Bruno Régaldo-Saint Blancard, Ph.D.

Research Fellow | Machine Learning x (Astro)physics

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bregaldo.github.io github.com/bregaldo Google Scholar

Research Experience

Flatiron Institute, Research Fellow - New York, NY — Jan 2022 - now

Development of statistical methods for astrophysics / cosmology and broader physics applications using machine learning and signal processing (@ Center for Computational Mathematics). Also involved in:

- the SIMBIG collaboration, dedicated to the analysis of galaxy clustering with simulation-based inference.
- the POLYMATHIC AI initiative, focused on the development of foundation models for science.

Development of methods for:

- Analysis of interstellar dust emission data with scattering statistics.
- Cosmological inference from galaxy clustering data with simulation-based inference.
- Bayesian blind denoising and source separation for cosmic microwave background data with diffusion models.
- Model optimization in simulation-based inference using meta-learning / stacking techniques.
- Surrogate modeling of physics PDEs with transformer-based foundation models.

École Normale Supérieure, Ph.D. Student (after 4-month internship) - Paris, France — Mar 2018 - Nov 2021

Topic: Statistical modeling of the emission of Galactic dust. *Supervision:* F. Levrier, F. Boulanger (@ LPENS).

Development of data-driven models of the Galactic dust emission under highly constrained data budgets leveraging the wavelet scattering transform — a technique closely related to convolutional neural networks. Explored a variety of astrophysics and data science topics, including:

- Physics of the interstellar medium.
- General data analysis and scientific computing.
- Signal/image processing, wavelet analysis, denoising and source separation.
- Features extraction and generative modeling.

Canadian Institute for Theoretical Astrophysics, Research Intern - Toronto, Canada — Apr 2017 - Jul 2017

Statistics on the intrinsic alignment of dark matter halos. *Supervision:* S. Codis, J. R. Bond, M. Alvarez.

École Polytechnique, Student Project - Palaiseau, France — Sep 2016 - Mar 2017

Deep learning for the detection of interplanetary coronal mass ejection. *Supervision:* N. Aunai (@ LPP).

École Normale Supérieure, Student Project - Paris, France — Sep 2015 - May 2016

FPGA programming for quantum field tomography in superconducting circuits. *Supervision:* B. Huard (@ LPA).

Education

École Normale Supérieure, Ph.D. in Astrophysics - Paris, France — 2018 - 2021

Research at the interface of ASTROPHYSICS, DATA SCIENCE, SIGNAL PROCESSING. *See details above.*

Observatoire de Paris, Master's in Astrophysics - Paris, France — 2017 - 2018

Master 2 Astronomie, Astrophysique et Ingénierie Spatiale (affiliation: Université de Paris).
Majors: ASTROPHYSICS, ASTRONOMY

École Polytechnique, (Master's-level) Engineering Degree - Palaiseau, France — 2014 - 2018

Ingénieur Polytechnicien program (X2014).
Majors: MATHEMATICS & PHYSICS (Year 1 & 2).

Specialization: THEORETICAL PHYSICS (Year 3), ASTROPHYSICS (Year 4, *see above*).

Lycée Michel Montaigne, Classes Préparatoires MPSI/MP* - Bordeaux, France 2011 - 2014
Majors: MATHEMATICS, PHYSICS

Publications (also see Google Scholar) [# publications ≥ 29 | # citations ≥ 500 | h-index ≥ 14]

20 peer-reviewed journal publications / 7 peer-reviewed conference publications (4 in main conferences and 3 in workshops) / 2 preprints

➢ Lead and Major Contributions

Listening to the Noise: Blind Denoising with Gibbs Diffusion 2024
D. Heurtel-Depeiges*, C. Margossian, R. Ohana & B. Régaldo-Saint Blancard (* Supervised student) ICML

Cosmological constraints from non-Gaussian and nonlinear galaxy clustering 2024
C. Hahn, P. Lemos, L. Parker, B. Régaldo-Saint Blancard, *et al.* NATURE ASTRONOMY

Galaxy clustering analysis with SimBIG and the wavelet scattering transform 2024
B. Régaldo-Saint Blancard, C. Hahn, S. Ho *et al.* PHYSICAL REVIEW D

Multiple Physics Pretraining for Physical Surrogate Models 2024
M. McCabe, B. Régaldo-Saint Blancard, L. Parker, *et al.* NEURIPS

Simulation-Based Stacking 2024
Y. Yao*, B. Régaldo-Saint Blancard* & J. Domke (* Joint first-authors) AISTATS

Statistical Component Separation for Targeted Signal Recovery in Noisy Mixtures 2024
B. Régaldo-Saint Blancard & M. Eickenberg TMLR

