SIMONE PARADISO

simone.paradiso@outlook.it
Link to my personal website

RESEARCH EXPERIENCE

INAF - OAS June 2024 - current
Postdoctoral Fellow *Bologna, Italy*

· Investigating cosmic birefringence from CMB polarization data;
· Development of novel statistical estimators to extract information on new physics from CMB polarization data.

Waterloo Centre for Astrophysics - University of Waterloo January 2023 - June 2024
Postdoctoral Fellow *Waterloo, ON, Canada*

· Development of novel statistical techniques in Cosmology;
· Undergraduate students co-tutoring.

University of Milan October 2021 - December 2022
Postdoctoral Fellow *Milan, Italy*

· Q and U Bolometric Interferometer for Cosmology (QUBIC) data analysis and forecasting. Component separation.
· Large Scale Polarisation Explorer (LSPE) project data analysis: forecasts on cosmological parameters constraints and component separation using a Bayesian approach (commander).
· LSPE-STRIP data analysis: atmospheric contribution characterisation, mapmaking, forecasts on cosmological parameters constraints.

EDUCATION

University of Milan October 2021
Ph.D. in Physics, Astrophysics and Applied Physics
Thesis advisor: Davide Maino
Thesis co-advisor : Loris Colombo
Thesis title : CMB Likelihood and Cosmological Parameter estimation in a Bayesian end-to-end framework
Milan, Italy

· BeyondPlanck
· CMB maps production and quality assessment; CMB mask definition.
· Reionisation history modelling from CMB polarisation data.
· Angular power spectrum estimation from CMB maps.
· Likelihood implementation for CMB data within the BeyondPlanck framework.
· Cosmological parameter estimation.

University of Rome "La Sapienza" October 2016
MS in Astronomy and Astrophysics
Thesis advisor: Alessandro Melchiorri
Thesis title : Constraints on Cosmological Parameters from CMB and Weak Lensing surveys
Grade: 110 cum laude - 1st class honours equivalent
Rome, Italy

· Cosmological parameters forecasts for the CORE project proposal.

University of Rome "La Sapienza" December 2014
BS in Physics and Astrophysics
Thesis advisor: Paolo De Bernardis
Thesis title : Astrophysical evidence of Dark Matter
Rome, Italy

· Galaxy rotation curves, galaxy velocity dispersion in clusters, Galaxy haloes.

INTERNATIONAL PROJECTS AND COLLABORATIONS

During my Masters thesis, I contributed to the scientific forecasting efforts for the proposed CMB satellite mission *CORE*, resulting in two publicationsone of which I authored as first author on scientific forecasts.

As a graduate student, I joined the *BeyondPlanck* collaboration, which aimed to establish a new standard for CMB data analysis through a fully Bayesian end-to-end framework. My main responsibilities included generating CMB maps from *Planck* LFI data, implementing the cosmological likelihood pipeline, and deriving updated constraints on cosmological parameters. I also investigated CMB polarization signatures related to the reionization history of the Universe, although these were not included in the final analysis due to the limited sensitivity of *Planck* LFI.

During my postdoctoral appointments at the University of Milan and later at the University of Waterloo (Canada), I continued my involvement with the *Cosmoglobe* collaboration. I contributed to the first data release (DRI) by producing CMB temperature maps, power spectra, and cosmological parameter estimates based on *Planck* LFI and *WMAP* data.

In parallel, I was involved with the *QUBIC* and *LSPE/STRIP* CMB experiments. My work focused on implementing and developing data analysis pipelines, with particular emphasis on map-making, component separation, and parameter estimation. I also produced scientific forecasts that led to multiple publications.

During 2025 I have contributed to the DESI DRII cosmological parameters from the full shape analysis of Cluster measurements paper as external collaborator. In particular, I have brought the expertise on the Generalized Additive Model (GAM) methodology to remove projection effects from the cosmological analysis in presence of Effective Field Theory nuisance parameters.

I am currently a member of the *LiteBIRD* collaboration, a future space mission targeting large-scale CMB polarization. My contributions center on the development of the analysis pipeline, the production of forecasts for cosmic birefringence measurements, and the investigation of large-scale CMB anomalies.

In addition, I remain an active member of the *Cosmoglobe* collaboration, now extending the *BeyondPlanck* methodology to the entire electromagnetic spectrum and the full *Planck* dataset, including both LFI and HFI data.

