# Bastien Carreres

## PhD in Astrophysics and Cosmology

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> ### Research Interests
>
> **Keywords: observational cosmology, dark energy, large-scale structures, Type Ia Supernovae**
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> I am currently a postdoctoral researcher at Duke University. My primary research focuses on inferring cosmological parameters from Type Ia supernova (SNe Ia) data. In particular, I am using low-redshift SNe Ia to measure peculiar velocities and constrain the growth of cosmic structure.

## Education

**PhD – Astrophysics and Cosmology** | Aix-Marseille Université — *Marseille, France* — 2023
Thesis title: Measurement of the growth rate of structures with Type Ia Supernovae of the ZTF photometric survey.

**Master's degree – Subatomic Physics and Cosmology** | Université Grenoble-Alpes — *Grenoble, France* — 2020
Graduated with honors

**Bachelor's degree – Fundamental Physics** | Université de Montpellier — *Montpellier, France* — 2018
Graduated with high honors

## Research Experience

**Post-doctoral Associate** | Duke University — *Durham, NC, USA* — Nov. 2023 – Present
Supervisor: Prof. Dan Scolnic.
Subjects: Cosmology with low-$z$ SNe Ia, peculiar velocities, survey simulation, data analysis.

**PhD candidate** | Centre de Physique des Particules de Marseille — *Marseille, France* — Oct. 2020 – Sept. 2023
Supervisors: Drs. Dominique Fouchez, Benjamin Racine et Julian Bautista.
Subjects: SNe Ia cosmology, growth rate of structure measurement, peculiar velocities, survey simulation.

## Teaching & Mentoring Experience

### Teaching

**PhD candidate with teaching duties** | Aix-Marseille Université — *Marseille, France* — Sept. 2020 – June 2023
64h / year. Bachelor's lectures in basic physics: Electricity, Optics, Thermodynamics

**Calculus tutoring** | Université de Montpellier — *Montpellier, France* — Oct. 2017 – Dec. 2017
Tutoring for first-year college students.

**Math tutoring** — Sept. 2016 – June 2018
Independant tutoring for middle-school and high-school students.

### Student Mentoring

**PhD student Mentoring** | Duke University — Nov. 2023 – Present
Maria Acevedo – Subject: Cosmology with the DEBASS survey.

**Graduate student project supervision** | Duke University — Sept. 2024 – June 2025
Subject: Estimation of the velocity power spectrum in a N-body simulation.

## Responsibilities & Services

**Co-lead of the DESC Peculiar Velocities Topical Team**                    Jan. 2026 – Present

**Member of the SOC of the DESC Peculiar Velocities workshop**                    Apr. 2025 – Sept. 2025
Workshop took place at the Centre de Physique des Particules de Marseille, France

**Member of the SOC of the 2025 DESC summer meeting**                    Apr. 2025 – Sept. 2025
Meeting tootk place at the University of Illinois, Urbana-Champaign, IL, USA

**Member of the DESC Collaboration Council**                    Dec. 2024 – Present
Elected for a 2 year term.

**Reviewer for MNRAS**                    Feb. 2025 – Present
Review of 1 publication.

**Co-organiser of the CPPM cosmology group' journal club**                    Sept. 2021 – June 2023

**Co-organiser & Volunteer of the CPPM cosmology "Fête de la Science" stands**                    Oct. 2021 – 2023

## Collaborations

- Full member of the Dark Energy Science Collaboration (DESC) of the Legacy Survey of Space and Time (LSST).

- External collaborator of the cosmology group of the Zwicky Transient Facility (ZTF) survey.

## Awards & Grant

**Marie Skłodowska-Curie Actions Postdoctoral Fellowship** | European Commission                    2025
Project "PEGASUS": Probing dark Energy and Gravity through Analysis of the growth of Structure Using Supernovae
Amount: €276,187
Host organisation: University of Oxford, UK
Awarded with an evaluation score of 99.4/100 (top 1.62% of 1669 proposals in the EF-PHY panel)

**Science Catalyst Grant** | LSST Discovery Alliance                    2021
Amount: $5,000

**French National PhD fellowship** | ED352 – Aix-Marseille Université                    2020
3 years contract

## Technical skills

**Programming languages:**

- Python 🐍 (Expert)
- LaTeX (Intermediate)

- C/C++  (Novice)
- CSS/HTML (Novice)

**Contributions to public codes:**

- `SNSim` ⊙ (Creator and main developer)
- `flip` ⊙ (Co-developer)
- `OpSimSummaryV2` ⊙ (Principal maintainer)
- `SNCosmo` ⊙ (Contributor)
- `SNANA` ⊙ (Contributor)

# Selected publications

I have (co-)signed 19 publications: 3 as first-author, 5 in which I did a significant contribution and 11 as co-author. I present here a selection; a full list is available on this NASA ADS link. A complete list of my presentations is available here.

