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Education

University of Birmingham, Birmingham, UK — PhD, 2014
University of Bologna, Bologna, Italy — M.Sc., 2009
Carleton University, Ottawa, Canada — B.Sc (Double Honours), 2006

Positions

Assistant Professor of Physics, University of Connecticut, 2019 —

Associate Research Scientist, Flatiron Institute, CCA, 2019—2023

I have a joint tenure-track position, shared between the Flatiron Institute's Center for Computational Astrophysics (CCA) and the University of Connecticut (UConn) until 2023. After this, I will be full-time at UConn.

Ada Lovelace Director of Diversity, Flatiron Institute, CCA, 2019-2023

My role is to increase diversity in computation astrophysics by advising on gender balance, and all issues pertaining to equity and inclusion at CCA. My main focus has been to actively increase the diversity of our Flatiron Fellow applicant pool so that we may hire more diverse Fellows, and helping to create and develop the Inclusion, Diversity, Equity & Advocacy (IDEA) Scholar Program at the Flatiron Institute.

Flatiron Research Fellow 2017 - 2019

Flatiron Research Fellow at the CCA.

Marie Curie International Outgoing Fellow — 2014 - 2017

I spent the outgoing phase of the MC IOF postdoctoral fellowship at Caltech, with visiting status at NASA's Jet Propulsion Laboratory, with the European reintegration phase at the Max Planck Institute for Radio Astronomy in Bonn, Germany.

Leadership, Mentorship, and Collaboration Work

- **Chair of the 2020 & 2021 Gravitational Wave International Committee (GWIC) -Braccini Thesis Prize Committee.** As chair I assembled a team of 15 experts to evaluate the best PhD thesis across all fields of gravitational-wave science.
- **Founder and Chair** of the International Pulsar Timing Array gravitational wave analysis working group (March 2018-March 2020; end of term).
- **Member** of the GWIC-Braccini Thesis Prize committee (2019).
- **Chair:** European Pulsar Timing Array detection working group (Jan 2017-2018).
- **Student Advising:** J. Andrew Casey-Clyde (PhD advisor 2019—, UConn); Bjorn Larsen (PhD Advisor 2021 —, UConn); Andrea Mejia (PhD Advisor 2021 —, UConn); London Willson (PhD Advisor 2022 —, UConn); Sean Oh (Master's advisor, 2020 — 2022, UConn), Nicole Khusid (Senior Thesis Advisor and SURF, 2021-22), Abigail Moran (Undergraduate Research and SURF, UConn 2021-22), UConn Chengcheng Xin (2019-2020, undergraduate, Columbia University and

Flatiron Institute CCA), Brianna Isola (2018-2019, undergraduate, Flatiron Institute CCA), Morgan Nañez (2018-2019, undergraduate, Flatiron Institute CCA).

- **NANOGrav Contributions:** I wrote the astrophysical interpretation of the 12.5-yr GW background results, the astrophysical interpretation of the 12.5-yr and the 11-yr continuous GW searches, led the first astrophysical interpretation of the 9-year data; conceived of and ran analyses for primordial GWs for 9-yr data, carried out first search for anisotropy in the 9-yr data — results never published due to "anomaly" present in data which is an outstanding issue, and led the change in reporting GW limits from strain-only to $\Omega_{gw}(f)$ which is more general.
- **Binary Stars Art Installation, CCA**: Together with David Spergel, I led the commissioning of a custom piece of scientific art for the CCA from artist LA-based Lia Halloran. Halloran has also worked with Harvard and Caltech.
- **OzGrav Governance Committee:** OzGrav is a multimillion Australian GW collaboration. The governance committee meets at least once a year to advice on how OzGrav is run. I have been a member since June 2017.
- **Supernova Foundation:** scientific mentor to women in astronomy and astrophysics in developing countries (July 2017 - January 2020).
- **Caltech Women Mentoring Women:** scientific mentor to women across all fields at Caltech (Oct 2014 — Jul 2016).