Detail of my involvement in international collaborations:

The Large Scale Polarization Explorer (LSPE) - STRIP 2018 - Present
Ground based segment of the LSPE CMB experiment. *CMB experiment*

· Data analysis, component separation, likelihood and cosmological parameters.

Q and U Bolometric Interferometer for Cosmology (QUBIC) 2020 - Present
Ground based CMB experiment based on boloometric interferometry. *CMB experiment*

· Data analysis, component separation, likelihood and cosmological parameters.

LiteBIRD 2025 - Present
CMB measurement from space. *CMB experiment*

· Cosmic birefringence.

DESI 2025 - Present

· External collaborator for the cosmological constraints paper from Full shape analysis clustering measurements (DR2).

Cosmoglobe 2021 - Present
Development of CMB an end-to-end Bayesian analysis framework *Collaboration*

· link to website
· Likelihood methods, CMB maps, Cosmological Parameters estimation.

BeyondPlanck 2018 - 2022
Development of CMB an end-to-end Bayesian analysis framework for Planck-LFI data *Collaboration*

· link to website
· Likelihood methods, CMB maps, Cosmological Parameters estimation.

TEACHING EXPERIENCE

Throughout my Graduate program at the University of Milan I have been assisting as a teaching assistant (art. 45) in the field of scientific computing, astronomy and statistics. During my postdoc at University of Waterloo (Ontario), I have been 1) directly responsible of organizing and teaching a Graduate-held course for Graduate students on statistical topics in Cosmology and Astrophysics and, 2) supervising a Graduate student from the dept. of Statistics and Actuarial sciences and an undergraduate student from the dept. of Physics and Astronomy on a co-op project on novel statistical methods in cosmology.

University of Waterloo 2023 - 2024
Undergraduate tutoring *Waterloo, Ontario, Canada*

· Co-op co-supervising on statistics and cosmology related topics:

1. Exploring cosmological likelihoods and statistical techniques to analyze SNIa and investigate the Hubble tension. Posterior predictive check, likelihood coarsening, cosmological likelihood modifications.

2. Implementing an importance sampling based Bayesian model averaging to analyze cosmological dataset and marginalize over the cosmological model uncertainty. Exploring Early dark energy as a possible solution to the Hubble tension.

· PHYS-437 Lab course co-tutoring: development of a RJ-MCMC for cosmological applications.

University of Waterloo 2024
Statistical tools for Astronomers. PHYS 788 *Waterloo, Ontario, Canada*

· Frequentist statistics.
· General Bayesian statistics and ML.
· Application to Cosmology and Astrophysics.

University of Milan 2019 - 2022
Graduate teaching assistant *Milan, Italy*

· Numerical data treatment laboratory.
· Astronomy laboratory.
· Data modelling laboratory.

THESIS ADVISOR/CO-ADVISOR

Since the end of my PhD I have actively contributed to the supervising work of both Graduate and under-Graduate students. In particular, I have been unofficially co-supervising a Graduate student at the University of Milan with a thesis in the context of the CMB experiment QUBIC, and specifically on the data analysis and simulation pipeline. I am currently supporting the thesis work of a Graduate student at INAF-OAS and University of Ferrara by producing and co-supervising the CMB analysis and simulation necessary to the PhD thesis work.

University of Milan 2022
Undergraduate thesis co-advisor *Milan, Italy*

· Title: Characterization of Planck-LFI detector behaviour using the final BeyondPlanck data release.

University of Milan 2022
Master thesis co-advisor *Milan, Italy*

· Title: Component separation in Cosmic Microwave Background B-modes experiments involving Bolometric Interferometry.

University of Milan 2021
Undergraduate thesis co-advisor *Milan, Italy*

· Title: Study of time dependance of Planck-LFI detector properties.

INVITED CONTRIBUTIONS

Hints of new physics from CMB polarization measurement 25/3/2025
Hot topics in Modern Cosmology – Spontaneous Workshop XVII
Institute of Scientific Studies of Cargèse (IESC) *Cargèse, FR*

· Invited talk. Link to the conference webpage.

Advancing cosmological data analysis:
reducing biases and including model choice as a source of uncertainty. 20/1/2025
University of Milan, Astro seminar *Milano, IT*

· Invited talk.

