Léo Vacher

PH.D IN ASTROPHYSICS AND COSMOLOGY

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Positions

Laboratoire de Physique des 2 infinis Irène Joliot-Curie (IJCLab), CNRS *Orsay, France*

CHARGÉ DE RECHERCHE (PERMANENT RESEARCHER) *Since 2025*

- Cosmology, fundamental physics and astrophysics with Cosmic Microwave Background polarisation

International School for Advanced Studies (SISSA) *Trieste, Italy*

POSTDOCTORAL RESEARCH FELLOW *2023-2025*

- Data analysis for Cosmic Microwave Background studies

Education

Université Paul Sabatier and IRAP *Toulouse, France*

DOCTOR OF PHILOSOPHY (PH.D), ASTROPHYSICS AND COSMOLOGY *2020-2023*

- Thesis: Understanding the Galactic polarized signal in the quest for new fundamental physics in the Cosmic Microwave Background
- Supervisors: Dr. J. Aumont and Dr. L. Montier

Université de Lorraine *Nancy, France*

MASTER'S DEGREE, LOGIC, PHILOSOPHY AND HISTORY OF SCIENCES *2021 - 2025*

- With high honors (très bien), for the first year.
- Thesis project: What is geometric about gauge theories?

Université Grenoble-Alpes *Grenoble, France*

MAGISTER AND MASTER'S DEGREE, SUBATOMIC PHYSICS AND COSMOLOGY *2018 - 2020*

- With high honors (très bien)
- master thesis: Modeling the spectral complexity of CMB Galactic foregrounds in the quest of primordial B-modes (IRAP, Toulouse)

Université Clermont Auvergne *Clermont-Fd, France*

BACHELOR DEGREE, FUNDAMENTAL PHYSICS *2015 - 2018*

- With high honors (très bien)

Selected publications

Papers: 30 (+5 submitted), **Citations:** 1481, **h-index:** 14 (inspirehep.net, October 2025)

The full publication list can be found at https://leovacher.github.io/publications/

1. **L. Vacher**, A. Carones, J. Aumont, J. Chluba, N. Krachmalnicoff, C. Ranucci, M. Remazeilles, A. Rizzieri. 2024. How bad could it be? Modelling the 3D complexity of the polarised dust signal using moment expansion. Submitted to A&A. Preprint available at arXiv:2411.11649.

2. N. Schöneberg. and **L. Vacher**. 2024. The mass effect – Variations of masses and their impact on cosmology. Submitted to JCAP. Preprint available at arXiv:2407.16845.

3. **L. Vacher** and N. Schöneberg. 2024. Incompatibility of fine-structure constant variations at recombination with local observations. Phys.Rev. D 109, 103520. Preprint available at arXiv:2403.02256.

4. N. Schöneberg, **L. Vacher**, J. D. F. Dias, M. M. C. D. Carvalho, C. J. A. P. Martins (2023). News from the Swampland – Constraining string theory with astrophysics and cosmology. JCAP 2023(10):039. Preprint available at arXiv:2307.15060.

5. U. Fuskeland et al. (including **L. Vacher**) (2023). Tensor-to-scalar ratio forecasts for extended LiteBIRD frequency configurations. A&A 676: A42. Preprint available at arXiv:2302.05228.

6. **L. Vacher**, N. Schöneberg, J. F. Dias, C. J. A. P. Martins, F. Pimenta. 2023. Runaway dilaton models: improved constraints from the full cosmological evolution. Phys. Rev. D 107 (10): 104002. Preprint available at arXiv:2301.13500.

7. **L. Vacher**, J. Aumont, F. Boulanger, L. Montier, V. Guillet, A. Ritacco, J. Chluba. 2022. Frequency dependence of the thermal dust E/B ratio and EB correlation: insights from the spin-moment expansion. A&A 672: A146. Preprint available at arXiv:2210.14768.

8. **L. Vacher**, J. F. Dias, N. Schöneberg, C. J. A. P. Martins, S. Vinzl, S. Nesseris, G. Cañas-Herrera, M. Martinelli. 2022. Constraints on extended Bekenstein models from cosmological, astrophysical, and local data. Phys.Rev. D 106,083522. Preprint available at arXiv:2207.03258.

9. B. Régaldo-Saint Blancard, E. Allys, C. Auclair, F. Boulanger, M. Eickenberg, F. Levrier, **L. Vacher**, S. Zhang. 2022. Generative Models of Multi-channel Data from a Single Example – Application to Dust Emission. ApJ:10.3847/1538-4357/aca538. Preprint available at arXiv:2208.03538.

