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Research Interests

- **Gravitational Waves (GW)**
  - Science with current and upcoming GW detectors
    - Sources and searches for persistent Stochastic GW Background (SGWB)
    - Efficient detection of Compact Binary Coalescence (CBC)
    - Characterisation and reduction of noise in laser interferometric detectors
  - LIGO-India: Various activities regarding proposal, site survey, data management etc.
  - Planning and design of future ground-based and space-based detectors
  - Training a new generation of interested researchers for GW astronomy
- **Cosmic Microwave Background (CMB)** : Systematic effects and analysis strategies
- **High Performance Computing (HPC) & AI** : Setting up of facilities and optimal usage for science

Positions Held

Professor (Scientist G), IUCAA, Pune, India, Jul 2020 - to date
Associate Professor (Scientist F), IUCAA, Pune, India, Jul 2015 - Jun 2020
Assistant Professor (Scientist E), IUCAA, Pune, India, Oct 2011 - Jun 2015
Planck Project Specialist, University of California Santa Barbara, US, Apr 2011 - Sep 2011
Post-doctoral Fellow, Jet Propulsion Laboratory, Caltech, US, Feb 2008 - Jan 2011
Post-doctoral Fellow, Observatoire de la Côte d'Azur, France, Jan 2007 - Oct 2007

Education

Ph.D. (Physics), IUCAA, Dec 2006 (Degree awarded by University of Pune in 2007)
M.Sc. (Physics), University of Calcutta, Kolkata, Jul 2001 (First Class)
B.Sc. (Physics), University of Calcutta, Kolkata, Jul 1999 (First Class)

Awards and Fellowships

2019	Giuseppe and Vanna Cocconi Prize awarded to the WMAP & Planck Collaborations by EPS
2018	Gruber Cosmology Prize for mapping the CMB anisotropies as part of the Planck Team
2018	Faculty Research Awards 2018 by Careers 360
2017	Princess of Asturias Award for Technical and Scientific Research as part of the LIGO Scientific Collaboration (LSC)
2016	SwarnaJayanti Fellowship by the Department of Science & Technology (DST)
2016	A Special Breakthrough Prize in Fundamental Physics for the detection of gravitational waves as part of the LIGO Scientific Collaboration
2016	Gruber Cosmology Prize for the detection of gravitational waves as part of the LSC
2011	JPL-NASA Team STAR Award for outstanding contribution to Planck
2010-11	Three NASA Group Achievement Awards for contribution to Planck
2007	LIGO thesis prize - Honorary mention
2002-06	Junior and Senior Research Fellowship awarded by CSIR, India

Grants

2016 DST Swarnajayanti Fellowship Award (Jul-2017 to Jun-2022)
2013 SERB Fast Track Scheme for Young Scientists (Aug-2013 to Aug-2016)
2013 India-UK Scientific Seminar at Cardiff University from DST, India & the Royal Society, UK

Synergistic Activities

- Member of LIGO Scientific Collaboration (LSC) since 2004
- Member of Planck Team as a Planck Scientist since 2008

Teaching and Mentoring

- Teaching
  - Pune University M.Sc. course on General Relativity, four years (2013-15, 2018)
  - IUCAA graduate school Mathematical Methods - II (2015, 2018)
  - Lectures on GW and CMB in several schools and workshops
- Ph.D. Students
  - Deepali Agarwal (Aug 2019 - present)
  - Kanchan Soni (Aug 2019 - present)
  - Shreejit Jadav (Aug 2018 - present)
  - Ashish Mhaske (Aug 2017 - present, Scientific Officer at IUCAA)
  - Nikhil Mukund (Aug 2014 - Jul 2018, now PDF at AEI, Hannover)
  - Abhishek Parida, JMI (Aug 2013 - Jul 2019, Co-advised with Prof. Sanjay Jhingan)
  - Bhooshan Gadre (Aug 2013 - Jul 2018, now PDF at AEI, Potsdam)
  - Anirban Ain (Aug 2012 - Jul 2017, now PDF at INFN, Pisa)
- Post-doctoral Fellows (PDFs)
  - Sajal Mukherjee (Jul 2019 - present)
  - Santosh Roy (since Aug 2018 - present)
  - T R Saravanan (Aug 2019 - October 2020, now Scientific Officer at IUCAA)
  - Sheelu Abraham (Sep - Dec 2018, now Assistant Professor at Marthoma College)
  - Jishnu Suresh (Jul 2016 - Jan 2019, now PDF at ICRR, Tokyo)
- More than 10 long term project students, who are now placed well in reputed institutions or industry