Generative Models of Multi-channel Data from a Single Example of Dust Emission 2023
B. Régaldo-Saint Blancard, E. Allys, C. Auclair, *et al.* THE ASTROPHYSICAL JOURNAL

Removing Dust from CMB Observations with Diffusion Models 2023
D. Heurtel-Depeiges*, B. Burkhart, R. Ohana & B. Régaldo-Saint Blancard (* Supervised student) ML4PS @ NEURIPS

CMB B-mode inference with realistic foregrounds from a single training image 2022
N. Jeffrey, F. Boulanger, B. D. Wandelt, B. Regaldo-Saint Blancard, *et al.* MNRAS: LETTERS

Statistical exploration of halo anisotropic clustering and intrinsic alignments 2021
B. Regaldo-Saint Blancard, S. Codis, J. Bond & G. Stein MNRAS

A new approach for the statistical denoising of Planck dust polarization data 2021
B. Regaldo-Saint Blancard, E. Allys, F. Boulanger, F. Levrier & N. Jeffrey A&A LETTERS

Statistical description of interstellar dust polarized emission: A RWST approach 2020
B. Regaldo-Saint Blancard, F. Levrier, E. Allys, E. Bellomi & F. Boulanger A&A

The RWST: statistical description of the non-Gaussian structures in the ISM 2019
E. Allys, F. Levrier, S. Zhang, C. Colling, B. Regaldo-Saint Blancard, *et al.* A&A

➢ Contributory and Supporting Roles

Sensitivity Analysis of Simulation-Based Inference for Galaxy Clustering 2025
C. Modi, S. Pandey, M. Ho, C. Hahn, B. Régaldo-Saint Blancard, *et al.* MNRAS

The Well: Large-Scale and Diverse Physics Simulations for Machine Learning 2024
R. Ohana, M. McCabe, L. Meyer, R. Morel, *et al.* NEURIPS

Cosmological constraints from the redshift-space galaxy skew spectra 2024
J. Hou, A. Moradinezhad Dizgah, C. Hahn, M. Eickenberg, S. Ho, *et al.* PHYSICAL REVIEW D

Cosmological Constraints using SBI from the Galaxy Marked Power Spectra 2024
E. Massara, C. Hahn, M. Eickenberg, S. Ho, J. Hou, *et al.* PHYSICAL REVIEW D

Field-level SBI of galaxy clustering with convolutional neural networks 2024
P. Lemos, L. Parker, C. Hahn, S. Ho, M. Eickenberg, *et al.* PHYSICAL REVIEW D

Cosmological constraints from the nonlinear galaxy bispectrum 2024
C. Hahn, M. Eickenberg, S. Ho, J. Hou, P. Lemos, *et al.* PHYSICAL REVIEW D

Separation of dust emission from the CIB in Herschel observations with WPH 2024
C. Auclair, E. Allys, F. Boulanger, M. B´ethermin, A. Gkogkou, *et al.* A&A

A forward modeling approach to analyzing galaxy clustering with SimBIG 2023
C. Hahn, M. Eickenberg, S. Ho, J. Hou, P. Lemos, *et al.* PNAS

Cosmological Information in the Marked Power Spectrum of the Galaxy Field 2023
E. Massara, F. Villaescusa-Navarro, C. Hahn, M. M. Abidi, M. Eickenberg, *et al.* THE ASTROPHYSICAL JOURNAL

SimBIG: mock challenge for a forward modeling approach to galaxy clustering 2023
C. Hahn, M. Eickenberg, S. Ho, J. Hou, P. Lemos, *et al.* JCAP

Towards a non-Gaussian Generative Model of large-scale Reionization Maps 2022
Y.-H. Lin, S. Hassan, B. Régaldo-Saint Blancard, M. Eickenberg & C. Modi ML4PS @ NEURIPS

Wavelet Moments for Cosmological Parameter Estimation 2022
M. Eickenberg, E. Allys, A. Moradinezhad Dizgah, P. Lemos, E. Massara, *et al.* N/A

Statistical characterization of turbulent data illustrated on centroid velocity maps 2021
J.-B. Durrive, P. Lesaffre, T. Ghosh & B. Regaldo-Saint Blancard N/A

Automatic Detection of ICME from In Situ Data: A Deep Learning Approach 2021
G. Nguyen, N. Aunai, D. Fontaine, E. Le Pennec, J. Van den Bossche, *et al.* THE ASTROPHYSICAL JOURNAL

➢ Other Collaboration Papers

AstroCLIP: a cross-modal foundation model for galaxies 2024
L. Parker, F. Lanusse, S. Golkar, L. Sarra, M. Cranmer, *et al.* MNRAS

xVal: A Continuous Number Encoding for Large Language Models 2023
S. Golkar, M. Pettee, M. Eickenberg, A. Bietti, M. Cranmer, *et al.* AI4SCIENCE @ NEURIPS

Teaching

Teaching Assistant, École Normale Supérieure - Paris, France 2018 - 2021
Numerical methods for differential equations in Physics, part of the ICFP master's program. *Faculty:* L. Tuckerman.

