Caner Ünal

Middle East Technical University, Ankara, Türkiye

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1 RESEARCH AREA : Theoretical cosmology, gravitational waves & particle pheno

Primordial universe, cosmological perturbations, axions, multimessengers, gravitational waves, primordial black holes, high energy astrophysics

2 EDUCATION

2013-2018 University of Minnesota (UMN), Minneapolis, MN, USA
Ph.D. in Physics, Concentration: Theoretical Cosmology and High Energy Physics
(Adviser: Prof. Marco Peloso)

2007-2013 Middle East Technical University (METU), Ankara, Türkiye
B.Sc. in Physics (High Honor, Double Major), Concentration: Theoretical Physics
B.Sc. in Electrical & Electronics Eng. (High Honor), Concentration: Control Theory

3 EXPERIENCE

2024- Middle East Technical University (METU), Ankara, Türkiye
Research Fellow

2024- The Research and Application Center for Space and Accelerating Technologies (METU IVMER), Ankara, Türkiye
Member

2022- Feza Gürsey Center for Physics and Mathematics, Istanbul, Türkiye
Member

2020-2024 Ben-Gurion University (BGU), Be'er Sheva, Israel
Kreitman Fellow (BGU)
Excellence Fellow (Israel Academy of Sciences and Council of Higher Education)

2018-2020 Institute of Physics of Czech Academy of Sciences, Prague, Czechia
Research Fellow (CEICO)

2013-2018 University of Minnesota (UMN), Minneapolis, MN, USA
Teaching/Research Assistant

2012-2013 Middle East Technical University (METU), Ankara, Türkiye
Teaching/Research Assistant

2010-2010 The European Organization for Nuclear Research (CERN), Geneva, Switzerland
Summer Student (Adviser: Marco Cirelli)

4 SELECTED HONORS AND AWARDS

2026	Science Academy Young Scientist Award (BAGEP) 2026
2024	73rd Lindau Nobel Laureate Meetings
2021-2024	Excellence Fellow - Israel Academy of Sciences & Council of Higher Education
2021-2023	Kreitman Fellow - Ben-Gurion University
2020	70th Lindau Nobel Laureate Meetings (Online)
2017	Aneesur Rahman Award - University of Minnesota
2016-2017	Doctoral Dissertation Fellowship - University of Minnesota
2011-2012	Academic Excellence Scholarship - Middle East Technical University
2007-2011	Outstanding Achievement Scholarship [1] - Republic of Türkiye Ministry of Education
2007	Ranked 79th in nationwide exam among $\sim$ 1.5 million candidates

5 SELECTED TALKS

- (**invited**) *Explorations in the Cosmic and Particle Universe*, Istanbul Technical University, **10/26, Istanbul, Türkiye**

- *Nonlinear Gravitational-Wave Memory Background: A Universal Low-Frequency Spectrum*, Galileo Galilei Institute, **09/26, Florence, Italy**

- *Universal Low-Frequency Gravitational Wave Background : Nonlinear Memory*, APS Global Physics Summit, **03/26, Denver, CO, USA**

- (**invited**) *Nonlinear GW Memory Background : a Universal Infrared Spectrum for All GW*, Middle East Technical University Colloquium, **03/26, Ankara, Türkiye**

- (**invited**) *Detection of nHz Gravitational Waves Using Pulsar Timing Arrays*, Research Institute for Fundamental Sciences (TÜBİTAK TBAE), **02/26, Kocaeli, Türkiye**

(**invited**) *Nonlinear GW Memory Background : Universal Infrared Spectrum of All Gravitational Waves*, LISA GW Memory Group, **01/26, Remote talk**

- (**invited**) *Gravitational Waves and Stochastic Backgrounds*, Izmir Institute of Technology IZTECH, **10/25, Izmir, Türkiye**

- (**invited**) *Axions in the Early and Late Universe + Pulsar Timing Arrays and Fundamental Physics*, Heidelberg University, **06/24, Heidelberg, Germany**

- (**invited**) *Superradiance and Pulsar Timing Array Signatures of Bosons/Axions*, Bar-Ilan University, **06/24, Ramat Gan, Israel**

- (**invited**) *Primordial Black Holes in the Era of PTAs*, Institut Henri Poincaré Paris Workshop : Primordial Black Holes and Gravitational Waves, **11/23, Paris, France**