High Performance Computing

- Lead the effort in setting up the present 530TF LIGO Data Analysis System (LDAS) at IUCAA
- Have been a "top user" of the NERSC super computing facility at LBL, Berkeley
- Set up and administration of a 16 node Pentium 4 Beowulf cluster at IUCAA (2004)

Administrative Responsibilities

- Lead the proposal and Project Coordinator, Teaching Learning Centre (TLC) for higher education in Astronomy funded by the MHRD under the PMMMNMTT scheme [December 2017 - September 2018]
- Chair, Interim sub-committee for LIGO-India EPO activities [September 2017 - present]
- In charge, Gravitational Wave Data Centre at IUCAA [August 2016 - present]
- Chair, IUCAA SciPOP Committee [November 2014 - April 2019]
- Chair, IUCAA Press Committee [November 2014 - December 2015]
- Chair, IUCAA Standing Local Organising Committee [October 2012 - December, 2015]
- Chaired several administrative and purchase committees at IUCAA
- Organised several introductory and advanced workshops on GW, including GWPAW-2013

Publications

- INSPIRE-HEP: Citations 88,000+, h-index 107
- Scopus (AuthorID 56643292200): Citations 53,000+, h-index 88

Limited Author Publications

[1] J. Suresh, A. Ain, and S. Mitra, "Unified Mapmaking for Anisotropic Stochastic Gravitational Wave Background,"*arXiv e-prints* (Nov., 2020) arXiv:2011.05969, arXiv:2011.05969 [gr-qc].

[2] S. Jadhav, N. Mukund, B. Gadre, S. Mitra, and S. Abraham, "Improving significance of binary black hole mergers in Advanced LIGO data using deep learning : Confirmation of GW151216,"*arXiv e-prints* (Oct., 2020) arXiv:2010.08584, arXiv:2010.08584 [gr-qc].

[3] S. Mukherjee, S. Mitra, and S. Chatterjee, "Detectability of hyperbolic encounters of compact stars with ground-based gravitational waves detectors,"*arXiv e-prints* (Oct., 2020) arXiv:2010.00916, arXiv:2010.00916 [gr-qc].

[4] S. Panda, S. Bhagwat, J. Suresh, and S. Mitra, "Stochastic gravitational wave background mapmaking using regularized deconvolution,"Phys. Rev. D **100** (Aug, 2019) 043541, arXiv:1905.08276 [gr-qc].

[5] B. Gadre, S. Mitra, and S. Dhurandhar, "Hierarchical search strategy for the efficient detection of gravitational waves from nonprecessing coalescing compact binaries with aligned-spins,"Phys. Rev. D **99** (Jun, 2019) 124035, arXiv:1807.06803 [astro-ph.IM].

[6] N. Mukund, B. O'Reilly, S. Somala, and S. Mitra, "Effect of induced seismicity on advanced gravitational wave interferometers,"*Classical and Quantum Gravity (Letter)* **36** (May, 2019) 10LT01, arXiv:1811.11817 [astro-ph.IM].

[7] A. Parida, J. Suresh, S. Mitra, and S. Jhingan, "Component separation map-making for stochastic gravitational wave background,"*arXiv e-prints* (Apr, 2019) , arXiv:1904.05056 [gr-qc].

[8] C. Afle, A. Gupta, B. Gadre, P. Kumar, N. Demos, G. Lovelace, H. G. Choi, H. M. Lee, S. Mitra, M. Boyle, D. A. Hemberger, L. E. Kidder, H. P. Pfeiffer, M. A. Scheel, and B. Szilagyi, "Detection and characterization of spin-orbit resonances in the advanced gravitational wave detectors era,"Phys. Rev. D **98** (Oct., 2018) 083014, arXiv:1803.07695 [gr-qc].

[9] A. Ain, J. Suresh, and S. Mitra, "Very fast stochastic gravitational wave background map making using folded data,"Phys. Rev. D **98** (July, 2018) 024001, arXiv:1803.08285 [gr-qc].