CMB analysis within a Bayesian end-to-end framework 23/2/2023
Waterloo Centre for Astrophysics Astroseminar *Waterloo, ON, Canada*

· Invited talk.

CMB constraints with end-to-end error propagation 7/6/2021
Cosmoglobe Kick-off meting *Online*

· Invited talk - Presentation of BeyondPlanck results.

CMB analysis with end-to-end error propagation: Likelihood and cosmological parameters
19/11/2020
BeyondPlanck release conference *Online*

· Invited talk - Presentation of BeyondPlanck results.
· Link to the talk recording
· Link to the slides

PARTICIPATION TO CONFERENCES, SCHOOLS AND WORKSHOPS

The cosmological analysis of Planck LFI raw data from BeyondPlanck and Beyond 7/7/2024 - 12/7/2024
17th Marcel Grossmann meeting *Pescara, IT*

· Conference talk.

Introducing Bayesian Model Averaging to include model uncertainty in our cosmological parameters' estimates 7/7/2024 - 12/7/2024
17th Marcel Grossmann meeting *Pescara,IT*

· Conference talk.

CMB likelihood implementation for BeyondPlanck September 2020
Ph.D. seminar *Dept. of Physics, University of Milan, Milan, Italy*

· Presentation of the BeyondPlanck likelihood implementation (methodological aspects).

Probing the reionisation history of the universe with CMB polarisation data September 2019
Ph.D. seminar *Dept. of Physics, University of Milan, MIlan, Italy*

· A review of methodologies to probe the reionisation history of the Universe through CMB data, including an original technique.

Poster: Models for studying the reionisation history of the Universe with CMB polarisation data 18/6/2019
10th Young researcher meeting *Rome, Italy*

· A review of methodologies to probe the reionisation history of the Universe through CMB data, including an original technique.

Workshops:

1. **Surveys 2 Discoveries Conference.** Montreal, Canada. 16/5/2023 - 18/5/2023

Summer/Winter Schools:

1. **Cosmological component separation course.** Oslo, Norway. August 19th-30th, 2019.
2. **ISAPP 2023: Neutrino physics, astrophysics and cosmology.** Varenna, Italy. June, 27th - July, 6th, 2023.

EDI AND OUTREACH

University of Waterloo 2023 - 2024
EDI Journal Club *Waterloo, Canada*

· Journal Club on EDI topics carried on by postdocs on a weekly basis.

University of Waterloo 2023 - 2024
Grad/Undergrad mentoring program *Waterloo, Canada*

· Term-lasting mentoring program with graduate and undergraduate students, oriented to improve the quality of work environment.

Planetario di Milano "Ulrico Hoepli" 2019 - 2023
Public lecturer *Milan, Italy*

· Public lectures on Cosmology and Astrophysics (Podcast):

- "La (molto) lunga evoluzione dell'Universo in una sera".

- "I primi tre minuti dell'Universo"
- "Dove e quando? Evoluzione della Fisica dal determinismo allindeterminazione".

INDUSTRY EXPERIENCE

Edison s.p.a. November 2016 - November 2017
Data Scientist *Milan, Italy*

· Neural networks, Machine learning, Meteorological forecasts, Renewable energy production forecasting, Gas employment forecasting.

Freeda Media November 2017 - February 2018
Data Scientist *Milan, Italy*

· Neural networks, Machine learning, Social network algorithm, digital content impact forecasting.

TECHNICAL STRENGTHS

Coding Languages	Fortran, IDL, Python
Python packages	numpy, matplotlib, scipy, pandas, seaborn, MCMC tools, ML tools
Database	SQL
Tools	Vim, Emacs
Cosmology tools	CAMB, CosmoMC, Commander1, Commander3, Healpix, PySM, Cobaya

PUBLICATIONS

I have a total of 35 publications (31 refereed), divided in 33 papers and 2 proceedings, with a total of 607 refereed citations and a h-index of 16 (15 refereed)–as of May, 2025 - source: NasaADS)..

In the last two years I have produced first author and first-tier author publication on statistical cosmology (focusing on the model uncertainty marginalization in Cosmology within a Bayesian framework), and application of novel statistical techniques to the cosmological analysis of large scale structure data–with a focus on the upcoming new observations on the field.

