

Caner Ünal

Department of Physics, Ben-Gurion University of the Negev

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1 RESEARCH AREA : Theoretical cosmology, astroparticle physics & gravitation

Primordial universe, cosmological perturbations, scattering amplitudes, axion physics, multi-messenger cosmology, stochastic gravitational wave backgrounds, primordial black holes, jet production in black holes and superradiance

2 CITIZENSHIP

Turkish , USA (Permanent Residence expected in 2025)

3 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
M.Sc. in Physics (attended until starting Ph.D. at UMN)
B.Sc. in Physics (High Honor, Double Major), Concentration: Theoretical Physics
B.Sc. in Electrical & Electronics Eng. (High Honor), Concentration: Control Theory

4 APPOINTMENTS

2024-2025 Harvard University, Cambridge, MA, USA
Visiting Researcher (Center for Astrophysics & Black Hole Initiative)

2024-2025 New York University, New York, NY, USA
Visiting Researcher (The Center for Cosmology and Particle Physics)

2020-2025 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

5 HONORS AND AWARDS

2024	73 rd Lindau Nobel Laureate Meetings
2021-2024	Excellence Fellow - Israel Academy of Sciences & Council of Higher Education
2021-2023	Kreitman Fellow - Ben-Gurion University
2020	70 th Lindau Nobel Laureate Meetings
2017	Aneesur Rahman Award - University of Minnesota
2016-2017	Doctoral Dissertation Fellowship - University of Minnesota
2011-2012	Outstanding Success Scholarship - Middle East Technical University
2007-2011	High Achievement Scholarship - Ministry of Education
2007	Ranked 79 th in nationwide exam among ~ 1.5 million candidates

6 SELECTED TALKS

- (**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**) *What is NANOGrAV and PTAs, what is measured and is it related to New Physics?*, Ben-Gurion University High Energy Theory Group, **07/23, Be'er Sheva, Israel**
- (**invited**) *A Tour or Potpourri : From Probing Small Scales of the Universe to Light Bosons*, CERN, **05/23, Meyrin, Switzerland**
- (**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 Astrophysics Meeting, **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**
- **(invited)** *Axion Inflation Models and Gravitational Waves*, METU, **05/17, Ankara, Türkiye**

- *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**

7 REFERENCES

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 / 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

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

8 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

Science outreach via public lectures, science festivals and observation nights

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 and did most of the work or did contribute similar level as the first author, except collaboration and white papers. The record below is without collaboration and white papers.

Citations : 1509 h-index : 14 (as of Sept 2024) (excl. 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)

Collaboration papers

17) “Prospects for Fundamental Physics with LISA,”

Gen.Rel.Grav. **52** (2020) 8, 81

(with LISA Fundamental Physics Group)

18) “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)

19) “Astrophysics with the Laser Interferometer Space Antenna,”

Living Rev.Rel. 26 (2023) 1, 2 ,

(with LISA Astrophysics Working Group)

20) “Cosmology with the Laser Interferometer Space Antenna,”

Living Rev.Rel. 26 (2023) 1, 5

(with LISA Cosmology Working Group)

21) “The NANOGrav 15 yr Data Set: Evidence for a Gravitational-wave Background,”

Astrophys.J.Lett. 951 (2023) 1, L8

(with NANOGrav)

22) “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)

23) “The NANOGrav 15 yr Data Set: Detector Characterization and Noise Budget,”

Astrophys.J.Lett. 951 (2023) 1, L10

(with NANOGrav)

- 24)** “The NANOGrav 15 yr Data Set: Bayesian Limits on Gravitational Waves from Individual Super-massive Black Hole Binaries,”
Astrophys.J.Lett. 951 (2023) 2, L50
(with NANOGrav)
- 25)** “ The NANOGrav 15 yr Data Set: Search for Signals from New Physics,”
Astrophys.J.Lett. 951 (2023) 1, L11
(with NANOGrav)
- 26)** “The NANOGrav 15 yr Data Set: Observations and Timing of 68 Millisecond Pulsars,”
Astrophys.J.Lett. 951 (2023) 1, L9
(with NANOGrav)
- 27)** “The NANOGrav 15 yr Data Set: Search for Anisotropy in the Gravitational-wave Background,”
Astrophys.J.Lett. 956 (2023) 1, L3
(with NANOGrav)

SUBMITTED

28) “Accretion, Evaporation and Superradiance Phase Diagram of (Primordial) Black Holes and $10^{-12} - 10^{21}$ eV Scalar, Vector, Tensor Fields,”
e-Print: 2301.08267 [hep-ph]
(single author)

Collaboration papers

29) “The NANOGrav 15 yr Data Set: Running of the Spectral Index,”
e-Print: 2408.10166 [astro-ph.HE]
(with NANOGrav)

30) “The NANOGrav 15 yr data set: Posterior predictive checks for gravitational-wave detection with pulsar timing arrays,”
e-Print: 2407.20510 [astro-ph.HE]pdf reference search2 citations
(with NANOGrav)

31) “The NANOGrav 15 yr Data Set: Looking for Signs of Discreteness in the Gravitational-wave Background,”
e-Print: 2404.07020 [astro-ph.HE]

32) “Primordial black holes and their gravitational-wave signatures,”
e-Print: 2310.19857 [astro-ph.CO]
(with LISA Cosmology Working Group)

33) “The NANOGrav 15-year data set: Search for Transverse Polarization Modes in the Gravitational-Wave Background,”
e-Print: 2310.12138 [gr-qc]
(with NANOGrav)

34) “The NANOGrav 12.5-year data set: Multi-messenger targeted search for gravitational waves from an eccentric supermassive binary in 3C 66B,”
e-Print: 2309.17438 [astro-ph.HE]
(with NANOGrav)

35) “How to Detect an Astrophysical Nanohertz Gravitational-Wave Background,”
e-Print: 2309.04443 [gr-qc]
(with NANOGrav)

36) “Comparing recent PTA results on the nanohertz stochastic gravitational wave background,”
e-Print: 2309.00693 [astro-ph.HE]
(with NANOGrav)

37) “The NANOGrav 12.5-year Data Set: Search for Gravitational Wave Memory,”
e-Print: 2307.13797 [gr-qc]
(with NANOGrav)

38) “The NANOGrav 15-year Gravitational-Wave Background Analysis Pipeline,”
e-Print: 2306.16223 [astro-ph.HE]
(with NANOGrav)

39) “Electromagnetic probes of primordial black holes as dark matter,”

e-Print: 1903.04424 [astro-ph.CO]
(Astro2020 Science White Paper)

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