[10] N. Mukund, S. Thakur, S. Abraham, A. K. Aniyan, S. Mitra, N. Sajeeth Philip, K. Vaghmare, and D. P. Acharjya, "An Information Retrieval and Recommendation System for Astronomical Observatories,"ApJS **235** (Mar., 2018) 22, arXiv:1710.05350 [astro-ph.IM].

[11] N. Mukund, S. Abraham, S. Kandhasamy, S. Mitra, and N. S. Philip, "Transient classification in LIGO data using difference boosting neural network,"Phys. Rev. D **95** (May, 2017) 104059, arXiv:1609.07259 [astro-ph.IM].

[12] S. V. Dhurandhar and S. Mitra, "Einsteins centennial gift: Gravitational waves discovered,"*Physics Education* **32** (June, 2016) . http://www.physedu.in/pub/Apr-Jun-2016/PE16-05-380.

[13] M. Coughlin, N. Mukund, J. Harms, J. Driggers, R. Adhikari, and S. Mitra, "Towards a first design of a Newtonian-noise cancellation system for Advanced LIGO,"*Classical and Quantum Gravity* **33** (Dec., 2016) 244001, arXiv:1606.01716 [gr-qc].

[14] S. Das, S. Mitra, A. Rotti, N. Pant, and T. Souradeep, "Statistical isotropy violation in WMAP CMB maps resulting from non-circular beams,"*Astron. & Astrophys.* **591** (June, 2016) A97, arXiv:1401.7757.

[15] A. Parida, S. Mitra, and S. Jhingan, "Component separation of a isotropic Gravitational Wave Background,"J. Cosmology Astropart. Phys. **4** (Apr., 2016) 024, arXiv:1510.07994.

[16] N. Pant, S. Das, A. Rotti, S. Mitra, and T. Souradeep, "Estimating statistical isotropy violation in CMB due to non-circular beam and complex scan in minutes,"J. Cosmology Astropart. Phys. **3** (Mar., 2016) 035, arXiv:1511.03672.

[17] A. Ain, P. Dalvi, and S. Mitra, "Fast gravitational wave radiometry using data folding,"*Phys. Rev. D* **92** (July, 2015) 022003, arXiv:1504.01714 [gr-qc].

[18] A. Ain, S. Kastha, and S. Mitra, "Stochastic gravitational wave background from exoplanets,"*Phys. Rev. D* **91** (June, 2015) 124023, arXiv:1504.01715 [gr-qc].

[19] E. Thrane, S. Mitra, N. Christensen, V. Mandic, and A. Ain, "All-sky, narrowband, gravitational-wave radiometry with folded data,"*Phys. Rev. D* **91** (June, 2015) 124012, arXiv:1504.02158 [astro-ph.IM].

[20] S. Das, S. Mitra, and S. Tabitha Paulson, "Effect of noncircularity of experimental beam on CMB parameter estimation,"J. Cosmology Astropart. Phys. **3** (Mar., 2015) 48, arXiv:1501.02101.

[21] S. Kumar, A. Rotti, M. Aich, N. Pant, S. Mitra, and T. Souradeep, "Orthogonal bipolar spherical harmonics measures: Scrutinizing sources of isotropy violation,"*Phys. Rev. D* **91** (Feb., 2015) 043501, arXiv:1409.4886.

[22] N. Mazumder, S. Mitra, and S. Dhurandhar, "Astrophysical motivation for directed searches for a stochastic gravitational wave background,"*Phys. Rev. D* **89** (Apr., 2014) 084076, arXiv:1401.5898 [gr-qc].

[23] F. A. Ramamonjisoa, S. Ray, S. Mitra, and T. Souradeep, "Fast algorithm for the computation of the CMB polarization TE power spectrum using non-circular beam,"*New Astronomy* **64** (Oct., 2018) 44.

[24] N. Joshi, S. Das, A. Rotti, S. Mitra, and T. Souradeep, "Revealing Non-circular beam effect in WMAP-7 CMB maps with BipoSH measures of Statistical Isotropy,"*ArXiv e-prints* (Oct., 2012) , arXiv:1210.7318 [astro-ph.CO].