My contributions in collaborations and many-authors papers have been:

- In the **CORE papers (2018)** I gave my contribution by computing Fisher forecasts on cosmological parameters and some LCDM extensions.
- My involvement in the **LSPE** collaboration paper is in the Fisher forecasts analysis aiming to detecting primordial B-modes with the LSPE instruments. I also performed several analyses for LSPE-STRIP to assess component separation and CMB reconstruction performances.
- In the **BeyondPlanck papers**, I have been responsible to carry on the full cosmological analysis described in BeyonPlanck XII. Moreover, I gave an active and major contribution to the CMB maps estimation and quality assessment, as well as in many aspects of the Commander III component separation (BeyondPlanck I, X, XI).
- I have been responsible to produce CMB maps, cosmological parameters constraints and power spectra estimates for **Cosmoglobe DRI**.
- I have given a significant contribution to Regnier et al. (2023) by co-tutoring the two first-tier authors Manzan, E. and Zapelli, L. in their PhD and Master thesis respectively during their work for this paper.
- I have been involved in the **cosmoverse** white paper to contribute to the writing of CMB-related section.

List of papers:

34. *The CosmoVerse White Paper: Addressing observational tensions in cosmology with systematics and fundamental physics*
Eleonora Di Valentino, Jackson Levi Said, Adam Riess, Agnieszka Pollo, Vivian Poulin, Adri Gmez-Valent, Amanda Weltman, Antonella Palmese et al.
arXiv e-prints, arXiv:2504.01669 (2025) – Accepted by Physics of the Dark Universe

33. *Reducing nuisance prior sensitivity via non-linear reparameterization, with application to EFT analyses of large-scale structure*
S. Paradiso, M. Bonici, M. Chen, W. J. Percival, G. D'Amico, H. Zhang, G. McGee
arXiv e-prints, arXiv:2412.03503 (2024) - Accepted by JCAP

32. *Evaluating extensions to LCDM: an application of Bayesian model averaging and selection*
S. Paradiso, G. McGee, W. J. Percival
Journal of Cosmology and Astroparticle Physics, 2024, 021 (2024)

31. *HOD-informed prior for EFT-based full-shape analyses of LSS*
Hanyu Zhang, Marco Bonici, Guido D'Amico, **Simone Paradiso**, Will J. Percival
Journal of Cosmology and Astroparticle Physics, 2025, 041 (2025)

30. *Identifying frequency decorrelated dust residuals in B-mode maps by exploiting the spectral capability of bolometric interferometry*
M. Regnier, E. Manzan, J. -Ch Hamilton, A. Mennella, J. Errard, L. Zapelli, S. A. Torchinsky, **S. Paradiso** +16 co-authors
Astronomy and Astrophysics, 686, A271 (2024)

29. *The advantage of Bolometric Interferometry for controlling Galactic foreground contamination in CMB primordial B-modes measurements*
E. Manzan, M. Regnier, J-Ch. Hamilton, A. Mennella, J. Errard, L. Zapelli, S. A. Torchinsky, **S. Paradiso** +13 co-authors
mm Universe 2023 - Observing the Universe at mm Wavelengths, 293, 00029 (2024)

28. *LSPE-STRIP on-sky calibration strategy using bright celestial sources*
R. T. Génova-Santos, M. Bersanelli, C. Franceschet, M. Gervasi, C. López-Caraballo, L. Mandelli, M. Maris, A. Mennella +16 co-authors
Journal of Instrumentation, 19, P06016 (2024)

27. *Cosmological measurements from the CMB and BAO are insensitive to the tail probability in the assumed likelihood*
Jordan Krywonos, **Simone Paradiso**, Alex Krolewski, Shahab Joudaki, Will Percival
Journal of Cosmology and Astroparticle Physics, 2024, 015 (2024)

26. *A convenient approach to characterizing model uncertainty with application to early dark energy solutions of the Hubble tension*
S. Paradiso, M. DiMarco, M. Chen, G. McGee, W. J. Percival
Monthly Notices of the Royal Astronomical Society, 528, 1531 (2024)

25. *Cosmoglobe DR1 results. I. Improved Wilkinson Microwave Anisotropy Probe maps through Bayesian end-to-end analysis*
D. J. Watts, A. Basyrov, J. R. Eskilt, M. Galloway, L. T. Hergt, D. Herman, H. T. Ihle, **S. Paradiso** +25 co-authors
Astronomy and Astrophysics, 679, A143 (2023)