Grants (Awarded $1M)

- **PI, An Empirical Blueprint for the Gravitational-Wave Background**, NSF AAG Collaborative grant with Jenny E. Greene (Princeton), $313,047. UConn is the lead institution. Grant period 2021-2024
- **Co-I , The NANOGrav Physics Frontier Center,** NSF Physics Frontier Center, $282, 503. Grant period 2021-2026.
- **Amazon Web Services ML Award** — October 2018, Value of $120,000 (USD)
- **Marie Curie International Outgoing Fellowship** — 2014 - 2017 , Project name "GW ASAP", Proposal number 623380, value €262,975 (USD 330k)
- **Submitted** NSF AAG , NASA TCAN, Sloan, totaling **$2M**, and a NOI for the LISA and Roman open calls.

Telescope Use

- **Co-I Green Bank Telescope (21 hours),** High-Impact MSPs for the International Pulsar Timing Array, GBT17A-353 (Nov 2016)
- **Co-I Arecibo Telescope (32.5 hours),** High-Impact MSPs for the International Pulsar Timing Array, P3133 (Sep 2016)

Referee Service Work

I am currently a referee for Physical Review Letters, Physical Review D, Journal of Cosmology and Astroparticle Physics (JCAP), Physics Letters B, Astrophysical Journal, Astrophysical Journal Letters, Monthly Notices of the Royal Astronomical Society, and Classical and Quantum Gravity. I was also an NSF grant panelist (2016, 2022).

Code Sharing for the Scientific Community

My codes and lecture notes are available on my github account, https://github.com/ChiaraMingarelli. I work primarily in Python and publish my codes with Jupyter notebooks. My public codes from Mingarelli et al. (2017) have been widely used by the community, including researchers at Imperial College London, CCA and UConn.

Selection of Recent Prizes, Honors and Awards

- **2023 Early Career Prize**, American Astronomical Society, High Energy Astrophysics Division
- **Nature "Inspiring Women in Science Award" 2022**, Scientific Achievement Category. Runner-up (winner helped to invent the Moderna vaccine).
- **Marie Curie Actions "Communicating Science" Prize for 2017**, presented at the MCA Presidency Meeting in Malta, May 2017.
- **Woman Physicist of the Month**, American Physical Society, November 2016
- **Springer Thesis Award** — 2015, Thesis published by Springer Theses with $650 cash prize

Recent Conference and Meeting Organization

- SOC, NANOGrav Fall Meeting, UWM, October 2022
- SOC Chair, NANOGrav Spring Meeting, CCA, March 2022
- SOC, Gravitational Wave Physics and Astronomy Workshop (GWPAW), AEI Hannover, December 2021
- SOC, Fast Radio Bursts: theory meets observations, CCA Feb 2020
- SOC, NANOGrav Collaboration Meeting, Cornell, October 2019
- SOC Chair, Eternal Multimessenger Workshop, CCA, August 2018
- SOC Chair, 1st International Pulsar Timing Array Hack Week, CCA, Dec. 2017

Public Engagement in Science

Selection of Television Appearances and Podcasts:

How the Universe Works — Science Channel, Seasons 5, 7, 8, 9 and 10; Nova's "Universe", Orbital Path podcast with Michelle Thaller; Talk Nerdy with Cara Santa Maria, Episode 70; Story Collider podcast, "How I Ended Up At the Center of the Universe", Sean Carroll's "Mindscape" podcast, and "TWiV" podcast.

Popular Science Articles

Scientific American, "Searching for the Gravitational Waves LIGO Can't Hear", by CMF Mingarelli, 2016; Amy Poehler Smart Girls, "Conversations with a Theoretical Astrophysicist", invited blog series for Women's Month 2016

High Profile Public Lectures

Amazon MARS 2018, 2019, 2022, 2023 (2020-21 cancelled due to Covid), Talk given to Jeff Bezos; Dreamworks Animation Studios, Los Angeles, CA, USA; Ad Astra Academy (owned by Elon Musk), Bel Air, CA; Adler Planetarium, "Adler After Dark", Chicago, IL, USA.

Recent Invited Talks

I have given 70 invited talks at world-class research institutes such as Caltech, Princeton, Harvard, and NASA Headquarters, as well as high-profile meetings such as the American Astronomical Society, LISA symposium, and Amaldi. Here is a sample, with dates and locations of all talks are available upon request.