[25] D. Talukder, S. Mitra, and S. Bose, "Multibaseline gravitational wave radiometry,"*Phys. Rev. D* **83** (Mar., 2011) 063002, arXiv:1012.4530 [gr-qc].

[26] S. Mitra, G. Rocha, K. M. Górski, K. M. Huffenberger, H. K. Eriksen, M. A. J. Ashdown, and C. R. Lawrence, "Fast Pixel Space Convolution for Cosmic Microwave Background Surveys with Asymmetric Beams and Complex Scan Strategies: FEBeCoP,"*Astrophys. J. Suppl.* **193** (Mar., 2011) 5, arXiv:1005.1929 [astro-ph.CO].

[27] E. Thrane, S. Ballmer, J. D. Romano, S. Mitra, D. Talukder, S. Bose, and V. Mandic, "Probing the anisotropies of a stochastic gravitational-wave background using a network of ground-based laser interferometers,"*Phys. Rev. D* **80** (Dec., 2009) 122002, arXiv:0910.0858.

[28] S. Mitra, A. S. Sengupta, S. Ray, R. Saha, and T. Souradeep, "Cosmic microwave background power spectrum estimation with non-circular beam and incomplete sky coverage,"*Mon. Not. Roy. Astron. Soc.* **394** (Apr., 2009) 1419–1439, arXiv:astro-ph/0702100.

[29] S. Mitra, S. Dhurandhar, T. Souradeep, A. Lazzarini, V. Mandic, S. Bose, and S. Ballmer, "Gravitational wave radiometry: Mapping a stochastic gravitational wave background,"*Phys. Rev. D* **77** (Feb., 2008) 042002, arXiv:0708.2728.

[30] T. Souradeep, S. Mitra, A. Sengupta, S. Ray, and R. Saha, "Non-circular beam correction to the CMB power spectrum,"*New Astronomy Review* **50** (Dec., 2006) 1030–1035, arXiv:astro-ph/0608505.

[31] S. Mitra, S. V. Dhurandhar, and L. S. Finn, "Improving the efficiency of the detection of gravitational wave signals from inspiraling compact binaries: Chebyshev interpolation," *Phys. Rev. D* **72** (Nov., 2005) 102001, arXiv:gr-qc/0507011.

[32] S. Mitra, A. S. Sengupta, and T. Souradeep, "CMB power spectrum estimation using noncircular beams," *Phys. Rev. D* **70** (Nov., 2004) 103002, arXiv:astro-ph/0405406.

[33] T. K. Das, J. K. Pendharkar, and S. Mitra, "Multitransonic Black Hole Accretion Disks with Isothermal Standing Shocks," *Astrophys. J.* **592** (Aug., 2003) 1078–1088, arXiv:astro-ph/0301189.

LIGO-Virgo Collaboration Publications

[1] The LIGO Scientific Collaboration, the Virgo Collaboration, the KAGRA Collaboration, R. Abbott, *et al.*, "Constraints on cosmic strings using data from the third Advanced LIGO-Virgo observing run," *arXiv e-prints* (Jan., 2021) arXiv:2101.12248, arXiv:2101.12248 [gr-qc].

[2] The LIGO Scientific Collaboration, the Virgo Collaboration, the KAGRA Collaboration, R. Abbott, *et al.*, "Upper Limits on the Isotropic Gravitational-Wave Background from Advanced LIGO's and Advanced Virgo's Third Observing Run," *arXiv e-prints* (Jan., 2021) arXiv:2101.12130, arXiv:2101.12130 [gr-qc].

[3] The LIGO Scientific Collaboration, the Virgo Collaboration, the KAGRA Collaboration, R. Abbott, *et al.*, "Diving below the spin-down limit: Constraints on gravitational waves from the energetic young pulsar PSR J0537-6910," *arXiv e-prints* (Dec., 2020) arXiv:2012.12926, arXiv:2012.12926 [astro-ph.HE].

[4] The LIGO Scientific Collaboration, the Virgo Collaboration, R. Abbott, *et al.*, "All-sky search in early O3 LIGO data for continuous gravitational-wave signals from unknown neutron stars in binary systems," *arXiv e-prints* (Dec., 2020) arXiv:2012.12128, arXiv:2012.12128 [gr-qc].

