Koustav Chandra

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Research Interests

I am broadly interested in developing gravitational-wave detection methods and using these detections to test general relativity in the strong-field dynamical regime. To this end, I **develop searches for quasi-spherical binary black holes** and apply **machine learning techniques to improve gravitational-wave data analysis**. I conduct precision tests of general relativity through **black hole spectroscopy** and **parametrized waveform analyses**, while also evaluating the **data-analysis readiness of next-generation detectors**, such as Cosmic Explorer and the Einstein Telescope.

Education

Indian Institute of Technology, Bombay — Mumbai, IN
Ph.D. in Physics (Supervisor: Prof Archana Pai) — 2018–2023

- Thesis: "Hearing gravitational waves from intermediate-mass black hole binaries: Detection and Characterisation."

National Institute of Technology, Rourkela — Rourkela, IN
Integrated M.Sc. in Physics and Astronomy — 2013–2018

- Thesis: "An Algebraic Study of SO(10) Grand Unified Theory"

Experience

Max-Planck-Institut für Gravitationsphysik, Potsdam — Potsdam, DE
Postdoctoral Scholar — 2025–Current

Institute for Gravitation & the Cosmos, The Pennsylvania State University — State College, US
Postdoctoral Scholar — 2023–2025

Mentoring

- Mr Giovanni Benetti (Università di Padova) — 2025–Current
  Master's student. Supervising project on the impact of waveform systematics in golden dark siren cosmology, with emphasis on mitigating systematic biases in Hubble parameter estimation. Manuscript in preparation.
- Ms Akshita Mittal (Gran Sasso Science Institute, Italy) — 2024–Current
  PhD student (initially mentored as an undergraduate). Leading project on parameter estimation biases in eccentric compact binary mergers, focusing on spurious support for extremal spins in GW231123. Manuscript in preparation.
- Ms Shiksha Pandey (Penn State University) — 2024
  Undergraduate research assistant. Co-supervised project assessing the role of LIGO-India in multi-messenger astronomy for next-generation detectors. Resulted in publication: Astrophys. J. Lett. 985 (2025) L17.
- Mr Sayantan Ghosh (IIT Bombay) — 2023–2024
  PhD student. Developed coherence tests to distinguish noise transients from intermediate-mass black hole binary signals by assessing posterior consistency across detectors. Resulted in publication: Phys. Rev. D 109, 064015 (2024)
- Ms Kritti Sharma (IIT Bombay) — 2022–2023
  Undergraduate student. Developed a transfer learning framework to detect mass-asymmetric black hole binaries in Advanced LIGO data. Resulted in publication: Phys. Rev. D 108 124061 (2023)
- Mr Sagar Gupta (IIT Bombay) — 2022–2023
  Undergraduate student. Implemented a chirp-mass–based classifier for glitch identification in gravitational-wave data, improving transient search data-quality vetoes.

Colloquia, Invited Talks and Seminars

- **GW231123: The Shape-Shifting Gollum** August 2025
  School of Astrophysics, Presidency University, Kolkata, India
  School of Physical Sciences, Jawaharlal Nehru University, Delhi, India
- **Too Many, Too Long, Too Loud: CBC Data Analysis Challenges in the XG Era** May 2025
  PAX-X and CE Symposium, University of Illinois Urbana-Champaign, Urbana, USA
- **Exploring the XG Era: Foreground Noise Impact & LIGO India's Role** November 2024
  Detection and Analysis of Gravitational Waves in the Era of Multi-Messenger Astronomy, Banff, Alberta, Canada
- **Preparing for a Gravitationally-Bright Tomorrow** August 2024
  Department of Physics, Indian Institute of Technology Bombay, Mumbai, India
- **Intermediate-Mass Binary Black Holes and How to Find Them** February 2023
  Inference-Data-Experiments-Analysis (IDEA) Talks, TIFR, Mumbai, India
- **Prospects of Observing Mass-Asymmetric IMBH Binaries with A+ Sensitivity** May 2023
  Science with LIGO-India Meeting, IUCAA, Pune, India
- **Hunting for IMBHs with the International Gravitational-Wave Observatory Network** February 2022
  Chennai Symposium on Gravitation and Cosmology (Online), Chennai, India

