AXEL LAPEL

Master student in Astrophysics

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RESEARCH EXPERIENCE

Internship – **New maps of the dark side**

Centro de Astrofísica da Universidade do Porto

March – August 2021 *(6 months)* Porto, Portugal

Exploration of some of the landscape of physically viable **dark energy** and **modified gravity** paradigms and elaboration of optimized **strategies for future experiments**, at the interface between data and theory.

- Development, optimization and forecast of the **redshift-drift** as a key model-independent probe of cosmology on forthcoming facilities (ELT, SKA) and investigation on synergies with Euclid.
- **Analytic** and **numerical modeling**, including **data analysis** and **code validation/verification/optimization**.
  → *The internship should result in a scientific publication.*

Internship – **Obscured AGNs and their X-ray spectra**

Università di Bologna

Jan 2021 – March 2021 *(2 months)* Bologna, Italia

X-ray spectral analysis of low-redshift heavily obscured active galactic nuclei to derive intrinsic properties and impact on the star-formation activity of host galaxies.

- **Theory** on AGNs, their multi-wavelength properties and high-energy underlying physical processes with a peculiar emphasis on obscured populations to question the unified model.
- **Reduction**, **statistical analysis** and **interpretation** of proprietary X-ray data (XMM-Newton, NuSTAR) using Monte-Carlo based models.

Internship – **Astrophysics of gaseous and dusty nebulae**

Observatoire de la Côte d'Azur – Laboratoire Lagrange

Nov 2020 – Dec 2020 *(2 months)* Nice, France

Theoretical study on the properties of ionized and dusty regions and **observational investigation** on the dust and gas budget of the Large Magellanic Cloud to witness both dynamical evolution of the galaxy and chemical enrichment of the interstellar medium from C-rich AGB stars.

- **Spectral fitting** of AGB stars' SED with a **radiative transfer code** and extraction of their properties to establish a phenomenological relation extendable to Spitzer's large photometric surveys.

Internship – **Deep learning for gravitational waves**

Observatoire de la Côte d'Azur – Laboratoire Artemis

Sep 2020 – Oct 2020 *(2 months)* Nice, France

Implementation of a new class of **likelihood-free Bayesian neural network** to constrain nuclear models of neutron stars' **equation of state** from the gravitational signature of binary **neutron star mergers** and investigate reliable **alternatives to standard sampling methods**.

- Modern machine learning methods of **supervised** and semi or fully **unsupervised learning** (MLP/CNN/VAE/*normalizing flows*/GAN), review of state of the art **Bayesian methods** for parameter estimation and theory on **gravitational waves**.
- Programming of neural network models with **Pytorch / Scikit-learn** and use of a **computing cluster facility** for intensive trainings.

EDUCATION

International Master in Astrophysics

Université Côte d'Azur (MAUCA)

Nice, France, since 2019

- **Rank: 1st**.
- General relativity, cosmology, quantum physics, statistical physics, planetology, stellar physics, signal processing, fluid mechanics/magnetohydrodynamics, numerical methods, Fourier optics, mathematics and statistics.

Bachelor in Physics

Université Caen Normandie

Caen, France, 2019

- Quantum mechanics, statistical physics, general astrophysics, special relativity, atomic and subatomic physics, optics, electromagnetism, classical mechanics, thermodynamics, numerical methods, mathematics, fluid mechanics

Bac S - Major in Physics

Lycée Thomas Corneille

Barentin, France, 2016

- *Mention "très bien" - (with honours)*

COMPUTER SKILLS

Efficient with:

Python | C++ | Linux | Git | LaTeX

Familiar with:

Matlab | IDL | Julia | HTML/CSS

LANGUAGES

French (native)
English (C1)
Spanish (B1)

RESEARCH INTERESTS

- **Theoretical and observational cosmology**
- **Dark energy and large-scale structures**
- **Galaxy formation and evolution**
- **Gravitational wave astronomy**
- **Fundamental physics**

Internship – **Planet forming region in protoplanetary disks**

Observatoire de la Côte d'Azur – Laboratoire Lagrange

May 2020 – June 2020 *(2 months)* Nice, France

Feasibility study on the MATISSE instrument (VLTi) through **numerical simulations** to investigate its ability to probe relevant physical parameters characterizing the inner region of protoplanetary disks.

- Theory of **protoplanetary disks**, **long baseline interferometry**, **radiative transfer** and introduction to the MATISSE instrument.
- **Parametric modeling** of protoplanetary disks with a 3-dimensional **radiative transfer code** and extraction of interferometric quantities for the VLTi in realistic conditions.

Internship – **Galaxy formation, evolution and detection**

Observatoire de la Côte d'Azur – Laboratoire Lagrange

March 2020 – Apr 2020 *(2 months)* Nice, France

In depth theoretical review of current knowledge in **galaxy formation and evolution** and **detection theory** emphasizing a **frequentist** approach: application for the detection of **Lymann-α emitters**.

- Introduction to the MUSE instrument, its data and detection of the emission lines of high redshift Lymann-α emitters with **likelihood ratio** tests and **Monte Carlo methods** to study the earliest phases of galaxy evolution.

Internship – **Extreme angular resolution astronomy**

Observatoire de la Côte d'Azur – Laboratoire Lagrange

Nov 2019 – Jan 2020 *(2 months)* Nice, France

Investigation to expand the scope of **Kernel phase analysis** from direct imaging of point like sources to extended sources in a context of ground-based Fizeau interferometry with **protoplanetary disks**.

- Contribution to the XARA library by **creating** and **implementing** a **parametric model** of protoplanetary disk.
- **Numerical simulation** of the model applied to the Subaru telescope and **parameter inference** using minimum χ^2 estimation.

Training course – **C2PU**

Observatoire du plateau de Calern

Nov 2019 *(1 month)* Site de Calern, France

Hands-on experience of **observation** with fully operational one meter telescopes. Introduction to **data reduction** and modern methods of optical **photometry, spectroscopy**, to astronomical softwares and writing of proposals.

- Project: **spectroscopic study of the planetary nebula NGC 2392.**

Internship – **Equation of state of neutron stars**

Laboratoire de Physique Corpusculaire

May 2019 - June 2019 *(2 months)* Caen, France

Connecting observational constraints over neutron stars' masses and radii to current models of **equation of state** and **moment of inertia** from numerical integration of the **Tolman-Oppenheimer-Volkoff** equation.

- Theory on the hydrostatic equilibrium of neutron stars and the development of their unknown equation of state.
- **Numerical modeling** of the equations and integration of macroscopic parameters to make the connection with astronomical observations.

WORKSHOPS

- **Cosmology 2021: Rise of Field Theory** Cambridge University (*4-8 Jan 2021*)
- **Iberian Cosmology Meeting 2021** (*29-31 March 2021*)
- **Annual meeting of the Portuguese Astronomical Society** – (*July 2021)*
  $\rightarrow$ Possibility to present the results from the *New maps of the dark side* internship.

- **INAF - OAS Bologna weekly seminars and AGN team meetings** (*Jan - March 2021*)
- **Lagrange laboratory weekly seminars** (*Since 2019*)

ONLINE COURSES

The Evolving Universe

Coursera - Caltech

2017 – (10 weeks training)

From the Big Bang to Dark Energy

Coursera - University of Tokyo

2016 – (4 weeks training)

REFEREES

Prof. Marcel Carbillet – Director M2

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Prof. David Mary – Director M1

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