[5] LIGO Scientific Collaboration, Virgo Collaboration, R. Abbott, *et al.*, "VizieR Online Data Catalog: 2015-2017 LIGO obs. analysis for 221 pulsars (Abbott+, 2019)," *VizieR Online Data Catalog* (Nov., 2020) J/ApJ/879/10.

[6] The LIGO Scientific Collaboration, the Virgo Collaboration, R. Abbott, *et al.*, "Search for Gravitational Waves Associated with Gamma-Ray Bursts Detected by Fermi and Swift During the LIGO-Virgo Run O3a," *arXiv e-prints* (Oct., 2020) arXiv:2010.14550, arXiv:2010.14550 [astro-ph.HE].

[7] The LIGO Scientific Collaboration, the Virgo Collaboration, R. Abbott, *et al.*, "Population Properties of Compact Objects from the Second LIGO-Virgo Gravitational-Wave Transient Catalog," *arXiv e-prints* (Oct., 2020) arXiv:2010.14533, arXiv:2010.14533 [astro-ph.HE].

[8] The LIGO Scientific Collaboration, the Virgo Collaboration, R. Abbott, *et al.*, "Tests of General Relativity with Binary Black Holes from the second LIGO-Virgo Gravitational-Wave Transient Catalog," *arXiv e-prints* (Oct., 2020) arXiv:2010.14529, arXiv:2010.14529 [gr-qc].

[9] LIGO Scientific Collaboration, Virgo Collaboration, R. Abbott, *et al.*, "GWTC-2: Compact Binary Coalescences Observed by LIGO and Virgo During the First Half of the Third Observing Run," *arXiv e-prints* (Oct., 2020) arXiv:2010.14527, arXiv:2010.14527 [gr-qc].

[10] LIGO Scientific Collaboration, Virgo Collaboration, R. Abbott, *et al.*, "Gravitational-wave Constraints on the Equatorial Ellipticity of Millisecond Pulsars,"ApJ **902** (Oct., 2020) L21, arXiv:2007.14251 [astro-ph.HE].

[11] LIGO Scientific Collaboration, Virgo Collaboration, R. Abbott, *et al.*, "GW190521: A Binary Black Hole Merger with a Total Mass of 150 M,"Phys. Rev. Lett. **125** (Sept., 2020) 101102, arXiv:2009.01075 [gr-qc].

[12] KAGRA Collaboration, LIGO Scientific Collaboration, VIRGO Collaboration, B. P. Abbott, *et al.*, "Prospects for observing and localizing gravitational-wave transients with Advanced LIGO, Advanced Virgo and KAGRA,"*Living Reviews in Relativity* **23** (Sept., 2020) 3.

[13] LIGO Scientific Collaboration, Virgo Collaboration, R. Abbott, *et al.*, "Properties and Astrophysical Implications of the 150 M Binary Black Hole Merger GW190521,"ApJ **900** (Sept., 2020) L13, arXiv:2009.01190 [astro-ph.HE].

[14] LIGO Scientific Collaboration, Virgo Collaboration, R. Abbott, *et al.*, "GW190412: Observation of a binary-black-hole coalescence with asymmetric masses,"Phys. Rev. D **102** (Aug., 2020) 043015, arXiv:2004.08342 [astro-ph.HE].

[15] LIGO Scientific Collaboration, Virgo Collaboration, R. Abbott, *et al.*, "GW190814: Gravitational Waves from the Coalescence of a 23 Solar Mass Black Hole with a 2.6 Solar Mass Compact Object,"ApJ **896** (June, 2020) L44, arXiv:2006.12611 [astro-ph.HE].

[16] LIGO Scientific Collaboration, Virgo Collaboration, R. Hamburg, *et al.*, "A Joint Fermi-GBM and LIGO/Virgo Analysis of Compact Binary Mergers from the First and Second Gravitational-wave Observing Runs,"ApJ **893** (Apr., 2020) 100, arXiv:2001.00923 [astro-ph.HE].

[17] The LIGO Scientific Collaboration, the Virgo Collaboration, B. P. Abbott, *et al.*, "A guide to LIGO-Virgo detector noise and extraction of transient gravitational-wave signals,"*Classical and Quantum Gravity* **37** (Mar., 2020) 055002, arXiv:1908.11170 [gr-qc].

