

# 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 JAX, PyTorch, and machine learning, and with an 8+ years track record in high-performance computing. *Some metrics: Authored 16 articles with nearly 600 citations, developed 3 codes, supervised 3 PhD students and 2 MSc students, and presented research findings at 28 occasions.*

## Work Experience

### Horizon Postdoctoral Research Fellow

ADVISOR: PROF. MARC KAMIONKOWSKI

Johns Hopkins University, USA

2022 - present

Deeply immersed in the development of numerical and theoretical 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 observations of young galaxies, **2)** leveraging machine-learning techniques to write GPU-accelerated gravity simulations and optimize signal extraction in noisy astrophysical data, and **3)** studying the potential of atomic quantum systems, such as atomic interferometers, in fundamental physics searches.

## Education

### PhD in Physics

ADVISOR: PROF. DIEGO BLAS

King's College London, UK

2018 - 2022

Research in fundamental physics, with an emphasis on utilizing numerical simulations together with cosmological, astrophysical, and laboratory probes to constrain particle physics and cosmological models. Thesis can be found [here](#).

### Master of Science in Theoretical Physics

THESIS: "HEAVY NEUTRAL LEPTONS DURING THE BIG BANG NUCLEOSYNTHESIS EPOCH"

Leiden University, Netherlands

GPA: 9.0/10 (Cum Laude)

2016 - 2018

### Double Bachelor of Science in Physics and Astronomy

THESIS: "CONSTRAINING COSMOLOGICAL PARAMETERS USING THE CLASS CODE"

Leiden University, Netherlands

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

2013 - 2016

## Technical Skills

### Programming languages:

- **Python:** Extensive decade-long expertise in writing analysis 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++:** Experience in writing C++ code and wrapping within Python to accelerate simulations.

### Software:

- **Developer:** pyBBN (package in Python, C++, and Fortran to model the early Universe), GALLUMI (Pipeline in Python to analyze galaxy datasets), Cheetah (GPU-accelerated gravity simulation in JAX)
- **User:** CLASS, CAMB, MontePython, PRIMAT, Resonance-DM, Sterile-DM, CalcHEP

**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, normalizing flows, autoencoders, diffusion models, and transformers.

**HPC:** 8+ 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

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### 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

Organizer 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

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### 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

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**Fluent:** English, Dutch

**Intermediate:** Arabic

**Basic:** Russian

## References

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

## Publications

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### Published

1. S. C. Hotinli, [N. Sabti](#), J. North, and M. Kamionkowski, *Unveiling Neutrino Halos with CMB Lensing*, **Phys. Rev. D** **108**, 103504 [2306.15715].
2. 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].

3. [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 \[2110.13161\]](#).
4. J. Alvey, M. Escudero and [N. Sabti](#), *What can CMB observations tell us about the neutrino distribution function?*, [JCAP 02 \(2022\) 037 \[2111.12726\]](#).
5. J. Alvey, M. Escudero, [N. Sabti](#) and T. Schwetz, *Cosmic Neutrino Background Detection In Large-Neutrino-Mass Cosmologies*, [Phys. Rev. D 105, 063501 \[2111.14870\]](#).
6. [N. Sabti](#), J. B. Muñoz and D. Blas, *GALLUMI: A Galaxy Luminosity Function Pipeline for Cosmology and Astrophysics*, [Phys. Rev. D 105, 043518 \[2110.13168\]](#).
7. [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 \[2107.11232\]](#).
8. A. Boyarsky, M. Ovchinnikov, [N. Sabti](#) and V. Syvolap, *When FIMPs Decay into Neutrinos: The  $N_{\text{eff}}$  Story*, [Phys. Rev. D 104, 035006 \[2103.09831\]](#).
9. 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 \[2010.03572\]](#).
10. [N. Sabti](#), J. B. Muñoz and D. Blas, *First Constraints on Small-Scale Non-Gaussianity from UV Galaxy Luminosity Functions*, [JCAP 01 \(2021\) 010 \[2009.01245\]](#).
11. [N. Sabti](#), A. Magalich and A. Filimonova, *An Extended Analysis of Heavy Neutral Leptons during Big Bang Nucleosynthesis*, [JCAP 11 \(2020\) 056 \[2006.07387\]](#).
12. 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 \[1910.10730\]](#).
13. [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 \[1910.01649\]](#).