Selected Contributed Talks/Posters

- **Inspiral-Merger Informed Ringdown Analysis of Black-Hole Merger Remnants** April 2025
  April APS Meeting 2025, Anaheim, USA
- **Introduction to gwforge** June 2024
  XG Mock Data Challenge Workshop, State College, USA
- **Preparing for Tomorrow: Simulating the Scientific Challenges of Next-Generation Ground-Based Gravitational Wave Interferometers** April 2024
  April APS Meeting, Sacramento, USA
- **First Gravitational-Wave Search for Intermediate-Mass Black Hole Binaries with Higher-Order Harmonics** December 2022
  32^{nd} Meeting of Indian Association for General Relativity and Gravitation (IAGRG), Kolkata, India
- **Searching for Gravitational-Wave Higher-Order Modes from Asymmetric Intermediate-Mass Black Hole Binaries** July 2022
  23^{rd} International Conference on General Relativity and Gravitation (Online), Beijing, China
- **Are the Sources of GW190521 and ZTF19abanrhr the Same?** March 2022
  40^{th} Meeting of Astronomical Society of India
- **An Optimized PyCBC Search for Gravitational Waves from Intermediate-Mass Black Hole Mergers** July 2021
  14^{th} Edoardo Amaldi Conference (Online), Melbourne, Australia
  16^{th} Marcel Grossmann Meeting (Online), Rome, Italy
- **NuRIA: Sensitivity Study of Generically Spinning Intermediate-Mass Black Hole Binaries in Advanced LIGO Data** December 2020
  31^{st} Meeting of the Indian Association for General Relativity and Gravitation (Online), India

Outreach talks

- **Gravitational Wave Searches for Compact Binary Mergers** May 2023
  Gravitational Wave Open Data Workshop (Online)
- **How to Search for Gravitational Waves** January 2021
  Krittika Winter Workshops, Techfest 2021 (Online), Indian Institute of Technology Bombay, Mumbai
- **Gravitational Waves 101** May 2019
  Vigyan Samagam, Nehru Science Centre, Mumbai, India

Academic Awards

- **Naik and Rastogi Excellence in Ph. D. Thesis**, Indian Institute of Technology, Bombay 2024
- **Department Prize for Outstanding Student Performance**, National Institute of Technology, Rourkela 2016

References

- **Prof. Alessandra Buonanno**
  Max Planck Institute for Gravitational Physics
  Am Mühlenberg 1, Potsdam, Germany-14476
  alessandra.buonanno@aei.mpg.de
- **Prof. Archana Pai**
  Department of Physics, IIT Bombay
  Mumbai, Maharashtra, India-400076
  archanap@iitb.ac.in
- **Prof. Ian Harry**
  Institute of Cosmology & Gravitation
  University of Portsmouth, Portsmouth, PO1 3FX, UK
  ian.harry@port.ac.uk
- **Prof. B. Sathyaprakash**
  Institute of Cosmos and Gravity
  Penn State University, State College, PA, USA-16802
  bss25@psu.edu
- **Prof. Juan Calderón Bustillo**
  Galician Institute for High Energy Physics
  University of Santiago de Compostela, Spain-15782
  juancalderonbustillo@gmail.com

Short Author Publications

[1] J. Calderón Bustillo, A. del Rio, N. Sanchis-Gual, K. Chandra, and S. H. W. Leong, "Testing Mirror Symmetry in the Universe with LIGO-Virgo Black-Hole Mergers", *Phys. Rev. Lett.*, vol. 134, no. 3, p. 031 402, 2025. arXiv: 2402.09861 [gr-qc].

