VACHER Léo

PHD in fundamental physics

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Summary:

Position: PHD student at Institut de Recherche en astrophysique et planétologie (IRAP).

Referees: Supervisors: J. Aumont (IRAP) and L. Montier (IRAP)
Others: C. J.A.P. Martins (CAUP) , L. Derome (LPSC), A. Ralko (Neel)

Specialities: Cosmology, astrophysics, CMB, foregrounds, *LiteBIRD*, interstellar medium, observational probes of inflation , fundamental constants stability, tests of the Einstein's equivalence principle and foundations of general relativity

Publications with major contribution:

2022 : **"Moment expansion of polarized dust SED: a new path towards capturing the CMB *B*-modes with *LiteBIRD* »**
L. Vacher, *J. Chluba, J. Aumont, A. Rotti, L. Montier,*

2022 : **"Probing Cosmic Inflation with the LiteBIRD Cosmic Microwave Background Polarization Survey»**
LiteBIRD collaboration

2022 : **"Moment expansion of polarized dust SED: a new path towards capturing the CMB *B*-modes with *LiteBIRD* »**
L. Vacher, *J. Aumont, L. Montier, S. Azzoni, F. Boulanger, M. Remazeilles (for the LiteBIRD collaboration). A&A 10.1051/0004-6361/202142664*

2019 : **"Astrophysical and local constraints on string theory: runaway dilaton models"**
*C.A.P. Martins ,**L. Vacher**. Phys.Rev. D 100, 123514 -2019.*

Education (Physics):

2018-2020: Magisterium and Master's degree "Subatomic Physics and Cosmology"
Quantum field theory, standard model of particle physics and beyond, cosmology
Université Grenoble-Alpes, France. With high honors (Très bien, ranked 1/5 and 2/15)

2015-2018 : Bachelor's degree of fundamental Physics
University Clermont Auvergne, France. With high honors (Très bien, ranked 1/31)

2015 : Science Baccalauréat, speciality ''Mathematics''
Lycée R.Descartes, Cournon d'Auvergne. France

Education (Other):

2021-today: Master's degree "Philosophy and history of science, logic"
History and philosophy of physics, chemistry and biology.
Propositional and modal logic, philosophy of logic and mathematics.
Université de Nancy, France.

2015-2016: First year of Bachelor's degree in Biology.
University Clermont Auvergne, France.

Research projects and internships :

2020-2023 : PHD: Foregrounds characterization for the detection of inflationary *B*-modes
IRAP Toulouse, France in collaboration with ENS Paris
- *Moment expansion in harmonic and real space for parametric fitting of the dust SED and application to LiteBIRD and QUBIC.*
- *Signal denoising with wavelet scattering transform for B-mode detections*

2020 -2023: PHD: Instrumental and systematics studies for LiteBIRD
IRAP Toulouse, France in collaboration with the LiteBIRD collaboration
- *optimization of the scanning strategy and design of the LiteBIRD mission.*
- *quantifying the impact of far side lobes asymmetries on r measurement.*

2020-2023: PHD: Phenomenology Astrophysical and local tests of the stability of fundamental constants and Einstein's Equivalence Principle.
IRAP Toulouse, France in collaboration with Aachen University and Centro de Astrofisica da Universidade do Porto
- Application to class-II models as string dilaton and Bekenstein model.
- Application to the Euclid mission in the framework of the theory working group WP10.

2020 : **Master's degree year 2 thesis: Observational cosmology.**
IRAP Toulouse, France, supervised by J. Aumont (IRAP)
" Characterizing the complexity of polarized emission from the galactic foreground for the measurement of primordial gravitational waves fingerprints in the CMB"
Modelisation and data analysis

2019 : **Master's degree year 1 thesis: Phenomenology in cosmology.**
CAUP Porto, Portugal, supervised by C.J.A.P Martins (CAUP)
« Astrophysical and Local Tests of the Einstein Equivalence Principle »
Data analysis and phenomenology.

2019 : **Magisterium numerical project**
IPAG, Grenoble France, supervised by P. Hily-Blant (IPAG)
Simulation of the turbulent diffusive emission of molecular clouds

2019 : **Magisterium experimental project**
IPAG, Grenoble, France, supervised by M. Schott (IPAG)
Aging an open star cluster by drawing its HR diagram:
3 night of observation + data reducing

2018 : **Bachelor's degree volunteer internship : mathematical physics**
LAPTH,Annecy, France, supervised by L. *Frappat (LAPTH)*
«Introduction to coordinate and algebraic Bethe Ansatz, spin chains XXX and XXZ. »
Solving of the Hamiltonian for a chain of L spins with periodic boundary conditions.
Yang-Baxter equation, tensorial and Lie algebras, integrable systems.