24. *Cosmoglobe DR1 results. II. Constraints on isotropic cosmic birefringence from reprocessed WMAP and Planck LFI data*
J. R. Eskilt, D. J. Watts, R. Aurlien, A. Basyrov, M. Bersanelli, M. Brilenkov, L. P. L. Colombo,

H. K. Eriksen +23 co-authors
Astronomy and Astrophysics, 679, A144 (2023)

23. *Measuring the CMB primordial B-modes with Bolometric Interferometry*
A. Mennella, P. Ade, A. Almela, G. Amico, L. H. Arnaldi, J. Aumont, S. Banfi, E. S. Battistelli +106 co-authors
arXiv e-prints, arXiv:2311.02779 (2023)

22. *Cosmoglobe: Towards end-to-end CMB cosmological parameter estimation without likelihood approximations*
J. R. Eskilt, K. Lee, D. J. Watts, V. Anshul, R. Aurlien, A. Basyrov, M. Bersanelli, L. P. L. Colombo +15 co-authors
Astronomy and Astrophysics, 678, A169 (2023)

21. *BeyondPlanck I. Global Bayesian analysis of the Planck Low Frequency Instrument data*
[BeyondPlanck Collaboration], K. J. Andersen, R. Aurlien, R. Banerji, A. Basyrov, M. Bersanelli, S. Bertocco, M. Brilenkov +37 co-authors
Astronomy and Astrophysics, 675, A1 (2023)

20. *BeyondPlanck II. CMB map-making through Gibbs sampling*
E. Keihänen, A. -S. Suur-Uski, K. J. Andersen, R. Aurlien, R. Banerji, M. Bersanelli, S. Bertocco, M. Brilenkov +32 co-authors
Astronomy and Astrophysics, 675, A2 (2023)

19. *BeyondPlanck VII. Bayesian estimation of gain and absolute calibration for CMB experiments*
E. Gjerløw, H. T. Ihle, S. Galeotta, K. J. Andersen, R. Aurlien, R. Banerji, M. Bersanelli, S. Bertocco +30 co-authors
Astronomy and Astrophysics, 675, A7 (2023)

18. *BeyondPlanck VI. Noise characterization and modelling*
H. T. Ihle, M. Bersanelli, C. Franceschet, E. Gjerløw, K. J. Andersen, R. Aurlien, R. Banerji, S. Bertocco +33 co-authors
Astronomy and Astrophysics, 675, A6 (2023)

17. *BeyondPlanck XIV. Polarized foreground emission between 30 and 70GHz*
T. L. Svalheim, K. J. Andersen, R. Aurlien, R. Banerji, M. Bersanelli, S. Bertocco, M. Brilenkov, M. Carbone +30 co-authors
Astronomy and Astrophysics, 675, A14 (2023)

16. *BeyondPlanck X. Bandpass and beam leakage corrections*
T. L. Svalheim, K. J. Andersen, R. Aurlien, R. Banerji, M. Bersanelli, S. Bertocco, M. Brilenkov, M. Carbone +31 co-authors
Astronomy and Astrophysics, 675, A9 (2023)

15. *BeyondPlanck III. Commander3*
M. Galloway, K. J. Andersen, R. Aurlien, R. Banerji, M. Bersanelli, S. Bertocco, M. Brilenkov, M. Carbone +30 co-authors
Astronomy and Astrophysics, 675, A3 (2023)

14. *BeyondPlanck VIII. Efficient Sidelobe Convolution and Correction through Spin Harmonics*
M. Galloway, M. Reinecke, K. J. Andersen, R. Aurlien, R. Banerji, M. Bersanelli, S. Bertocco, M. Brilenkov +30 co-authors
Astronomy and Astrophysics, 675, A8 (2023)

13. *BeyondPlanck XVI. Limits on Large-Scale Polarized Anomalous Microwave Emission from Planck LFI and WMAP*
D. Herman, B. Hensley, K. J. Andersen, R. Aurlien, R. Banerji, M. Bersanelli, S. Bertocco, M.