- (**invited**) *Axions in the Early and Late Universe*, Institute de Fisica Corpuscular (IFIC) of University of Valencia, **10/23, Valencia, Spain**

- (**invited**) *Axion-Gauge Dynamics During Inflation as the Origin of Pulsar Timing Array Signals and Primordial Black Holes*, Warsaw University Workshop : Early Universe cosmology with Gravitational Waves and Primordial Black Holes, **09/23, Warsaw, Poland**

- (**invited**) *A Tour or Potpourri : From Probing Small Scales of the Universe to Light Bosons*, CERN, **05/23, Meyrin, Switzerland**

[1] special scholarship for students ranked top 100 in the university exam

- (**invited**) *Probing scalar, vector and tensor ultralight dark matter with pulsar timing arrays*, Weizmann Institute, **03/23, Rehovot, Israel**

- (**invited**) *Scalar Induced GWs and non-Gaussianity*, INFN Padua Workshop : Messengers of the very early universe: gravitational waves and primordial black holes, **12/22, Padua, Italy**

- (**invited**) *Primordial non-Gaussianity from Induced GWs*, Technion Workshop : Extracting competitive constraints on primordial non-Gaussianity with future galaxy surveys, **12/22, Haifa, Israel**

- *Primordial non-Gaussianity in Scalar Induced GWs*, Madrid IFT Workshop : A Cosmic Window to Fundamental Physics: Primordial Non-Gaussianity and Beyond, **09/22, Madrid, Spain**

- (**invited**) *from Inflation, Axions, PBHs, GWs to AGN Spins and Ultralight Particles*, Tel Aviv University, **07/22, Tel Aviv, Israel**

- (**invited**)*Spin in Fundamental Plane of Black Hole Activity and Ultralight Particle Properties*, METU, **05/22, Ankara, Türkiye**

- (**invited**)*A tour from Inflation, axions, PBHs, GWs, primordial non-Gaussianity to Jets and Ultralight Bosons*, Weizmann Institute, **06/22, Rehovot, Israel**

- (**invited**)*Spin in Fundamental Plane of Black Hole Activity and Ultralight Particle Properties*, CEICO at Czech Academy of Sciences Institute of Physics, **05/22, Prague, Czech Republic**

- (**invited**)*A tour from PBHs, GWs, primordial non-Gaussianity and Small Scales of Inflation to Jets and Ultralight Bosons*, Bar-Ilan University, **03/22, Ramat-Gan, Israel**

- *Primordial Black Holes and Conclusive Tests via Multi-messenger Probes*, Aspen Center for Physics Workshop : Dynamical Formation of Gravitational Wave Sources, **01/22, Aspen, CO, USA**

- *Multi-messengers (Pulsar Timing Arrays and CMB Distortions) will Probe "Conclusively" Small Scales of Inflation and Primordial Black Holes*, Nanograv 2021 Fall Meeting, Vanderbilt University, **10/21, Nashville, TN, USA**

- (**invited**)*PBHs, GWs and Small Scales of Inflation*, Advanced Topics in Theoretical Physics 2021, **09/21, Virtual Meeting**

- (**invited**)*Probing Small Scales of Inflation, Primordial Black Holes and Stochastic Gravitational Waves at Interferometers*, Istanbul Theoretical Physics Days, **09/21, Istanbul, Türkiye**

- (**invited**)*The Ineludible Nonlinear Nature of the Primordial Black Hole Abundance*, GWVerse Global Meeting, **09/21, Lisbon, Portugal**

- (**invited**)*Probing Small Scales of Inflation and the Imprints of Primordial Non-Gaussianity on Gravitational Wave (GW) Spectrum*, Institute of Cosmology and Gravitation, University of Portsmouth **06/21, Portsmouth, UK**

- *Spin Dependence of Blandford-Znajek Jets and Fundamental Plane of BH Activity*, LISA Astrophysics Working Group Meeting, **05/21, Virtual Meeting**

- (**invited**)*Primordial GWs, and the Imprints of Primordial Non-Gaussianity on Gravitational Wave (GW) Spectrum*, Gravitational-Wave Primordial Cosmology Workshop, **05/21, Paris, France**

- *On the Spin Dependence of the Fundamental Plane of BH Activity*, Supermassive BH Conf., **12/20, Concepción, Chile**

- *Pulsar Timing Arrays and CMB Distortions as Multimessenger Probes of Inflationary Fluctuations and Primordial BHs*, ICTP-SAIFR Dark Matter Workshop, **12/20, São Paulo, Brazil**

