-learning algorithm for the detection and the first iteration of the real-time inference website with Django. www.fireneuralnetwork.com

- **Space Systems Design Club President/Treasurer**

Fall 2017 – Spring 2021

Space Systems Design Club, University of Florida

- **Leadership an outreach:** Ran meetings, speakers, funding applications and outreach; taught a Python-for-research workshop.
- **Space systems engineering projects:** Competed three years in the NASA Micro-g Challenge (hull-breach plugging tool 2017; software lead for a UAV-deployable autonomous boat 2019; team lead for an Artemis bag dispenser 2020).