SIMONE PARADISO

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RESEARCH EXPERIENCE

Waterloo Centre for Astrophysics - University of Waterloo January 2023 - current
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.

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

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 meting *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 - present
EDI Journal Club *Waterloo, Canada*

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

University of Waterloo 2023 - present
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 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 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.

List of papers:

29. *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)

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
arXiv e-prints, arXiv:2401.03802 (2024)

27. *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)

26. *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)

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: 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)

22. *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
arXiv e-prints, arXiv:2309.02957 (2023)

21. *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)

20. *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)

19. *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)

18. *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)

17. *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)

16. *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)

15. *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)

14. *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)

13. *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)

12. *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)

11. *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)

10. *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) (**36 citations** on NASA ADS)

9. *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)

8. *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)

7. *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)

6. *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)

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) (**37 citations** on NASA ADS)

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) (**133 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) (**143 citations** on NASA ADS)

REFERENCES

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