10. **L. Vacher**, J. Chluba, J. Aumont, A. Rotti, L. Montier. 2022. High precision modeling of polarized signals: Moment expansion method generalized to spin-2 fields. A&A: 669: A5. Preprint available at arXiv:2205.01049.

11. The LiteBIRD collaboration (including **L. Vacher**). 2022. Probing Cosmic Inflation with the LiteBIRD Cosmic Microwave Background Polarization Survey. PTEP Issue 4, 042F01. Preprint available at arXiv:2202.02773.

12. **L. Vacher**, J. Aumont, L. Montier, S. Azzoni, F. Boulanger, M. Remazeilles (for the LiteBIRD collaboration). 2022. Moment expansion of polarized dust SED: a new path towards capturing the CMB B-modes with LiteBIRD. A&A 660: A111. Preprint available at arXiv:2111.07742.

13. C.J.A.P. Martins and **L. Vacher**. 2019. Astrophysical and local constraints on string theory: runaway dilaton models. Phys.Rev. D 100, 123514. Preprint available at arXiv:1911.10821.

Presentations, conferences and summer schools

1. Talk. 2025. Simons Observatory F2F meeting, University of Manchester, UK.
2. Talk. 2025. Cosmology seminar. Université Clermont-Auvergne. Online/Clermont-Ferrand, France.
3. Leading discussion. 2025. Pan-Experiment Galactic Science Group. Online.
4. Invited Talk. 2025. CMB B-Mode-NEXT. Tokyo, Japon.
5. Talk. 2025. Pan-Experiment Galactic Science Group. Online.
6. Talk. 2024. LiteBIRD E/B-modes workshop. Madrid (Remote).
7. Invited talk. 2024. Parity Violation from Home. Online.
8. Talk. 2024. LiteBIRD hands-on meeting. KEK, Tsukuba, Japan.
9. Talk. 2024. FWP: Parity violation through CMB observations. IFPU, Trieste, Italy.
10. Talk. 2024. ASI LiteBIRD meeting. Roma, Italy.
11. Kick-off meeting. 2024. Radioforeground+ . Santander, Spain.
12. Talk. 2023. From the Galaxy to the Big-Bang. Banyuls, France.
13. Talk and Organization Comitee (LOC). 2023. Ibericos. Ponte de Lima, Portugal.
14. Talk. 2022. Galactic science and CMB foregrounds Workshop. Tenerife, Spain.
15. Talk and Organization comitee (LOC). 2022. LiteBIRD F2F meeting. Okayama University, Japan.
16. Talk. 2022. CMB france #4. IAP, France.
17. Invited talk. 2022. Pan-Experiment Galactic Science Group. Online.
18. Talk. 2022. Cosmology session of the 56th Rencontres de Moriond. La Thuile, Italy. Proceedings: arXiv:2203.07246.
19. Talk. 2022. PHD Day. IRAP, France. First prize for best oral presentation.
20. Talk. 2022. CMB France #3. IAP, France.
21. Talk. 2021. IJUP, Universidade do Porto, Portugal. Best oral communication in "Maths, Physics & Astronomy".
22. Summer School. 2021 and 2022. Euclid Summer School , France.
23. Summer School. 2021. "Fundamental cosmology from the ELT and space". Angra do Heroísmo, Açores, Portugal.
24. Talk. 2021. CMB france #2. IAP, France.

25. Talk. 2021. Ibericos. Universidade de Coimbra, Portugal.
26. Talk. 2021. Theory of Gravitation and Variation in Cosmology. CIRM, Marseille, France.
27. Talk. Cosmo21. University of Illinois, USA.
28. Talk. 2021. PHD Day. IRAP, France. Second prize for best oral presentation.
29. Poster. 2021. Fall LiteBIRD S2S meeting. Online.
30. Talk. 2020. CMB france #1. IAP, France.
31. Organization comitee (LOC). 2019. IAU Symposium #352. IAU Symposium. Viana do Castelo, Portugal.

Academic teaching

Qualified since 2024 at the "fonction de maître de conférence".

2023	**Jury member for the DU: "parcours spéciaux"**, Jury (4 h). Université Paul Sabatier.
2023	**Fluid mechanics (L2/L3)**, Tutorials (14 h). Université Paul Sabatier.
2023	**Geometrical optics (L1)**, Tutorials (16 h). Université Paul Sabatier.
2022	**Astrophysics (L3)**, Tutorials (12 h). Université Paul Sabatier.
2021, 2022	**Thermodynamics (L2)**, Tutorials (45h). Université Paul Sabatier.
2021	**Point Mechanics (L1)**, Tutorials (15h). Université Paul Sabatier.
2021	**Light** & **colors (L1)**, Tutorials (18h). Université Paul Sabatier.
2021, 2022	**Mechanics** & **Electrokinetics (L1)**, Lab (40h). Université Paul Sabatier.