[18] B. P. Abbott *et al.*, "GW190425: Observation of a Compact Binary Coalescence with Total Mass $\sim$ 3.4 M,"ApJ **892** (Mar., 2020) L3, arXiv:2001.01761 [astro-ph.HE].

[19] (The LIGO Scientific Collaboration, The Virgo Collaboration), B. P. Abbott, *et al.*, "Model comparison from LIGOVirgo data on GW170817's binary components and consequences for the merger remnant,"*Classical and Quantum Gravity* **37** (Feb., 2020) 045006, arXiv:1908.01012 [astro-ph.HE].

[20] LIGO Scientific Collaboration, Virgo Collaboration, B. P. Abbott, *et al.*, "Search for gravitational waves from Scorpius X-1 in the second Advanced LIGO observing run with an improved hidden Markov model,"Phys. Rev. D **100** (Dec, 2019) 122002, arXiv:1906.12040 [gr-qc].

[21] The LIGO Scientific Collaboration, the Virgo Collaboration, R. Abbott, *et al.*, "Open data from the first and second observing runs of Advanced LIGO and Advanced Virgo,"*arXiv e-prints* (Dec, 2019) , arXiv:1912.11716 [gr-qc].

[22] LIGO Scientific Collaboration, Virgo Collaboration, B. P. Abbott, *et al.*, "Tests of general relativity with the binary black hole signals from the LIGO-Virgo catalog GWTC-1,"Phys. Rev. D **100** (Nov., 2019) 104036, arXiv:1903.04467 [gr-qc].

[23] B. P. Abbott *et al.*, "Search for Gravitational-wave Signals Associated with Gamma-Ray Bursts during the Second Observing Run of Advanced LIGO and Advanced Virgo,"ApJ **886** (Nov, 2019) 75, arXiv:1907.01443 [astro-ph.HE].

[24] LIGO Scientific Collaboration, Virgo Collaboration, B. P. Abbott, *et al.*, "Search for Subsolar Mass Ultracompact Binaries in Advanced LIGO's Second Observing Run,"Phys. Rev. Lett. **123** (Oct, 2019) 161102, arXiv:1904.08976 [astro-ph.CO].

[25] The LIGO Scientific Collaboration, the Virgo Collaboration, B. P. Abbott, *et al.*, "Search for Eccentric Binary Black Hole Mergers with Advanced LIGO and Advanced Virgo during Their First and Second Observing Runs,"ApJ **883** (Oct, 2019) 149, arXiv:1907.09384 [astro-ph.HE].

[26] LIGO Scientific Collaboration, the Virgo Collaboration, B. P. Abbott, *et al.*, "Directional limits on persistent gravitational waves using data from Advanced LIGO's first two observing runs,"Phys. Rev. D **100** (Sep, 2019) 062001, arXiv:1903.08844 [gr-qc].

[27] The LIGO Scientific Collaboration, the Virgo Collaboration, B. P. Abbott, *et al.*, "Binary Black Hole Population Properties Inferred from the First and Second Observing Runs of Advanced LIGO and Advanced Virgo,"ApJ **882** (Sep, 2019) L24, arXiv:1811.12940 [astro-ph.HE].

[28] The LIGO Scientific Collaboration, the Virgo Collaboration, B. P. Abbott, *et al.*, "A gravitational-wave measurement of the Hubble constant following the second observing run of Advanced LIGO and Virgo,"*arXiv e-prints* (Aug, 2019) arXiv:1908.06060, arXiv:1908.06060 [astro-ph.CO].

[29] The LIGO Scientific Collaboration, the Virgo Collaboration, B. P. Abbott, *et al.*, "An Optically Targeted Search for Gravitational Waves emitted by Core-Collapse Supernovae during the First and Second Observing Runs of Advanced LIGO and Advanced Virgo,"*arXiv e-prints* (Aug, 2019) arXiv:1908.03584, arXiv:1908.03584 [astro-ph.HE].

[30] LIGO Scientific Collaboration, Virgo Collaboration, B. P. Abbott, *et al.*, "GWTC-1: A Gravitational-Wave Transient Catalog of Compact Binary Mergers Observed by LIGO and Virgo during the First and Second Observing Runs,"*Physical Review X* **9** (Jul, 2019) 031040, arXiv:1811.12907 [astro-ph.HE].