- (**invited**) *Axion Inflation, Gravitational Waves at Interferometers and Primordial Black Holes*, Bogazici University, **12/19, Istanbul, Türkiye**

- (**invited**)*Probing Small Scales of Inflation and the Imprints of Primordial Non-Gaussianity on Gravitational Wave (GW) Spectrum*, Galileo Galilei Institute (GGI), **09/19, Florence, Italy**

- *Primordial Non-Gaussianity and Gravitational Waves*, LISA Cosmo WG, **09/19, Padua, Italy**

- *Imprints of Primordial Non-Gaussianity on GW Spectrum*, COSMO19, **09/19, Aachen, Germany**

- *Probing the Small Scales of Inflation via Gravitational Waves*, Harvard University (Dvorkin Group), **05/19, Cambridge, MA, USA**

- *Axion Inflation, Gravitational Waves at Interferometers and Primordial Black Holes*, UC San Diego, **04/19, San Diego, CA, USA**

- *Imprints of Primordial Non-Gaussianity on GW Spectrum*, APS April, **04/19, Denver, CO, USA**

- *Gravitational Wave Signatures of Inflationary Models producing Primordial Black Holes*, PASCOS2018, **06/18, Cleveland, OH, USA**

- *Gravitational Wave signatures of Inflationary Models from Primordial Black Hole Dark Matter*, COSMO17, **08/17, Paris, France**

- *Gravitational Waves in Axion Inflation: Implications for CMB and Small-Scales Interferometer Measurements*, APS April, **01/17, Washington DC, USA**

- *Testing the Link between GWs and Scale of Inflation*, COSMO16, **08/16, Ann Arbor, MI, USA**

- *Phenomenology for Axion Models*, University of Minnesota, **09/15, Minneapolis, MN, USA**

- *Expected Anisotropy in Solid Inflation*, ICTP Summer School on Cosmology, **08/14, Trieste, Italy**

6 REFERENCES

Marco Cirelli, Centre National de la Recherche Scientifique (CNRS), Paris, France

Juan Garcia-Bellido, Universidad Autonoma de Madrid, Madrid, Spain

Ely Kovetz, Ben-Gurion University, Be'er Sheva, Israel

Abraham Loeb, Harvard University, Cambridge, MA, USA

Marco Peloso, University of Padua, Padua, Italy (earlier University of Minnesota, MN, USA)

Antonio Riotto, University of Geneva, Geneva, Switzerland

Ignacy Sawicki, Czech Academy of Sciences, Prague, Czech Republic

Lorenzo Sorbo, University of Massachusetts, Amherst, MA, USA

Costas Skordis, Czech Academy of Sciences, Prague, Czech Republic

Bayram Tekin, Bilkent University, Ankara, Türkiye

Alexander Vikman, Czech Academy of Sciences, Prague, Czech Republic

7 MEMBERSHIPS, ACADEMIC AND PUBLIC SERVICE

Scientific Community Member : American Physical Society (**APS**), American Association for the Advancement of Science (**AAAS**),

Experiment Member : Laser Interferometer Space Antenna (**LISA**), North American Nanohertz Observatory for Gravitational Waves (**NANOGRAV**), Square Kilometer Array (**SKA**), Ultra-High Frequency Gravitational Wave Initiative, Cosmic Explorer (**CE**)

Referee : Journal of Cosmology and Astroparticle Physics (JCAP), Physical Review D (PRD), Physical

Review Letters (PRL), General Relativity and Gravitation (GERG), Monthly Notices of the Royal Astronomical Society (MNRAS)

Organizer : Multi-Messenger Winter Workshop @ Prague (MMWW2019), BGU Cosmology Talks

Math and science lecturer for disabled high school students

PUBLICATIONS (https://inspirehep.net/authors/1311789?ui-citation-summary=true)

In astrophysics, the author giving the most contribution becomes the first author. In theoretical particle physics and cosmology, authors are usually ordered according to their last names, independent of their contributions. In my all papers, independent of the order of my name, I am either the main author or did contribute similar level as the first author, except collaboration and white papers.

