Nashwan Sabti

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Summary

I am a postdoctoral researcher with a PhD in physics, passionate about advancing numerical and theoretical frameworks for addressing challenging problems at the intersection of physics, data science, and machine learning. Highly skilled in programming, engineering simulations, and analyzing data. Expert in Python, experienced with PyTorch, JAX, and machine learning, and with a 9+ years track record in high-performance computing. *Some metrics: Authored 16 articles with over 600 citations, developed 4 codes, supervised 3 PhD students and 2 MSc students, and presented research findings at 29 occasions.*

Work Experience

Horizon Postdoctoral Research Fellow *Johns Hopkins University, USA*

Advisor: Prof. Marc Kamionkowski *2022 - present*

Deeply immersed in the development of numerical frameworks in modern cosmology and astrophysics, spanning three main directions: **1)** building a multi-probe, high-performance Bayesian analysis (MCMC) pipeline tailored to investigate properties of the Universe using telescope data of young galaxies, **2)** leveraging machine-learning techniques to write GPU-accelerated gravity simulations, and **3)** applying deep-learning methods to optimize signal extraction in noisy astrophysical data.

Education

PhD in Physics *King's College London, UK*

Advisor: Prof. Diego Blas *2018 - 2022*

Research in fundamental physics, with an emphasis on developing numerical simulations and using cosmological, astrophysical, and laboratory probes to constrain particle physics and cosmological models. Thesis can be found here.

Master of Science in Theoretical Physics *Leiden University, Netherlands*

Thesis: "Heavy Neutral Leptons during the Big Bang Nucleosynthesis epoch" *2016 - 2018*

GPA: 9.0/10 (Cum Laude)

Double Bachelor of Science in Physics and Astronomy *Leiden University, Netherlands*

Thesis: "Constraining cosmological parameters using the CLASS code" *2013 - 2016*

GPA: 9.0/10 (Cum Laude) in both degrees

Technical Skills

Programming Languages:

- `Python`: 11+ years expertise in writing codes, pipelines, and packages, utilizing key libraries such as `NumPy`, `SciPy`, `Numba`, `emcee`, `Matplotlib`, `PyTorch`, and `JAX`.
- `Mathematica`: 5+ years proficiency in writing scientific software and crosslinking with `Python`.
- `C++`: 1+ years experience in writing `C++` code and wrapping within `Python` to accelerate simulations.

Software Development:

- `GALLUMI`: Multi-probe Bayesian analysis pipeline in `Python` designed for analyzing galaxy datasets.
- `Cheetah`: GPU-accelerated gravity simulation in `JAX`, achieving a speed increase of 500+ times.
- `pyBBN`: Code in `Python`, `C++`, and `Fortran` that simulates the early Universe during primordial nucleosynthesis.
- `samplex`: Package that includes useful inference algorithms written in MLX.

Machine learning: Experience in designing, training, and evaluating tailored neural network architectures for supervised and unsupervised learning on astrophysical data. Architectures include multilayer perceptrons, convolutional neural networks, graph neural networks, normalizing flows, autoencoders, and diffusion models.

HPC: 9+ years expertise in high-performance computing using both CPU and GPU platforms, including experience with tier-1 supercomputers. Proficient in `SLURM` workload manager and other HPC-specific software tools.

Other Experience

Referee for Science Journals
The Astrophysical Journal, Physical Review.

Supervision and Teaching
Supervising PhD and MSc students in their research and teaching undergraduate courses.

Seminars and Colloquiums
Organizor of the joint physics and astronomy seminar series at JHU and committee member for STScI colloquiums.

Extracurricular
Project lead for imaging analysis of the Cosmic Horseshoe lensing system using the Isaac Newton Telescope in La Palma.

Outreach
Mentoring of A-level students in the UK as part of the Realising Opportunities program.

Awards and Certificates

Hendrik Casimir Prize
Awarded by the Casimir Research School for best performance during the Master's program in physics.

Young Talent Encouragement Award
Awarded by the Royal Holland Society of Sciences and Humanities for best performance during the first year of the Bachelor's program in physics.