### Submitted to journal

14. [N. Sabti](#), J. B. Muñoz, and M. Kamionkowski, *Insights from HST into Ultra-Massive Galaxies and Early-Universe Cosmology*, [\[2305.07049\]](#) (accepted for publication in Physical Review Letters).

### 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’.

## Presentations

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### Talks

1. UT Austin, 11/13/2023  
– *Cosmology and the high-redshift Universe*
2. University of Florida, 10/31/2023  
– *Cosmology and the high-redshift Universe*
3. GRAPPA University of Amsterdam, 04/21/2023  
– *The GALLUMI ecosystem: A unified framework for cosmology with high-redshift galaxies*
4. Cosmic DAWN Center Copenhagen, 04/17/2023  
– *Cosmology with the high-redshift UV galaxy luminosity function*

5. Johns Hopkins lunch seminar, 05/12/2022  
– *What will it take to detect the Cosmic Neutrino Background?*
6. Harvard Physics seminar, 04/11/2022  
– *The GALLUMI ecosystem: A unified framework for cosmology with high-redshift galaxies*
7. Harvard-Smithsonian Center for Astrophysics, 03/11/2022  
– *The GALLUMI ecosystem: A unified framework for cosmology with high-redshift galaxies*
8. Cosmological Probes of New Physics University 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*
9. Circle University meeting, 08/06/2022  
– *What will it take to detect the Cosmic Neutrino Background?*
10. Seminar at IFAE and UAB, 17/05/2022  
– *What will it take to detect the Cosmic Neutrino Background?*
11. 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*
12. Cosmo/Astro coffee at Princeton University/IAS, 07/03/2022  
– *Cosmology with UV Galaxy Luminosity Functions*
13. Sazerac - learning the high-redshift Universe, 02/02/2022  
– *GALLUMI: A Galaxy Luminosity Function Pipeline for Cosmology and Astrophysics*
14. 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*
15. Seminar at Università 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*
16. 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*
17. 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*
18. Seminar at IFPU in Trieste, 27/10/2021  
– *Astrophysical Probes of Dark Matter*
19. Seminar at Perimeter Institute, 19/10/2021  
– *Cosmological and Astrophysical Probes of Sterile Neutrinos*
20. 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  $N_{\text{eff}}$  Story*
21. PPC 2021: XIV International Workshop on Interconnections between Particle Physics and Cosmology, University of Oklahoma, 15/05/2021  
– *Cosmology with UV Luminosity Functions*
22. First EuCAPT Annual Symposium, 06/05/2021  
– *Cosmology with UV Luminosity Functions*

23. MPA Cosmology Seminar, MPA Garching, 30/03/2021  
– *Probing Small-Scale Non-Gaussianity with UV Luminosity Functions*
24. High-z Galaxy Evolution Meeting, Harvard-CfA, 08/02/2021  
– *Cosmology with UV Luminosity Functions*
25. KCL PhD Seminar Series, 08/02/2021  
– *How do FIMPs that can decay into neutrinos affect  $N_{\text{eff}}$ ?*
26. London Cosmology Discussion Meeting, 21/01/2021  
– *What BBN can tell us about thermal dark sectors*
27. CTA Dark Matter Journal Club, 12/11/2020  
– *New Constraints on the Mass of Fermionic Dark Matter from Dwarf Spheroidal Galaxies*
28. 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  $N_{\text{eff}}$  Story*
2. Weak Interactions and Neutrinos 2021, University of Minnesota. 07-12/06/2021  
– *When FIMPs Decay into Neutrinos: The  $N_{\text{eff}}$  Story*
3. RAS Early Career Poster Exhibition 2020, 14-28/09/2020  
– *First Constraints on Small-Scale Non-Gaussianity from UV Galaxy Luminosity Functions*