[2] K. Chandra, "gwforge: a user-friendly package to generate gravitational-wave mock data", *Class. Quant. Grav.*, vol. 42, no. 2, p. 025 003, 2025. arXiv: 2407.21109 [gr-qc].

[3] K. Chandra and J. Calderón Bustillo, "Black-hole ringdown analysis with inspiral-merger informed templates and limitations of classical spectroscopy", Sep. 2025. arXiv: 2509.17315 [gr-qc].

[4] J. Fernandes, A. Pai, and K. Chandra, "Improving the detection significance of gravitational wave transient searches with CNN models", May 2025. arXiv: 2505.08332 [gr-qc].

[5] I. Gupta, K. Chandra, and B. S. Sathyaprakash, "Foreground signals minimally affect inference of high-mass binary black holes in next-generation gravitational-wave detectors", *Phys. Rev. D*, vol. 111, no. 10, p. 104 013, 2025. arXiv: 2410.22302 [gr-qc].

[6] S. Khadkikar, I. Gupta, R. Kashyap, K. Chandra, R. Gamba, and B. Sathyaprakash, "Cosmic Calipers: Precise and Accurate Neutron Star Radius Measurements with Next-Generation Gravitational Wave Detectors", Feb. 2025. arXiv: 2502.03463 [astro-ph.HE].

[7] S. Pandey, I. Gupta, K. Chandra, and B. S. Sathyaprakash, "The Critical Role of LIGO-India in the Era of Next-generation Observatories", *Astrophys. J. Lett.*, vol. 985, no. 1, p. L17, 2025. arXiv: 2411.10349 [gr-qc].

[8] A. Rashti, R. Gamba, K. Chandra, D. Radice, B. Daszuta, W. Cook, and S. Bernuzzi, "Binary black hole waveforms from high-resolution gr-athena++ simulations", *Phys. Rev. D*, vol. 111, no. 10, p. 104 078, 2025. arXiv: 2411.11989 [gr-qc].

[9] K. Chandra, I. Gupta, R. Gamba, R. Kashyap, D. Chattopadhyay, A. Gonzalez, S. Bernuzzi, and B. S. Sathyaprakash, "On the Origins, Remnant, and Multimessenger Prospects of the Compact Binary Merger GW230529", *Astrophys. J.*, vol. 977, no. 2, p. 167, 2024.

[10] K. Chandra, A. Pai, S. H. W. Leong, and J. Calderón Bustillo, "Impact of Bayesian priors on the inferred masses of quasicircular intermediate-mass black hole binaries", *Phys. Rev. D*, vol. 109, no. 10, p. 104 031, 2024. arXiv: 2309.01683 [gr-qc].

[11] S. Ghosh, K. Chandra, and A. Pai, "Unmasking noise transients masquerading as intermediate-mass black hole binaries", *Phys. Rev. D*, vol. 109, no. 6, p. 064 015, 2024. arXiv: 2312.01211 [gr-qc].

[12] S. Ronchini *et al.*, "Constraining Possible γ-Ray Burst Emission from GW230529 Using Swift-BAT and Fermi-GBM", *Astrophys. J. Lett.*, vol. 970, no. 1, p. L20, 2024. arXiv: 2405.10752 [astro-ph.HE].

[13] J. Calderon Bustillo, N. Sanchis-Gual, S. H. W. Leong, K. Chandra, A. Torres-Forne, J. A. Font, C. Herdeiro, E. Radu, I. C. F. Wong, and T. G. F. Li, "Searching for vector boson-star mergers within LIGO-Virgo intermediate-mass black-hole merger candidates", *Phys. Rev. D*, vol. 108, no. 12, p. 123 020, 2023. arXiv: 2206.02551 [gr-qc].

[14] J. Calderon Bustillo, I. C. F. Wong, N. Sanchis-Gual, S. H. W. Leong, A. Torres-Forne, K. Chandra, J. A. Font, C. Herdeiro, E. Radu, and T. G. F. Li, "Gravitational-Wave Parameter Inference with the Newman-Penrose Scalar", *Phys. Rev. X*, vol. 13, no. 4, p. 041 048, 2023. arXiv: 2205.15029 [gr-qc].