Languages

Fluent: English, Dutch
Intermediate: Arabic
Basic: Russian

References

- **Prof. Marc Kamionkowski** – Bloomberg Center for Physics and Astronomy, Johns Hopkins University, Baltimore, Maryland, USA, *kamion@jhu.edu*
- **Prof. Julian B. Muñoz** – Department of Astronomy, The University of Texas at Austin, Austin, Texas, USA, *julianbmunoz@utexas.edu*
- **Prof. Diego Blas** – Departament de Física, Universitat Autònoma de Barcelona, Institut de Fisica d'Altes Energies (IFAE), The Barcelona Institute of Science and Technology, Bellaterra, Spain, *dblas@ifae.es*
- **Prof. Malcolm Fairbairn** – Department of Physics, King's College London, London, UK, *malcolm.fairbairn@kcl.ac.uk*

Publications

Published

1. N. Sabti, J. B. Muñoz, and M. Kamionkowski, *Insights from HST into Ultra-Massive Galaxies and Early-Universe Cosmology*, Phys. Rev. Lett. 132, 061002 [2305.07049] (Highlighted as Editor's Suggestion).
2. S. C. Hotinli, N. Sabti, J. North, and M. Kamionkowski, *Unveiling Neutrino Halos with CMB Lensing*, Phys. Rev. D 108, 103504 [2306.15715].
3. J. B. Muñoz, J. Mirocha, S. Furlanetto, and N. Sabti, *Breaking degeneracies in the first galaxies with clustering*, MNRAS L. Vol. 526 Iss. 1 pp L47-L55 [2306.09403].

4. N. Sabti, J. B. Muñoz and D. Blas, *New Roads to the Small-Scale Universe: Measurements of the Clustering of Matter with the High-Redshift UV Galaxy Luminosity Function*, ApJL 928 L20 [2110.13161].
5. J. Alvey, M. Escudero and N. Sabti, *What can CMB observations tell us about the neutrino distribution function?*, JCAP 02 (2022) 037 [2111.12726].
6. J. Alvey, M. Escudero, N. Sabti and T. Schwetz, *Cosmic Neutrino Background Detection In Large-Neutrino-Mass Cosmologies*, Phys. Rev. D 105, 063501 [2111.14870].
7. N. Sabti, J. B. Muñoz and D. Blas, *GALLUMI: A Galaxy Luminosity Function Pipeline for Cosmology and Astrophysics*, Phys. Rev. D 105, 043518 [2110.13168].
8. N. Sabti, J. Alvey, M. Escudero, M. Fairbairn and D. Blas, *Implications of LUNA for BBN and CMB constraints on MeV-scale Thermal Dark Sectors*, JCAP 08 (2021) A01 [2107.11232].
9. A. Boyarsky, M. Ovchynnikov, N. Sabti and V. Syvolap, *When FIMPs Decay into Neutrinos: The $N_{\rm eff}$ Story*, Phys. Rev. D 104, 035006 [2103.09831].
10. J. Alvey, N. Sabti, V. Tiki, D. Blas, K. Bondarenko, A. Boyarsky, M. Escudero, M. Fairbairn, M. Orkney and J. I. Read, *New Constraints on the Mass of Fermionic Dark Matter from Dwarf Spheroidal Galaxies*, MNRAS 501 (2021) 1, pp. 1188-1201 [2010.03572].
11. N. Sabti, J. B. Muñoz and D. Blas, *First Constraints on Small-Scale Non-Gaussianity from UV Galaxy Luminosity Functions*, JCAP 01 (2021) 010 [2009.01245].
12. N. Sabti, A. Magalich and A. Filimonova, *An Extended Analysis of Heavy Neutral Leptons during Big Bang Nucleosynthesis*, JCAP 11 (2020) 056 [2006.07387].
13. J. Alvey, N. Sabti, M. Escudero and M. Fairbairn, *Improved BBN Constraints on the Variation of the Gravitational Constant*, Eur. Phys. J.C80.2 (2020), p. 148 [1910.10730].
14. N. Sabti, J. Alvey, M. Escudero, M. Fairbairn and D. Blas, *Refined Bounds on MeV-scale Thermal Dark Sectors from BBN and the CMB*, JCAP 01 (2020) 004 [1910.01649].

White papers

15. *EuCAPT White Paper: Opportunities and Challenges for Theoretical Astroparticle Physics in the Next Decade*, [2110.10074]. Contributed to the section 'Astroparticle observables for dark matter'.
16. *Snowmass2021 Cosmic Frontier White Paper: Dark Matter Physics from Halo Measurements*, [2203.07354]. Contributed to the section 'Ultraviolet luminosity function probes of dark matter'.

In the media

- *JWST Sees More Galaxies than Expected*, Physics Magazine.
- *JWST's Puzzling Early Galaxies Don't Break Cosmology—But They Do Bend Astrophysics*, Scientific American.