1. Dark Interactions 2022: New Perspectives from Theory and Experiment, plenary talk, November 2022
2. Maria Mitchell Women of Science Symposium, invited panelist, September 2022
3. Giant Magellan Telescope Community Meeting, Plenary Talk, September 2022
4. TeVPA, Plenary Talk, Queen's University, August 2022
5. University of Zurich, Colloquium, Zurich, May 2022
6. Yale University, Department of Astronomy Colloquium, April 2022
7. Johns Hopkins & Space Telescope Science Institute Colloquium, March 2022
8. Cambridge Cosmology Seminar, March 2022
9. Galileo Galilei Institute, Colloquium, Florence, November 2021
10. Amaldi 14, Plenary Talk on the NANOGrav 12.5-yr results, July 2021
11. Stony Brook University, Astronomy Seminar, May 2021
12. Padova Cosmology Seminar Series, Padova, Italy, April 2021
13. Primordial Black Holes Confront GW Data, Plenary Talk, Rome, February 2021
14. GRASP Colloquium, Utrecht University, Netherlands, January 2021
15. Columbia University, Astronomy Colloquium, January 2021
16. CU Boulder, Departmental Colloquium, November 2020
17. Swarthmore University, Departmental Colloquium, November 2020
18. University College London, Astronomy Seminar Series, October 2020
19. Copernicus Webinar Series, October 2020
20. New York University, High Energy Physics Seminar, Department of Physics, February 2020
21. California Institute of Technology, TAPIR Seminar, January 2020
22. University of Florida, Theoretical Astrophysics Seminar, December 2019
23. North Carolina State University, Department of Physics Colloquium, November 2019
24. Penn State, Institute for Gravitation and the Cosmos Fundamental Theory Seminar, Oct 2019
25. Johns Hopkins University, Department of Physics and Astronomy Seminar, April 2019
26. Queen's University, Canada, Departmental Colloquium, March 2019
27. University of Southern California, Departmental Colloquium, Los Angeles CA, USA, January 2019
28. Vanderbilt University, Departmental Colloquium, January 2019
29. University of Auckland, NZ, Departmental Colloquium, December 2018
30. American Museum of Natural History, NY, Astronomy Seminar, November 2018
31. Cornell University, The Josephine Lawrence Hopkins Foundation Colloquium, October 2018

32. Interplay between Particle and Astroparticle physics, Plenary Talk, October 2018
33. SISSA, Trieste, Italy (APC Seminar) Pulsar Timing Arrays:The Next Window on the Gravitational-Wave Universe, September 2018
34. Observatoire Côte d'Azur (Seminare Lagrange) Pulsar Timing Arrays: The Next Window on the Gravitational-Wave Universe, September 2018
35. University of California, Berkeley (seminar) Astrophysics of Supermassive Black Hole Mergers with Pulsar Timing Arrays, February 2018
36. Harvard University (ITC Colloquium and ITC Luncheon Talk), Investigating supermassive black hole mergers with PTAs, December 2017
37. Princeton University (Gravity Group) Insights into Supermassive Black Hole Mergers, Stalling and Demographics with Pulsar Timing Arrays, April 2017
38. Perimeter Institute (Colloquium) Unlocking the potential of pulsar timing arrays, March 2017
39. 229th AAS Meeting Special Session: HEAD I (Plenary): "Astronomy Across the Gravitational Wave Spectrum", January 2017
40. 11th International LISA Symposium (Plenary) The Discovery Potential of Pulsar Timing Arrays, September 2016
41. NASA Headquarters (Colloquium) The Gravitational-Wave Universe seen by Pulsar Timing Arrays, April 2016
42. Canadian Institute for Advanced Research Meeting, CIFAR, The Discovery Potential of PTAs II: Anisotropy, Cosmology and Fundamental Physics, April 2016

Top 5 publications

My h index is 48 and I have 10,154 citations as of February 7th 2023 on Google Scholar. Here are my top 5 publications:

1. **C. M. F. Mingarelli**, T. Sidery, I. Mandel and A. Vecchio, *Characterizing stochastic gravitational wave background anisotropy with Pulsar Timing Arrays*, Phys. Rev. D 88, 062005 (2013). 124 citations.

2. **C. M. F. Mingarelli**, T. J. W. Lazio, A. Sesana et al., The local nanohertz gravitational-wave landscape from supermassive black hole binaries, Nature Astronomy, Volume 1, pages 886–892 (2017). 116 citations.

