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 : **"High precision modeling of polarized signals: moment expansion method generalized to spin-2 fields»**
L. Vacher, *J. Chluba, J. Aumont, A. Rotti, L. Montier. E-print arxiv.*

2022 : **"Probing Cosmic Inflation with the LiteBIRD Cosmic Microwave Background Polarization Survey»**
LiteBIRD collaboration. E-print arxiv.

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