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[33] LIGO Scientific Collaboration, Virgo Collaboration, B. P. Abbott, *et al.*, "All-sky search for continuous gravitational waves from isolated neutron stars using Advanced LIGO O2 data,"Phys. Rev. D **100** (Jul, 2019) 024004, arXiv:1903.01901 [astro-ph.HE].

[34] B. P. Abbott *et al.*, "Searches for Gravitational Waves from Known Pulsars at Two Harmonics in 2015-2017 LIGO Data,"ApJ **879** (Jul, 2019) 10, arXiv:1902.08507 [astro-ph.HE].

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[36] LIGO Scientific Collaboration, Virgo Collaboration, Abbott, B. P., *et al.*, "All-sky search for long-duration gravitational-wave transients in the second Advanced LIGO observing run,"Phys. Rev. D **99** (May, 2019) 104033, arXiv:1903.12015 [gr-qc].

[37] The DES Collaboration, the LIGO Scientific Collaboration, the Virgo Collaboration, M. Soares-Santos, *et al.*, "First Measurement of the Hubble Constant from a Dark Standard Siren using the Dark Energy Survey Galaxies and the LIGO/Virgo BinaryBlack-hole Merger GW170814,"ApJ **876** (May, 2019) L7, arXiv:1901.01540.

[38] The LIGO Scientific Collaboration, the Virgo Collaboration, B. P. Abbott, and others., "Search for Gravitational Waves from a Long-lived Remnant of the Binary Neutron Star Merger GW170817,"ApJ **875** (Apr, 2019) 160, arXiv:1810.02581 [gr-qc].

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[40] The LIGO Scientific Collaboration, the Virgo Collaboration, B. P. Abbott, and others., "Low-latency Gravitational-wave Alerts for Multimessenger Astronomy during the Second Advanced LIGO and Virgo Observing Run,"ApJ **875** (Apr, 2019) 161, arXiv:1901.03310 [astro-ph.HE].

[41] The LIGO Scientific Collaboration, the Virgo Collaboration, B. P. Abbott, *et al.*, "Search for Transient Gravitational-wave Signals Associated with Magnetar Bursts during Advanced LIGO's Second Observing Run,"ApJ **874** (Apr, 2019) 163, arXiv:1902.01557 [astro-ph.HE].

[42] The LIGO Scientific Collaboration, the Virgo Collaboration, B. P. Abbott, *et al.*, "A search for the isotropic stochastic background using data from Advanced LIGO's second observing run,"*arXiv e-prints* (Mar, 2019) arXiv:1903.02886, arXiv:1903.02886 [gr-qc].

[43] B. P. Abbott *et al.*, "Constraining the p-mode–g-mode tidal instability with GW170817,"*Physical Review Letters* **122** (Feb., 2019) 061104, arXiv:1808.08676 [astro-ph.HE].

[44] E. Burns *et al.*, "A Fermi Gamma-Ray Burst Monitor Search for Electromagnetic Signals Coincident with Gravitational-wave Candidates in Advanced LIGO's First Observing Run,"ApJ **871** (Jan., 2019) 90, arXiv:1810.02764 [astro-ph.HE].

[45] ANTARES, IceCube, LIGO Scientific Collaboration, Virgo Collaboration, A. Albert, *et al.*, "Search for Multimessenger Sources of Gravitational Waves and High-energy Neutrinos with Advanced LIGO during Its First Observing Run, ANTARES, and IceCube,"ApJ **870** (Jan., 2019) 134, arXiv:1810.10693 [astro-ph.HE].

[46] LIGO Scientific Collaboration, Virgo Collaboration, B. P. Abbott, *et al.*, "Properties of the Binary Neutron Star Merger GW170817,"*Physical Review X* **9** (Jan., 2019) 011001, arXiv:1805.11579 [gr-qc].

[47] B. P. Abbott *et al.*, "Search for Subsolar-Mass Ultracompact Binaries in Advanced LIGO's First Observing Run,"*Physical Review Letters* **121** (Dec., 2018) 231103, arXiv:1808.04771.

[48] B. P. Abbott *et al.*, "GW170817: Measurements of Neutron Star Radii and Equation of State,"*Physical Review Letters* **121** (Oct., 2018) 161101, arXiv:1805.11581 [gr-qc].

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