3. **C. M. F. Mingarelli,** J. Levin, T. J. W. Lazio, Fast radio bursts and radio transients from black hole batteries, The Astrophysical Journal Letters, Volume 814, Issue 2, article id. L20, 5 pp. (2015). 103 citations.

4. P. D. Lasky, **C. M. F. Mingarelli,** et al., Gravitational-wave cosmology across 29 decades in frequency, Physical Review X, Volume 6, Issue 1, id.011035 (2016). 203 citations. I was the **co-lead** author on this paper: I conceived of the idea, carried out the analysis on the PTA data, and wrote the complete first draft.

5. Z. Arzoumanian et al., *The NANOGrav Nine-year Data Set: Limits on the Isotropic Stochastic Gravitational Wave Background,* ApJ 821, Issue 1,13, (2016). 293 citations. **This is an alphabetically authored paper, where I played a leading role:** I developed the astrophysical framework to implement final parsec physics via stellar hardening and binary gas interactions, analytically defining at what frequency SMBHB evolution transitions to being GW-

dominated, instead of being driven to merge by the aforementioned environmental coupling effects. This marks the first time any PTA data was used to constrain underlying physical parameters of SMBHB mergers: by searching for the turnover in the spectrum, one can infer e.g. the density of stars surrounding the binaries, the gas accretion rate, or the binary eccentricity. Moreover, I developed and interpreted the primordial GW background results, and contributed to the cosmic string tension limits by comparing the new results to Planck. I also made sure that all strain upper limits appeared in the abstract in terms of $\Omega_{gw}(f)$ in addition to the characteristic strain, so that the results were more broadly understandable at a glance. I also did this in Lentati et al. (2015). Finally, I ran the data analysis pipelines and wrote large portions of the manuscript. The codes for this work are all public, as are the data which were analyzed. This author contribution section confirms all claims.

Bibliography

My publications are listed as follows: the first tier are either my first author papers or papers led by my graduate and undergraduate students (identified with an asterisk*). The next tier are short-author papers, including those with more advanced postdocs under my supervision, also denoted by an asterisk. The next are collaboration papers including NANOGrav but excluding LIGO.

Briefly I have one published monograph and one textbook in preparation, contracted with Princeton University Press, 17 papers where I played the leading role (11 first author, 6 with students), and 2 major collaboration papers where I played a leading role (Lasky et al. 2016 and Arzoumanian et al. 2016).

Monographs

- **C. M. F. Mingarelli**, Gravitational Wave Astrophysics with Pulsar Timing Arrays, Springer Thesis Series 2016, ISBN 978-3-319-18400-5.

- **C. M. F. Mingarelli**, Introduction to Gravitational Wave Astronomy, <u>contract signed</u> with Princeton University Press. <u>Expected publication Fall 2025.</u>

Selection of Articles

<u>*an asterisk * denotes a paper led by one of my students or postdocs*</u>

1. J. A. Casey-Clyde*, **C. M. F. Mingarelli,** J. E. Greene et al., Quasars are Likeliest Hosts of Supermassive Black Hole Binaries, Submitted upon request to Nature Astronomy.

2. **C. M. F. Mingarelli,** J. A. Casey-Clyde, Seeing the Gravitational Wave Universe, Science, Vol 378, Issue 6620 (2022).

3. A. Moran*, **C. M. F. Mingarelli,** M. Bedell, D. Good, Further Improving Distances to Binary Millisecond Pulsars with Gaia EDR3, submitted to ApJ, arXiv:2210.10816

4. N. Khusid*, **C. M. F. Mingarelli,** P. Natarajan, J. A. Casey-Clyde*, A. Barnacka, Strongly Lensed Supermassive Black Hole Binaries as Nanohertz Gravitational-Wave Sources, submitted to ApJ, arXiv:2210.00014.

5. J. A. Casey-Clyde*, **C. M. F. Mingarelli,** J. E. Greene et al., An AGN-based supermassive black hole binary population model: implications for the gravitational-wave background, ApJ, Volume 924, 2 (2022).

6. C. Xin*, **C. M. F. Mingarelli,** J. S. Hazboun, Multimessenger pulsar timing array constraints on supermassive black hole binaries traced by periodic light curves, ApJ Volume 915, Issue 2 (2021).