## Publications as first author

1. **Carreres** et al. 2025. *Type Ia Supernova Growth-rate Measurement with LSST Simulations: Intrinsic Scatter Systematics*
   Published in The Astrophysical Journal. DOI: 10.3847/1538-4357/ae11ac
   In this paper, I study the impact of intrinsic scatter of SNe Ia on the measurement of $f\sigma_8$. This study is done through the simulation of the full low-z LSST SNe Ia sample for different intrinsic scatter models. We found that the most realistic model of intrinsic scatter causes non-Gaussianities in the Hubble diagram residuals, resulting in a bias on $f\sigma_8$.

2. **Carreres** et al. 2025. *ZTF SN Ia DR2: Peculiar velocities' impact on the Hubble diagram*
   Published in Astronomy & Astrophysics. DOI: 10.1051/0004-6361/202450389
   This paper is part of the second data release of ZTF SNe Ia. In this paper, I study the impact of the peculiar velocity (PV) systematics on the Hubble diagram of the ZTF SN Ia DR2 sample. We show that not taking into account the full PV covariance matrix can lead to a slight underestimation of the error on the Hubble constant $H_0$ and could shift its value by $\sim 1 \, \text{km s}^{-1}$.

3. **Carreres** et al. 2023. *Growth-rate measurement with type-Ia supernovae using ZTF survey simulations*
   Published in Astronomy & Astrophysics. DOI: 10.1051/0004-6361/202346173
   This paper is the main publication of my thesis. In this paper, I present my work to prepare for the future measurement of the growth rate of structure ($f\sigma_8$) from ZTF SN Ia data. I describe my realistic simulation of the ZTF SN Ia sample and, using these simulations, I study the biases and systematics that can affect the measurement of $f\sigma_8$. I show that using SN Ia data from the full 6 years of the ZTF II sample with a cut at a redshift of $z < 0.06$ to avoid selection due to magnitude limit, we can expect an unbiased measurement of $f\sigma_8$ with an error of $\sim 19\%$.

## Publications with significant contribution

1. Acevedo, Sherman, Brout, **Carreres** et al. 2025. *The Dark Energy Bedrock All-sky Supernova Program: Cross Calibration, Simulations, and Cosmology Forecasts*
   Published in The Astrophysical Journal. DOI: 10.3847/1538-4357/ae1e78
   This publication introduces the Dark Energy Bedrock All-Sky Supernova (DEBASS) low-$z$ survey. The paper gives an overview of the survey, examines systematic effects such as photometric calibration and selection effects, presents simulations, and provides forecasts for future cosmological analysis. I wrote and ran the forecast codes, and I was actively involved in the simulations and writing process

2. Rosselli, **Carreres** et al. 2025. *Forecast for growth-rate measurement using peculiar velocities from LSST supernovae*
   Published in Astronomy & Astrophysics. DOI: 10.1051/0004-6361/202556181
   This paper presents a simulation-based forecast for the measurement of the growth rate of structure ($f\sigma_8$) with the Rubin-LSST survey. It shows that the full constraining power of the Rubin-LSST SNe Ia sample will enable a constraint at the $\sim 10\%$ level in the redshift range $0.02 < z < 0.14$. I participated in the development of the simulation and analysis code used in this publication. I was also involved in the writing and review process.

3. Ravoux, **Carreres** et al. 2025. *Generalized framework for likelihood-based field-level inference of growth rate from velocity and density fields*
Published in Astronomy & Astrophysics. DOI: 10.1051/0004-6361/202554319
This paper presents the FLIP Python library. This library is based on codes developed during my PhD and proposes a more general framework for the constraint of the growth rate of structure. I actively participated in the development of FLIP and in the writing of this paper.

4. Peterson, **Carreres** et al. 2025. *Improving the Determination of Supernova Cosmological Redshifts by Using Galaxy Groups*
Published in The Astrophysical Journal. DOI: 10.3847/1538-4357/ada285
In this paper, we used SNe Ia data and the Uchuu UniverseMachine simulation to study the improvement on the SNe Ia Hubble diagram that we can expect from averaging redshift over galaxy groups of SN Ia hosts. I ran the simulations and was actively involved in the analysis.