Citations : 2025 h-index : 16 (as of Oct 2026) (excluding collaboration and white papers)

1) "The Expected Anisotropy in Solid Inflation,"
JCAP **1411**, no. 11, 009 (2014)
(with N. Bartolo, M. Peloso and A. Ricciardone)

2) "Trajectories with Suppressed Tensor-to-scalar Ratio in Aligned Natural Inflation,"
JCAP **1506**, no. 06, 040 (2015)
(with M. Peloso)

3) "Scale-dependent Gravitational Waves from a Rolling Axion,"
JCAP **1601**, no. 01, 041 (2016)
(with R. Namba, M. Peloso, M. Shiraishi and L. Sorbo)

4) "Rolling Axions during Inflation:Perturbativity and Signatures,"
JCAP **1609**, no. 09, 001 (2016)
(with M. Peloso and L. Sorbo)

5) "Gravitational Waves at Interferometer Scales and Primordial Black Holes in Axion Inflation,"
JCAP **1612**, no. 12, 031 (2016)
(with J. Garcia-Bellido and M. Peloso)

6) "Gravitational Wave Signatures of Inflationary Models from Primordial Black Hole Dark Matter,"
JCAP **1709**, no. 09, 013 (2017)
(with J. Garcia-Bellido and M. Peloso)

7) "Nonlinear Perturbations from the Coupling of the Inflaton to a non-Abelian Gauge Field, with a Focus on Chromo-Natural Inflation,"
JCAP **1809**, no. 09, 030 (2018)
(with A. Papageorgiou and M. Peloso)

8) "Imprints of Primordial Non-Gaussianity on Gravitational Wave Spectrum,"
Phys. Rev. D **99**, no. 4, 041301(Rapid Comm.) (2019)
(single author)

9) "The Ineludible non-Gaussianity of the Primordial Black Hole Abundance,"
JCAP **1907**, 048 (2019)
(with V. De Luca, G. Franciolini, A. Kehagias, M. Peloso and A. Riotto)

10) "Nonlinear Perturbations from Axion-gauge Fields Dynamics during Inflation,"
JCAP **1907**, no. 07, 004 (2019)
(with A. Papageorgiou and M. Peloso)

11) "On Spin Dependence of the Fundamental Plane of Black Hole Activity,"
Mon. Not. Roy. Astron. Soc. **495**, no.1, 278-284 (2020)
(with A. Loeb)

12) "Multi-messenger Probes of Inflationary Fluctuations and Primordial Black Holes,"
Phys.Rev.D **103** no. 6, 063519 (2021)
(with E. D. Kovetz and S. P. Patil)

13) "Properties of Ultralight Bosons from Heavy Quasar Spins via Superradiance,"
JCAP **2105**, no. 05, 007 (2021)
(with F. Pacucci and A. Loeb)

14) "Unveiling cosmological information on small scales with line intensity mapping,"
Phys.Rev.D **106** (2022) 12, 123512
(with S. Libanore, D. Sarkar and E. D. Kovetz)

15) "Probing ultralight scalar, vector and tensor dark matter with pulsar timing arrays,"
Phys. Lett. B **855**, 138830 (2024)
(with E. D. Kovetz and F. Urban)

16) "Axion-gauge dynamics during inflation as the origin of pulsar timing array signals and primordial black holes,"
Phys. Lett. B **856**, 138873 (2024)
(with A. Papageorgiou, I. Obata)

17) "Accretion, Evaporation and Superradiance Phase Diagram of (Primordial) Black Holes and $10^{-21} - 10^{21}$ eV Scalar, Vector, Tensor Fields,"
Phys. Lett. B **864**, 139445 (2025)
(single author)

18) "Nonlinear Gravitational Wave Memory : Universal Low-Frequency Background,"
e-Print: 2511.08514 [gr-qc]
(with Doğa Veske)

Collaboration papers

19) "Prospects for Fundamental Physics with LISA,"
Gen.Rel.Grav. **52** (2020) 8, 81
(with LISA Fundamental Physics Group)

20) "Challenges and opportunities of gravitational-wave searches at MHz to GHz frequencies,"
Living Rev.Rel. 24 (2021) 1, 4 ,
(with High Frequency Gravitational Wave Initiative)

21) "Astrophysics with the Laser Interferometer Space Antenna,"
Living Rev.Rel. 26 (2023) 1, 2 ,
(with LISA Astrophysics Working Group)

22) "Cosmology with the Laser Interferometer Space Antenna,"
Living Rev.Rel. 26 (2023) 1, 5
(with LISA Cosmology Working Group)