7. K. Breivik*, **C. M. F. Mingarelli,** S. L. Larson, Constraining Galactic Structure with the LISA White Dwarf Foreground, ApJ, Volume 901, Issue 1, id.4, 9 pp. (2020).

8. **C. M. F. Mingarelli,** L. Anderson, M. Bedell, D. N. Spergel, Improving Binary Millisecond Pulsar Distances with Gaia, arXiv:1812.06262 (2018).

9. **C. M. F. Mingarelli,** Pulsar Timing Arrays: The Next Window on the Gravitational-Wave Universe, Nature Astronomy, Volume 3, p. 8-10 (2019).

10. **C. M. F. Mingarelli,** S. R. Taylor, B. S. Sathyaprakash, W. M. Farr, Understanding $\Omega_{gw}(f)$ in Gravitational Wave Experiments, submitted to CQG, arXiv:1911.09745.

11. **C. M. F. Mingarelli** and A. B. Mingarelli, Proving the short-wavelength approximation in Pulsar Timing Array gravitational-wave background searches, J. Phys. Commun. 2 105002 (2018).

12. **C. M. F. Mingarelli**, T. J. W. Lazio, A. Sesana et al., Detection Prospects of Local Continuous Nanohertz Gravitational-Wave Sources with Pulsar Timing Arrays, Nature Astronomy, Volume 1, pages 886–892 (2017)[1].

13. **C. M. F. Mingarelli** for NANOGrav, Interpreting the Recent Upper Limit on the Gravitational Wave Background from the Parkes Pulsar Timing Array; arXiv:1602.06301 (2016).

14. **C. M. F. Mingarelli**, J. Levin, T. J. W. Lazio, Fast Radio Bursts and Radio Transients from Black Hole Batteries, ApJL, Volume 814, L20 (2015).

15. **C. M. F. Mingarelli**, T. Sidery. Effect of small interpulsar distance variations in stochastic gravitational wave background searches with Pulsar Timing Arrays, Phys. Rev. D 90, 062011 (2014)[2].

16. **C. M. F. Mingarelli**, T. Sidery, I. Mandel and A. Vecchio. Characterizing stochastic gravitational wave background anisotropy with Pulsar Timing Arrays. Phys. Rev. D 88, 062005 (2013).

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[1] This was the first PTA paper to appear in a Nature journal. Nature Astronomy commissioned also a News & Views article to be written about the importance of this work, see L. Moustakas, Nature Astronomy Volume 1, 825--826 (2017)

[2] Selected for APS Kaleidoscope

17. **C. M. F. Mingarelli**, K. Grover, T. Sidery, R. J. E. Smith, and A. Vecchio. Observing the Dynamics of Supermassive Black Hole Binaries with Pulsar Timing Arrays. Phys. Rev. Lett., 109 081104 (2012)[3].

18. M. J. Koss with **C. M. F. Mingarelli**, UGC 4211: A Confirmed Dual AGN in the Local Universe at 230 pc Nuclear Separation, ApJL (in press; press release planned for AAS January 2023 meeting).

19. M. Renzo*, T. Callister*, K.Chatziioannou, L. Van Son, **C. M. F. Mingarelli** et al. Prospects of gravitational-waves detections from common-envelope evolution with LISA, submitted to ApJ, arXiv:2102.00078

20. Y. Ali-Haïmoud, T. L. Smith, **C. M. F. Mingarelli,** Insights into searches for anisotropies in the nanohertz gravitational-wave background, Phys. Rev. D, Volume 103, Issue 4, article id.042009 (2021).

21. G. Ogiya, O. Hahn, **C. M. F. Mingarelli**, M. Volonteri, Accelerated orbital decay of supermassive black hole binaries in merging nuclear star clusters, MNRAS, Volume 493, Issue 3, p.3676-3689 (2020).

22. Y. Ali-Haïmoud, T. L. Smith, **C. M. F. Mingarelli,** Fisher formalism for anisotropic gravitational-wave background searches with pulsar timing arrays, Phys. Rev. D, Volume 102, Issue 12, article id.122005 (2020).

23. A. Goulding, K. Pardo, J. Greene, **C. M. F. Mingarelli** et al., Discovery of a Close-separation Binary Quasar at the Heart of a z ~ 0.2 Merging Galaxy and Its Implications for Low-frequency Gravitational Waves, ApJL, Volume 879, Issue 2, article id. L21, 7 pp. (2019).