Brilenkov +30 co-authors
Astronomy and Astrophysics, 675, A15 (2023)

12. *BeyondPlanck XIII. Intensity foreground sampling, degeneracies, and priors*
K. J. Andersen, D. Herman, R. Aurlien, R. Banerji, A. Basyrov, M. Bersanelli, S. Bertocco, M. Brilenkov +36 co-authors
Astronomy and Astrophysics, 675, A13 (2023)

11. *From BeyondPlanck to Cosmoglobe: Preliminary WMAP Q-band analysis*
D. J. Watts, M. Galloway, H. T. Ihle, K. J. Andersen, R. Aurlien, R. Banerji, A. Basyrov, M. Bersanelli +35 co-authors
Astronomy and Astrophysics, 675, A16 (2023)

10. *BeyondPlanck V. Minimal ADC Corrections for Planck LFI*
D. Herman, R. A. Watson, K. J. Andersen, R. Aurlien, R. Banjeri, M. Bersanelli, S. Bertocco, M. Brilenkov +31 co-authors
Astronomy and Astrophysics, 675, A5 (2023)

9. *BeyondPlanck XII. Cosmological parameter constraints with end-to-end error propagation*
S. Paradiso, L. P. L. Colombo, K. J. Andersen, R. Aurlien, R. Banerji, A. Basyrov, M. Bersanelli, S. Bertocco +33 co-authors
Astronomy and Astrophysics, 675, A12 (2023)

8. *BeyondPlanck X. Planck LFI frequency maps with sample-based error propagation*
A. Basyrov, A. -S. Suur-Uski, L. P. L. Colombo, J. R. Eskilt, **S. Paradiso**, K. J. Andersen, R. Aurlien, R. Banerji +32 co-authors
Astronomy and Astrophysics, 675, A10 (2023)

7. *BeyondPlanck XI. Bayesian CMB analysis with sample-based end-to-end error propagation*
L. P. L. Colombo, J. R. Eskilt, **S. Paradiso**, H. Thommesen, K. J. Andersen, R. Aurlien, R. Banerji, M. Bersanelli +31 co-authors
Astronomy and Astrophysics, 675, A11 (2023)

6. *BeyondPlanck IV. On end-to-end simulations in CMB analysis – Bayesian versus frequentist statistics*
M. Brilenkov, K. S. F. Fornazier, L. T. Hergt, G. A. Hoerning, A. Marins, T. Murokoshi, F. Rahman, N. -O. Stutzer +43 co-authors
Astronomy and Astrophysics, 675, A4 (2023)

5. *From BeyondPlanck to Cosmoglobe: Open Science, Reproducibility, and Data Longevity*
S. Gerakakis, M. Brilenkov, M. Ieronymaki, M. San, D. J. Watts, K. J. Andersen, R. Aurlien, R. Banerji +34 co-authors
The Open Journal of Astrophysics, 6, 10 (2023)

4. *Status of QUBIC, the Q&U Bolometer for Cosmology*
L. Mousset, P. Ade, A. Almela, G. Amico, L. H. Arnaldi, J. Aumont, S. Banfi, E. S. Battistelli +103 co-authors
arXiv e-prints, arXiv:2210.03161 (2022)

3. *The large scale polarization explorer (LSPE) for CMB measurements: performance forecast*
The LSPE collaboration, G. Addamo, P. A. R. Ade, C. Baccigalupi, A. M. Baldini, P. M. Battaglia, E. S. Battistelli, A. Baù +97 co-authors
Journal of Cosmology and Astroparticle Physics, 2021, 008 (2021)

2. *Exploring Cosmic Origins with CORE: Survey requirements and mission design*
J. Delabrouille, P. de Bernardis, F. R. Bouchet, A. Achúcarro, P. A. R. Ade, R. Allison, F. Arroja,

E. Artal +196 co-authors
Journal of Cosmology and Astroparticle Physics, 2018, 014 (2018) (**137 citations** on NASA ADS)

1. *Exploring Cosmic Origins with CORE: Cosmological Parameters*
Eleonora Di Valentino, Thejs Brinckmann, Martina Gerbino, Vivian Poulin, François R. Bouchet, Julien Lesgourgues, Alessandro Melchiorri, Jens Chluba +121 co-authors
Journal of Cosmology and Astroparticle Physics, 2018, 017 (2018) (**149 citations** on NASA ADS)

REFERENCES

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