Teaching:

2020-2023 : **Doctorant chargé d'enseignement (PHD Teaching assistant)**
Université Paul Sabatier, Toulouse

- **Tutorials:**
  - Thermodynamics L2 (45h)
  - Astronophysics L3 (12h)
  - «Fundamental physics:» Newtonian point mechanics L1 (15h)
- **Labs:**
  - Mechanics L1 (21h)
  - Electrocinetics L1 (18h)
- **Student project:**
  - Interviews for professional project module (L2)
  - Light and colors L1 (18h) (Supervision and evaluation of interdisciplinary student projects)
- **Internships supervisions:**
  - N. Gentil (L2 - 7 months) - *Far Side Lobes asymmetries.*
  - S. Vizyl (L2 - 5 months) - *Extended Bekenstein model*

2020-2021 : **Marker for the PLANCKS-2021 event, cosmology session**
International competition for bachelor and masters students
Porto, Portugal
https://2021.plancks.org

2017-2018 : **Employee of the « Insignis » association**
Clermont-Ferrand and Cournon d'Auvergne
Weekly or holiday lessons of mathematics with classes of six students secondary to high school
http://association-insignis.fr/

2016-2023 : **Annual interventions in high school:**
Lycée René Descartes - Cournon d'Auvergne
Discussion in class of philosophy about research in modern physics

2015-2018 : **Private lessons**
Clermont-Ferrand
In every science fields from junior to high school.

Graduate classes, conferences and summer schools:

2021 : **Rencontres de Moriond, cosmology session**
La Thuile, Italy
Conference cycle
https://moriond.in2p3.fr/2022/

2021 : **Euclid Summer school: La science des futurs grands relevés cosmologiques**
Anglet, France
Doctoral school
https://ecole-euclid.cnrs.fr

2021 : ***Fundamental cosmology from the ELT and space***
4th Azores School on Observational Cosmology.
Angra do Heroísmo, Açores, Portugal
Doctoral school
http://www.iastro.pt/research/conferences/azores21/

2021 : **Theory of Gravitation and Variation in Cosmology**
Centre international de rencontre mathématiques, Marseille
Virtual research school
https://conferences.cirm-math.fr/2651.html

2021 : **ED-127: Bayesian statistics**
Sorbonne University
Doctoral formation.

Outreach and associative activities:

2021 : **Writing short article for the web-journal « pulsar #41»**
« A General Relativity Workbook de Thomas A. Moore »
Academic book review
https://www.nfist.pt/pulsar/pulsar41

2021 : **Writing article for the web-journal « explorer »**
« LiteBIRD en quête des premières fractions de secondes de l'Univers »
Scientific journalism
https://exploreur.univ-toulouse.fr/litebird-en-quete-des-premieres-fractions-de-secondes-de-lunivers

2021-2023 : **Animator for the association « UPS in space »**
Toulouse
active member: Astronomical observations and public talks
https://www.upsinspace.com/

2021-2023 : **Animator for the association of « UniverSciel »**
Toulouse
animations related to astronomy in schools and astronomical observations events
http://universciel.info

2021 : ***Animator for the association « les étoiles brillent pour tous »***
Toulouse
Science outreach in public places. Thematic of the year: « explosions »
https://ebpt.fr/

2019 : **Interventions in primary school: "questions and answers about the Universe"**
Ecole primaire Jules Verne Caluire et Cuire

2018 : **Founding member of the astronomy association « campus des étoiles »**
Université Clermont Auvergne, Clermont-Ferrand
Leading of public astronomical observations, science outreach.
https://www.facebook.com/LeCampusDesEtoiles/

Skills:

Frequently used tools and software:

- Redacting*: LateX, Office*
- *Programming languages: Python, shell, basic C++, basic Julia*
- *Data analysis: emcee, MontePython, mpfit*
- *Cosmological analysis: CLASS, Pymaster, X-Pol, CAMB*
- *Instrumental/foreground analysis: healpy, toast, litebird_sim, fgbuster, Pysm*
- *Analytical derivations: mathematica, sympy*

languages :

- *French: mother tongue*
- *English: fluent (C1/C2)*
- *German: basics (A2)*
- *Portuguese: basics (informal)*

Hobbies

Music:

- Diatonic and Chromatic Harmonica
- Drums and percussions

Sports:

- Climbing, Hiking, mountain sports
- Surf, bodyboard