Student advising

2022-2026	**C. Ranucci**, PHD co-supervision. SISSA. 4 years.
2024-2025	**S. Vinzl**, Master's (M2), Université Paul Sabatier. 6 months.
2023-2024	**J. Graglia**, Master's (M2), Université Paul Sabatier. 6 months.
2022-2023	**J. Delhomelle**, undergraduate (L2), Université Paul Sabatier. 6 months.
2020-2021	**S. Vinzl**, undergraduate (L2), Université Paul Sabatier. 7 months.
2021-2022	**N. Gentil**, undergraduate (L2), Université Paul Sabatier. 7 months.

Collaborations

LiteBIRD collaboration. Active member of systematics, simulation and foregrounds joint study groups and Galactic project study group.

Simons Observatory. Lead of the Galactic Science (GS.1) working group and active member of the BB working group.

Euclid consortium. Active member of work package #10 of the theoretical cosmology working group.

QUBIC. Occasional interventions and participation to discussions.

Scientific responsabilities and services

Lead of Simons Observatory Galactic Science working group on foregrounds modelling (GS.1.).

Referee (total=6): MNRAS [1], Phys. Rev. D [4] and JHEP [1] journals. (number of paper refereed under brackets).

Internal referee for the LiteBRD collaboration.

Grants and project funding

2023-2026	**Radioforeground+ and ASI LiteBIRD**, European grants co-funding a postdoctoral fellowship.
2023-2028	**ERC SciPol Grant. P.I.: J. Errard**, International collaborator associated with the project.
2022-2026	**COST Action CA21136 CosmoVerse**, Member of the three working groups.
2021-2025	**H2020-RISE Grant. P.I.: G. Patanchon**, Funded for travels and visits to Japan (2 months so far)
2023-2025	**FCT-Grant: #2022.04048.PTDC. "Phi from the Sky". PI: C.J.A.P. Martins**, Active member.
2020-2023	**Doctoral grant (SDU2E)**, Université Paul Sabatier

Outreach

Non Academic teaching activities

2021	**PLANCKS21**, Marker for the international competition, cosmology session.	*Porto*
2016-2018	**Insignis**, Weekly group lessons of mathematics from secondary to high school.	*Clermont-Fd*
2016-2021	**High-school interventions**, Introducing the challenges of modern physics in classes of philosophy.	*Clermont-Fd*
2016-2021	**Elementary school interventions.**, Introduction to astronomy.	*Lyon*

Associative activities

2025-2026	**Centro studi astronomici Antares**, Astronomical observations and public talks.	*Trieste*
2023-2025	**SISSA for schools**, Outreach of science for high school students.	*Trieste*
2020-2023	**UniverSciel**, Animations related to astronomy in schools.	*Toulouse*
2020-2023	**UPS in space**, Astronomical observations and public talks.	*Toulouse*
2020-2023	**Les étoiles brillent pour tous**, Science outreach for audiences with difficult access to knowledge (prison, hospital ...).	*Toulouse*
2018	**Le campus des étoiles**, Public astronomical observations, science outreach.	*Clermont-Fd*

Writings

2021-today	**Yolonomy**, Co-Founder of the website. Teaching and outreach in physics.
2021	**Exploreur**, Web article: LiteBIRD en quête des premières fractions de secondes de l'Univers.
2021	**Pulsar #41**, Book review. « A General Relativity Workbook by Thomas A. Moore».

Skills

Solely for indicative purposes , some skills have been auto-evaluated using the following criterion : advanced (+++), intermediate (++) and basic (+).

Programming languages: Python (+++), C (+), Julia (+), MPI (+), batch/shell (++), Markdown,(+), HTML (+), CSS (+).

Librairies: Numpy, Scipy, Pandas, Tensorflow, SimPy, Seaborn, Matplotlib ...

Softwares (cosmology): Astropy, Healpy, CLASS, MontePython, CAMB, Cobaya, Getdist, PySM, Toast, LiteBIRD-sim ...

Computing/redacting tools: Latex (+++), GitHub (++), Microsoft Office (+++).

Data analysis: Parameter inference and statistics (+++), Monte-Carlo Markov Chains (++), Machine learning (+).

Languages: French (mother tongue), English (+++), Italian (++), Portuguese (+), German (+).