24. C. Conneely*, A. H. Jaffe, **C. M. F. Mingarelli**, On the Amplitude and Stokes Parameters of a Stochastic Gravitational-Wave Background, MNRAS Volume 487, Issue 1, p.562-579 (2019).

25. J. Hazboun, **C. M. F. Mingarelli,** K. Lee, The Second International Pulsar Timing Array Mock Data Challenge, arXiv:1810.10527 (2018).

26. P. Lasky, **C. M. F. Mingarelli**, T. Smith et al., Gravitational-wave cosmology across 29 decades in frequency, Phys. Rev. X, Volume 6, Issue 1, 011035 (2016)[4].

27. S. R. Taylor, M. Vallisneri, J. A. Ellis, **C. M. F. Mingarelli**, T. J. W. Lazio, R. van Haasteren, Are we there yet? Time to detection of nanohertz gravitational waves based on pulsar-timing array limits, ApJL, Volume 819, L6 (2016).

[3] Highlighted in APS "Physics". Synopsis: Sailing Choppy Gravitational Seas

[4] Highlighted in APS "Physics". Synopsis: Homing in on Primordial Gravitational Waves

28. S. R. Taylor, **C. M. F. Mingarelli,** J. R. Gair, et al. Limits on anisotropy in the nanohertz stochastic gravitational-wave background Phys. Rev. Lett. 115, 041101 (2015).

29. G. Janssen et al., Gravitational wave astronomy with the SKA, Proceedings of Science (2014), arXiv:501.00127

30. J. R. Gair, J. D. Romano, S. R. Taylor, **C. M. F. Mingarelli**, Mapping gravitational-wave backgrounds using methods from CMB analysis: Application to pulsar timing arrays, Phys. Rev. D 90, 082001 (2014)[5].

31. J. D. Romano, S. R. Taylor, N. J. Cornish, J. Gair, **C. M. F. Mingarelli**, R. van Haasteren, Phase-coherent mapping of gravitational-wave backgrounds using ground-based laser interferometers, Phys. Rev. D 92, 042003 (2015).

32. A. Y. Kamenshchik and **C. M. F. Mingarelli**, A generalized Heckmann-Schücking cosmological solution in the presence of a negative cosmological constant. Phys. Lett. B (693), 213 (2010).

33. A. B. Mingarelli and **C. M. F. Mingarelli**, Conjugate points in the gravitational n-body problem, Celest. Mech. Dynam. Astron. 91, 391 (2005).

34. R. van Haasteren, **C. M. F. Mingarelli**, A. Vecchio, A. Lassus, Analysis of the first IPTA Mock Data Challenge by the EPTA timing data analysis working group, arXiv:1301.6673v1 (2013).

35. A. Lassus, R. van Haasteren, **C. M. F. Mingarelli**, K. J. Lee, A. Vecchio, Data Analysis Library for Gravitational Wave Detection, Proceedings IAU Symposium No. 291, Volume 8, pp 438-440 Beijing, China, August (2012).

36. L. Barack et al., Black holes, gravitational waves and fundamental physics: a roadmap, CQG, Volume 36, Issue 14, article id. 143001 (2019)[6]

37. S. Burke-Spolaor et al., The astrophysics of nanohertz gravitational waves, T A&A Review, Volume 27, Issue 1, article id. 5, 78 pp. (2019)

38. Z. Arzoumanian et al., Searching For Gravitational Waves From Cosmological Phase Transitions With The NANOGrav 12.5-year dataset, submitted to PRL, arXiv:2104.13930

39. Z. Arzoumanian et al., The NANOGrav 12.5-year Data Set: Search For An Isotropic Stochastic Gravitational-Wave Background, ApJL Volume 905, Issue 2, id.L34, 18 pp. (2020).

[5] Editor's Suggestion, Phys. Rev. D Highlights

[6] I wrote the section on pulsar timing arrays, and so appear in the first tier of authors.

40. Z. Arzoumanian et al., Multimessenger Gravitational-wave Searches with Pulsar Timing Arrays: Application to 3C 66B Using the NANOGrav 11-year Data Set, ApJ, Volume 900, Issue 2 (2020).

