

SIMONE PARADISO

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Link to my personal website

RESEARCH EXPERIENCE

INAF - OAS

Postdoctoral Fellow

June 2024 - current

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

Postdoctoral Fellow

January 2023 - June 2024

Waterloo, ON, Canada

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

University of Milan

Postdoctoral Fellow

October 2021 - December 2022

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

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

October 2021

- 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"

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

October 2016

- Cosmological parameters forecasts for the CORE project proposal.

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

INTERNATIONAL PROJECTS AND 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 bolometric interferometry.**CMB experiment*

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

LiteBIRD

2024 - Present

*CMB measurement from space.**CMB experiment*

- Cosmic birefringence.

Cosmoglobe

2021 - Present

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

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

TEACHING EXPERIENCE

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.

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.

PRESENTATIONS

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 analysis within a Bayesian end-to-end framework

23/2/2023

Waterloo Centre for Astrophysics Astroseminar

Waterloo, ON, Canada

- Invited speaker.

CMB constraints with end-to-end error propagation

7/6/2021

Cosmoglobe Kick-off meeting

Online

- Invited speaker - Presentation of BeyondPlanck results.

CMB analysis with end-to-end error propagation: Likelihood and cosmological parameters

19/11/2020

BeyondPlanck release conference

Online

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

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.

PARTICIPATION TO INTERNATIONAL 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 all'indeterminazione".

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 29 publications, with a total of 554 citation and a h-index of 13 (as of January, 2023).

- In the **CORE papers (2018)** I gave my contribution by computing Fisher forecasts on cosmological parameters and some Λ CDM 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 BeyondPlanck 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.

List of papers:

31. *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
DOI: 10.1051/0004-6361/202347890
Astronomy and Astrophysics, 686, A271 (2024)
30. *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
DOI: 10.1088/1748-0221/19/06/P06016 Journal of Instrumentation, 19, P06016 (2024)
29. *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
DOI: 10.1088/1475-7516/2024/06/015
Journal of Cosmology and Astroparticle Physics, 2024, 015 (2024)
28. *Evaluating extensions to Λ CDM: an application of Bayesian model averaging*
S. Paradiso, G. McGee, W. J. Percival
arXiv e-prints, arXiv:2403.02120 (2024)
27. *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
DOI: 10.1093/mnras/stae101
Monthly Notices of the Royal Astronomical Society, 528, 1531 (2024)

26. *Cosmoglobe DR1 results. II. Constraints on isotropic cosmic birefringence from reprocessed WMAP and Planck LFI data*
J. R. Eskilt, D. J. Watts, R. Aurlen, A. Basyrov, M. Bersanelli, M. Brilenkov, L. P. L. Colombo, H. K. Eriksen +23 co-authors
DOI: 10.1051/0004-6361/202346829
Astronomy and Astrophysics, 679, A144 (2023)
25. *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
arXiv e-prints, arXiv:2311.01814 (2023)
24. *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)
23. *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
DOI: 10.1051/0004-6361/202346414
Astronomy and Astrophysics, 679, A143 (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. Aurlen, A. Basyrov, M. Bersanelli, L. P. L. Colombo +15 co-authors
DOI: 10.1051/0004-6361/202347358
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. Aurlen, R. Banerji, A. Basyrov, M. Bersanelli, S. Bertocco, M. Brilenkov +37 co-authors
DOI: 10.1051/0004-6361/202244953
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. Aurlen, R. Banerji, M. Bersanelli, S. Bertocco, M. Brilenkov +32 co-authors
DOI: 10.1051/0004-6361/202142799
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. Aurlen, R. Banerji, M. Bersanelli, S. Bertocco +30 co-authors
DOI: 10.1051/0004-6361/202244061
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. Aurlen, R. Banerji, S. Bertocco +33 co-authors
DOI: 10.1051/0004-6361/202243619
Astronomy and Astrophysics, 675, A6 (2023)

17. *BeyondPlanck XIV. Polarized foreground emission between 30 and 70GHz*
T. L. Svalheim, K. J. Andersen, R. Aurlen, R. Banerji, M. Bersanelli, S. Bertocco, M. Brilenkov,
M. Carbone +30 co-authors
DOI: 10.1051/0004-6361/202243160
Astronomy and Astrophysics, 675, A14 (2023)
16. *BeyondPlanck X. Bandpass and beam leakage corrections*
T. L. Svalheim, K. J. Andersen, R. Aurlen, R. Banerji, M. Bersanelli, S. Bertocco, M. Brilenkov,
M. Carbone +31 co-authors
DOI: 10.1051/0004-6361/202243080
Astronomy and Astrophysics, 675, A9 (2023)
15. *BeyondPlanck III. Commander3*
M. Galloway, K. J. Andersen, R. Aurlen, R. Banerji, M. Bersanelli, S. Bertocco, M. Brilenkov,
M. Carbone +30 co-authors
DOI:10.1051/0004-6361/202243137
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. Aurlen, R. Banerji, M. Bersanelli, S. Bertocco, M.
Brilenkov +30 co-authors
DOI: 10.1051/0004-6361/202243138
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. Aurlen, R. Banerji, M. Bersanelli, S. Bertocco, M.
Brilenkov +30 co-authors
DOI: 10.1051/0004-6361/202243081
Astronomy and Astrophysics, 675, A15 (2023)
12. *BeyondPlanck XIII. Intensity foreground sampling, degeneracies, and priors*
K. J. Andersen, D. Herman, R. Aurlen, R. Banerji, A. Basyrov, M. Bersanelli, S. Bertocco, M.
Brilenkov +36 co-authors
DOI: 10.1051/0004-6361/202243186
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. Aurlen, R. Banerji, A. Basyrov, M.
Bersanelli +35 co-authors
DOI: 10.1051/0004-6361/202243410
Astronomy and Astrophysics, 675, A16 (2023)
10. *BeyondPlanck V. Minimal ADC Corrections for Planck LFI*
D. Herman, R. A. Watson, K. J. Andersen, R. Aurlen, R. Banjeri, M. Bersanelli, S. Bertocco, M.
Brilenkov +31 co-authors
DOI: 10.1051/0004-6361/202243639
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. Aurlen, R. Banerji, A. Basyrov, M. Bersanelli,
S. Bertocco +33 co-authors
DOI: 10.1051/0004-6361/202244060
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
DOI: 10.1051/0004-6361/202244819
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
DOI: 10.1051/0004-6361/202244619
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
DOI: 10.1051/0004-6361/202244958
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
DOI: 10.21105/astro.2205.11262
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
DOI: 10.1088/1475-7516/2021/08/008
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
DOI: 10.1088/1475-7516/2018/04/014
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
DOI: 10.1088/1475-7516/2018/04/017
Journal of Cosmology and Astroparticle Physics, 2018, 017 (2018) (**144 citations** on NASA ADS)

REFERENCES

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