Presentations

Talks

1. California Institute of Technology, 02/12/2024
   – *Cosmology and the high-redshift Universe*
2. UT Austin, 11/13/2023
   – *Cosmology and the high-redshift Universe*
3. University of Florida, 10/31/2023
   – *Cosmology and the high-redshift Universe*
4. GRAPPA University of Amsterdam, 04/21/2023
   – *The GALLUMI ecosystem: A unified framework for cosmology with high-redshift galaxies*

5. Cosmic DAWN Center Copenhagen, 04/17/2023
   – *Cosmology with the high-redshift UV galaxy luminosity function*
6. Johns Hopkins lunch seminar, 05/12/2022
   – *What will it take to detect the Cosmic Neutrino Background?*
7. Harvard Physics seminar, 04/11/2022
   – *The GALLUMI ecosystem: A unified framework for cosmology with high-redshift galaxies*
8. Harvard-Smithsonian Center for Astrophysics, 03/11/2022
   – *The GALLUMI ecosystem: A unified framework for cosmology with high-redshift galaxies*
9. Cosmological Probes of New Physics Univeristy of Maryland, 16/09/2022
   – *New Roads to the Small-Scale Universe: Measurements of the Clustering of Matter with the High-Redshift UV Galaxy Luminosity Function*
10. Circle University meeting, 08/06/2022
    – *What will it take to detect the Cosmic Neutrino Background?*
11. Seminar at IFAE and UAB, 17/05/2022
    – *What will it take to detect the Cosmic Neutrino Background?*
12. Cosmolunch at Princeton IAS, 07/03/2022
    – *New Roads to the Small-Scale Universe: Measurements of the Clustering of Matter with the High-Redshift UV Galaxy Luminosity Function*
13. Cosmo/Astro coffee at Princeton University/IAS, 07/03/2022
    – *Cosmology with UV Galaxy Luminosity Functions*
14. Sazerac - learning the high-redshift Universe, 02/02/2022
    – *GALLUMI: A Galaxy Luminosity Function Pipeline for Cosmology and Astrophysics*
15. Seminar at ICCUB, Barcelona, 18/11/2021
    – *New Roads to the Small-Scale Universe: Measurements of the Clustering of Matter with the High-Redshift UV Galaxy Luminosity Function*
16. Seminar at Universitá degli Studi di Padova, 11/11/2021
    – *New Roads to the Small-Scale Universe: Measurements of the Clustering of Matter with the High-Redshift UV Galaxy Luminosity Function*
17. Seminar at SNS, Pisa, 10/11/2021
    – *New Roads to the Small-Scale Universe: Measurements of the Clustering of Matter with the High-Redshift UV Galaxy Luminosity Function*
18. BSM Pandemic, 9/11/2021
    – *New Roads to the Small-Scale Universe: Measurements of the Clustering of Matter with the High-Redshift UV Galaxy Luminosity Function*
19. Seminar at IFPU in Trieste, 27/10/2021
    – *Astrophysical Probes of Dark Matter*
20. Seminar at Perimeter Institute, 19/10/2021
    – *Cosmological and Astrophysical Probes of Sterile Neutrinos*
21. 2021 Meeting of the Division of Particles and Fields of the American Physical Society (DPF21), Florida State University, 13/07/2021
    – *When FIMPs Decay into Neutrinos: The $N_{\rm eff}$ Story*
22. PPC 2021: XIV International Workshop on Interconnections between Particle Physics and Cosmology, University of Oklahoma, 15/05/2021
    – *Cosmology with UV Luminosity Functions*

23. First EuCAPT Annual Symposium, 06/05/2021
    – *Cosmology with UV Luminosity Functions*
24. MPA Cosmology Seminar, MPA Garching, 30/03/2021
    – *Probing Small-Scale Non-Gaussianity with UV Luminosity Functions*
25. High-z Galaxy Evolution Meeting, Harvard-CfA, 08/02/2021
    – *Cosmology with UV Luminosity Functions*
26. KCL PhD Seminar Series, 08/02/2021
    – *How do FIMPs that can decay into neutrinos affect $N_{\rm eff}$?*
27. London Cosmology Discussion Meeting, 21/01/2021
    – *What BBN can tell us about thermal dark sectors*
28. CTA Dark Matter Journal Club, 12/11/2020
    – *New Constraints on the Mass of Fermionic Dark Matter from Dwarf Spheroidal Galaxies*
29. UK Cosmology, University of Sheffield, 22/09/2020
    – *Probing Small-Scale Non-Gaussianity with UV Galaxy Luminosity Functions*

Posters

1. COSMO 2021, University of Illinois, 02-06/08/2021
   – *When FIMPs Decay into Neutrinos: The $N_{\rm eff}$ Story*
2. Weak Interactions and Neutrinos 2021, University of Minnesota. 07-12/06/2021
   – *When FIMPs Decay into Neutrinos: The $N_{\rm eff}$ Story*
3. RAS Early Career Poster Exhibition 2020, 14-28/09/2020
   – *First Constraints on Small-Scale Non-Gaussianity from UV Galaxy Luminosity Functions*