23) "The NANOGrav 15 yr Data Set: Evidence for a Gravitational-wave Background,"
Astrophys.J.Lett. 951 (2023) 1, L8
(with NANOGrav)

24) "The NANOGrav 15 yr Data Set: Constraints on Supermassive Black Hole Binaries from the Gravitational-wave Background,"

Astrophys.J.Lett. 952 (2023) 2, L37
(with NANOGrav)

25) "The NANOGrav 15 yr Data Set: Detector Characterization and Noise Budget,"
Astrophys.J.Lett. 951 (2023) 1, L10
(with NANOGrav)

26) "The NANOGrav 15 yr Data Set: Bayesian Limits on Gravitational Waves from Individual Supermassive Black Hole Binaries,"
Astrophys.J.Lett. 951 (2023) 2, L50
(with NANOGrav)

27) " The NANOGrav 15 yr Data Set: Search for Signals from New Physics,"
Astrophys.J.Lett. 951 (2023) 1, L11
(with NANOGrav)

28) "The NANOGrav 15 yr Data Set: Observations and Timing of 68 Millisecond Pulsars,"
Astrophys.J.Lett. 951 (2023) 1, L9
(with NANOGrav)

29) "The NANOGrav 15 yr Data Set: Search for Anisotropy in the Gravitational-wave Background,"
Astrophys.J.Lett. 956 (2023) 1, L3
(with NANOGrav)

30) "The NANOGrav 15 yr Data Set: Running of the Spectral Index,"
Astrophys.J.Lett. 978 (2025) 2, L29
(with NANOGrav)

31) "The NANOGrav 15 yr data set: Posterior predictive checks for gravitational-wave detection with pulsar timing arrays,"
Phys.Rev.D 111 (2025) 4, 042011
(with NANOGrav)

32) "The NANOGrav 15 yr Data Set: Looking for Signs of Discreteness in the Gravitational-wave Background,"
Astrophys.J. 978 (2025) 1, 31
(with NANOGrav)

33) "Primordial black holes and their gravitational-wave signatures,"
Living Rev.Rel. 28 (2025) 1, 1
(with LISA Cosmology Working Group)

34) "The NANOGrav 15-year data set: Search for Transverse Polarization Modes in the Gravitational-Wave Background,"
Astrophys.J.Lett. 964 (2024) 1, L14
(with NANOGrav)

35) "The NANOGrav 12.5 yr Data Set: A Computationally Efficient Eccentric Binary Search Pipeline and Constraints on an Eccentric Supermassive Binary Candidate in 3C 66B,"
Astrophys.J. 963 (2024) 2, 144
(with NANOGrav)

36) "How to Detect an Astrophysical Nanohertz Gravitational-Wave Background,"
Astrophys.J. 959 (2023) 1, 9
(with NANOGrav)

37) "Comparing recent PTA results on the nanohertz stochastic gravitational wave background,"
Astrophys.J. 966 (2024) 1, 105
(with NANOGrav)

38) "The NANOGrav 12.5-year Data Set: Search for Gravitational Wave Memory,"
Astrophys.J. 963 (2024) 1, 61
(with NANOGrav)

39) "NANOGrav 15-year gravitational-wave background methods,"
Phys.Rev.D 109 (2024) 10, 103012
(with NANOGrav)

40) "Electromagnetic probes of primordial black holes as dark matter,"
e-Print: 1903.04424 [astro-ph.CO]
(Astro2020 Science White Paper)
41) "The NANOGrav 15 yr Data Set: Search for Gravitational-wave Memory,"
Astrophys.J. 987 (2025) 1, 5
(with NANOGrav)

42) "Challenges and opportunities of gravitational-wave searches above 10 kHz,"
Living Rev.Rel. 28 (2025) 1, 10, Living Rev.Rel. 28 (2025) 10
(with high frequency GW group)

43) "The NANOGrav 15 Yr Data Set: Removing Pulsars One by One from the Pulsar Timing Array,"
Astrophys.J. 978 (2025) 2, 168
(with NANOGrav)

44) "The NANOGrav 15 yr Data Set: Harmonic Analysis of the Pulsar Angular Correlations,"
Astrophys.J. 985 (2025) 1, 99
(with NANOGrav)

45) "Inference on inner galaxy structure via gravitational waves from supermassive binaries,"
Nature Astron. 10 (2026) 4, 554-563
(with NANOGrav)

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