41. K. Aggarwal et al., The NANOGrav 11 yr Data Set: Limits on Gravitational Waves from Individual Supermassive Black Hole Binaries, ApJ 880, Issue 2, article id. 116, 11 pp. (2019).

42. N. Pol et al., Astrophysics Milestones For Pulsar Timing Array Gravitational Wave Detection, ApJL, Volume 911, Issue 2, id.L34, 10 pp. (2021).

43. M. Alam et al., The NANOGrav 12.5-year Data Set: Wideband Timing of 47 Millisecond Pulsars, ApJS, Volume 252, Issue 1, id.5, 53 pp. (2021).

44. The NANOGrav 12.5 yr Data Set: Observations and Narrowband Timing of 47 Millisecond Pulsars, ApJS, Volume 252, Issue 1, id.4, 48 pp. (2021).

45. M. Vallisneri et al., Modeling the Uncertainties of Solar System Ephemerides for Robust Gravitational-wave Searches with Pulsar-timing Arrays, ApJ, Volume 893, Issue 2, id.112, 11 pp. (2020).

46. J. Hazboun et al., The NANOGrav 11 yr Data Set: Evolution of Gravitational-wave Background Statistics, ApJ, Volume 890, Issue 2, id.108, 15 pp. (2020).

47. K. Aggarwal et al., The NANOGrav 11 yr Data Set: Limits on Gravitational Wave Memory, ApJ, Volume 889, Issue 1, id.38, 11 pp. (2020).

48. G. Hobbs et al., A pulsar-based time-scale from the International Pulsar Timing Array, MNRAS, Volume 491, Issue 4, p.5951-5965 (2020).

49. B. B. P. Perera, The International Pulsar Timing Array: Second data release, MNRAS, Volume 490, Issue 4, p. 4666-4687 (2019).

50. X. Siemens et al., Physics Beyond the Standard Model With Pulsar Timing Arrays, arXiv:1907.04960 (white paper)

51. D. R. Madison et al., The NANOGrav 11-year Data Set: Solar Wind Sounding Through Pulsar Timing, ApJ Volume 872, Issue 2, article id. 150, 13 pp. (2019).

52. NANOGrav Collaboration, Science with the Next-Generation VLA and Pulsar Timing Arrays, ASP Monograph Series, "Science with a Next-Generation VLA", ed. E. J. Murphy (ASP, San Francisco, CA), arXiv:1810.06594

53. R. N. Caballero et al., Studying the solar system with the International Pulsar Timing Array, MNRAS Volume 481, Issue 4, p.5501-5516 (2018).

54. Z. Arzoumanian et al., The NANOGrav 11-year Data Set: Pulsar-timing Constraints On The Stochastic Gravitational-wave Background, ApJ, Volume 859, Issue 1, article id. 47, 22 pp. (2018).

55. Z. Arzoumanian et al., The NANOGrav Eleven-year Data Set: High-precision timing of 45 Millisecond Pulsars, ApJS, Volume 235, Issue 2, article id. 37, 41 pp. (2018).

56. Z. Arzoumanian et al., The NANOGrav Nine-year Data Set: Limits on the Isotropic Stochastic Gravitational Wave Background, ApJ, Volume 821, Issue 1, (2016).

57. L. Lentati et al., From Spin Noise to Systematics: Stochastic Processes in the First International Pulsar Timing Array Data Release, MNRAS, Volume 458 (2016).

58. G. Desvignes et al., High-precision timing of 42 millisecond pulsars with the European Pulsar Timing Array, MNRAS, Volume 458 (2016).

59. J. P. W. Verbiest et al., The International Pulsar Timing Array: First Data Release, MNRAS, Volume 457 (2016).

60. S. Babak et al., European Pulsar Timing Array limits on continuous gravitational waves from individual supermassive black hole binaries, MNRAS Volume 455 (2016).

61. N. Caballero et al., The noise properties of 42 millisecond pulsars from the European Pulsar Timing Array and their impact on gravitational wave searches, MNRAS, Volume 457 (2016).

62. R. M. Shannon et al., Summary of session C1: pulsar timing arrays, General Relativity and Gravitation, Volume 46, Issue 8, article id. 1765, 11 pp. (2014).

63. L. Carbone et al., Computer-games for Gravitational Wave science outreach: Black Hole Pong and Space Time Quest, Journal of Physics Conference Series, 363 012057, June (2012).