Lecturer, École Normale Supérieure - Paris, France 2019 - 2021
Physique pour tous, a course designed for a broad non-scientific audience.

Educational Coordinator, Association Le Rocher - Les Mureaux, France 2014 - 2015
Managed a homework assistance program for primary and secondary students.

Supervision

Noah Amsel, 2nd-year PhD student in Computer Science at New York University May - Aug 2024
Summer intern @ Polymathic AI. Co-supervision with A. Bietti.

Hidalgo Mudonhi, Sophomore student at Alabama A&M University May - Aug 2024
Summer intern @ Flatiron Institute. Co-supervision with C. Modi.

Sébastien Pierre, 4th-year student of École Polytechnique, France — Apr - Aug 2024
Summer intern @ Flatiron Institute, then guest researcher. Co-supervision with M. Eickenberg.

David Heurtel-Depeiges, 3rd-year student of École Polytechnique, France — Apr - Aug 2023
Summer intern @ Flatiron Institute, then guest researcher. Co-supervised with R. Ohana. Led to 2 publications.

Software (more @ GitHub)

`GalWavelets`: Wavelet Scattering Transform statistics for 3D data with PyTorch. 2023

`PyWPH`: Wavelet Phase Harmonic statistics for 2D data with PyTorch. 2021

`PyWST`: (Reduced) Wavelet Scattering Transform for 2D data in Python. 2020

Other Work Experience

Thales, Software Engineer Intern - Manchester, UK — Jun 2016 - Aug 2016
Software development for a modernization project of the London underground.

Association Le Rocher, Social Work Intern - Les Mureaux, France — Oct 2014 - Apr 2015
Social work in disadvantaged estates of Les Mureaux.

Château Régaldo-Saint Blancard, Vineyard Worker - Sallebœuf, France — since ...

Selected Talks

Physics in the AI Era Workshop, Università di Pisa & Scuola Normale Superiore, Italy — Sep 2024
Dusting off the Cosmic Microwave Background with Diffusion Models.

CCA Galaxy Meeting Group, Flatiron Institute, New York — Feb 2024
Listening to the Noise: Blind Denoising with Gibbs Diffusion.

CCB Inference Discussion Group, Flatiron Institute, New York — Dec 2023
Simulation-Based Inference for Cosmology: Cosmological Inference from the Spatial Distribution of Galaxies.

Measure Transport, Diffusion, and Sampling Workshop, Flatiron Institute, New York — Dec 2023
Diffusion Models for Cosmology: Removing Dust from CMB Observations.

Hammers & Nails Workshop, Ascona, Switzerland — Nov 2023
Towards Foundation Models for Science.

Flatiron Wide Machine Learning Meeting, Flatiron Institute, New York — Jun 2023
Wavelet Scattering Statistics for Astrophysics.

CCM Colloquium, Flatiron Institute, New York — Mar 2022
Wavelet Scattering for Galactic Dust: Modeling Without Learning.

Pan-Experiment Galactic Science Group Meeting, virtual — Feb 2021
A new approach for the statistical denoising of Planck interstellar dust polarization data.

NenuFAR Cosmic Dawn Meeting, virtual — Oct 2020
Statistical description of dust polarized emission from the diffuse ISM.

IMAGINE Consortium Meeting, virtual — Jul 2020
Statistical description of dust polarized emission from the diffuse ISM.

SF2A, Session PCMI, Université de Nice Sophia-Antipolis, Nice, France — May 2019
Statistical description of the magnetized interstellar medium.

Gotham City Physics X ML Workshop, Flatiron Institute, New York — Apr 2019
Statistical description of the polarized interstellar medium.

TEDxPULV, Pôle Universitaire Léonard de Vinci, Paris-La Défense, France — Feb 2019
Un Univers sans limite ?.

Posters

International Conference on Machine Learning 2024, Vienna, Austria — Jul 2024
Listening to the Noise: Blind Denoising with Gibbs Diffusion.

ML4PS Workshop @ NeurIPS 2023, New Orleans, Louisiana — Dec 2023
Diffusion Models for Cosmology: Removing Dust from CMB Observations.

Hammers & Nails Workshop, Ascona, Switzerland — Nov 2023
Diffusion Models for Cosmology: Removing Dust from CMB Observations.

Various Skills

Programming languages: Python, C++, C
Machine learning framework: PyTorch (including DDP/FSDP), Scikit-learn
Languages: French (native), English (fluent), Spanish (intermediate)
Extracurricular: Piano, Guitar, Running, Squash