[15] K. Sharma, K. Chandra, and A. Pai, "Searching for massive black hole binaries with a transfer learning algorithm", *Phys. Rev. D*, vol. 108, no. 12, p. 124 061, 2023.

[16] J. Calderón Bustillo, S. H. W. Leong, and K. Chandra, "GW190412: measuring a black-hole recoil direction through higher-order gravitational-wave modes", Nov. 2022. arXiv: 2211.03465 [gr-qc].

[17] K. Chandra, J. Calderón Bustillo, A. Pai, and I. W. Harry, "First gravitational-wave search for intermediate-mass black hole mergers with higher-order harmonics", *Phys. Rev. D*, vol. 106, no. 12, p. 123 003, 2022. arXiv: 2207.01654 [gr-qc].

[18] K. Chandra, A. Pai, V. Villa-Ortega, T. Dent, C. McIsaac, I. W. Harry, G. S. C. Davies, and K. Soni, "Salient features of the optimised PyCBC IMBH search", in *16th Marcel Grossmann Meeting on Recent Developments in Theoretical and Experimental General Relativity, Astrophysics and Relativistic Field Theories*, Oct. 2021. arXiv: 2110.01879 [gr-qc].

[19] K. Chandra, V. Villa-Ortega, T. Dent, C. McIsaac, A. Pai, I. W. Harry, G. S. C. Davies, and K. Soni, "An optimized PyCBC search for gravitational waves from intermediate-mass black hole mergers", *Phys. Rev. D*, vol. 104, p. 042 004, 2021. arXiv: 2106.00193 [gr-qc].

[20] N. Bose, A. Pai, K. Chandra, and V. Gayathri, "Chirp mass based glitch identification in long-duration gravitational-wave detection", *Phys. Rev. D*, vol. 102, no. 8, p. 084 034, 2020. arXiv: 2007.03623 [gr-qc].

[21] K. Chandra, V. Gayathri, J. C. Bustillo, and A. Pai, "Numerical relativity injection analysis of signals from generically spinning intermediate mass black hole binaries in Advanced LIGO data", *Phys. Rev. D*, vol. 102, no. 4, p. 044 035, 2020. arXiv: 2002.10666 [astro-ph.CO].

Selected Collaboration-Authored Publications

[1] "Black Hole Spectroscopy and Tests of General Relativity with GW250114", Sep. 2025. arXiv: 2509.08099 [gr-qc].

[2] "GW230814: investigation of a loud gravitational-wave signal observed with a single detector", Sep. 2025. arXiv: 2509.07348 [gr-qc].

[3] "GW231123: a Binary Black Hole Merger with Total Mass 190-265 $M_\odot$", Jul. 2025. arXiv: 2507.08219 [astro-ph.HE].

[4] R. Abbott *et al.*, "Search for intermediate-mass black hole binaries in the third observing run of Advanced LIGO and Advanced Virgo", *Astron. Astrophys.*, vol. 659, A84, 2022. arXiv: 2105.15120 [astro-ph.HE].

[5] R. Abbott *et al.*, "GWTC-2: Compact Binary Coalescences Observed by LIGO and Virgo During the First Half of the Third Observing Run", *Phys. Rev. X*, vol. 11, p. 021 053, 2021. arXiv: 2010.14527 [gr-qc].

[6] R. Abbott *et al.*, "Population Properties of Compact Objects from the Second LIGO-Virgo Gravitational-Wave Transient Catalog", *Astrophys. J. Lett.*, vol. 913, no. 1, p. L7, 2021. arXiv: 2010.14533 [astro-ph.HE].

[7] R. Abbott *et al.*, "GW190521: A Binary Black Hole Merger with a Total Mass of $150M_\odot$", *Phys. Rev. Lett.*, vol. 125, no. 10, p. 101 102, 2020. arXiv: 2009.01075 [gr-qc].