

Bruno Régaldo-Saint Blancard

Ph.D. - Data Science and (Astro)Physics

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I am a Research Fellow in the Center for Computational Mathematics at the Flatiron Institute in New York, where I work at the interface between data science and (astro)physics. I develop statistical methods for astrophysics, cosmology, and beyond using signal processing and machine learning. I tackle various problems including generative modeling, inference, denoising, and source separation.

Work Experience

- since Jan. 2022 **Flatiron Research Fellow**, Simons Foundation, New York, NY.
Research fellow at the Center for Computational Mathematics, Flatiron Institute.
Statistical methods for astrophysics, cosmology, and beyond using signal processing and machine learning.
- Oct. 2018 **Ph.D. in Astrophysics**, *Laboratoire de Physique de l'École Normale Supérieure, ENS Paris*,
to Nov. 2021 *France*, Supervisors: F. Levrier, F. Boulanger.
Data-driven modeling of the emission of interstellar dust using the wavelet scattering transform — a technique closely related to the mathematics of convolutional neural networks.
- Mar. 2018 **Research Internship in Astrophysics**, *Laboratoire de Radioastronomie (LRA/LERMA)*,
to Jun. 2018 *ENS Paris, France*, Supervisors: F. Levrier, F. Boulanger.
Statistical modeling of observational and simulated maps of the interstellar medium with the wavelet scattering transform.
- Apr. 2017 **Research Internship in Cosmology**, *Canadian Institute for Theoretical Astrophysics*,
to Jul. 2017 *Toronto, Canada*, Supervisors: S. Codis, J. R. Bond, M. Alvarez.
Investigation of the intrinsic alignment of dark matter halos from simulations of the large-scale structure of the Universe.
- Jun. 2016 **Software Engineer Internship**, *Thales, Manchester, UK*.
to Aug. 2016 Network diagnostics on London underground infrastructure.
- Oct. 2014 **Intern at Association Le Rocher (Charitable Association)**, *Les Mureaux, France*.
to Apr. 2015 Social work in the sensitive neighborhoods of Les Mureaux.

Education

- Oct. 2018 **Ph.D. in Astrophysics**, *Laboratoire de Physique de l'École Normale Supérieure, ENS Paris*,
to Nov. 2021 *France*, Supervisors: F. Levrier, F. Boulanger.
Data-driven modeling of the emission of interstellar dust using the wavelet scattering transform — a technique closely related to the mathematics of convolutional neural networks.
- 2017 to 2018 **Master 2 Astronomie, Astrophysique et Ingénierie Spatiale (AAIS)**, *Observatoire de Paris, Université de Paris, Paris, France*.
Theory and modeling courses in astronomy and astrophysics (e.g., classical and relativistic gravitation, (magneto-)hydrodynamics, cosmology, radiative transfer, instrumentation).
- 2014 to 2018 **École Polytechnique**, *Palaiseau, France*.
One of France's leading institutions in science and engineering. Majors: Physics (specialization: *From particles to stars*) and Mathematics. Fourth year at Master 2 AAIS (Observatoire de Paris).
- 2011 to 2014 **Classes Préparatoires MPSI/MP**, *Lycée Michel Montaigne, Bordeaux, France*.
Preparation for the national competitive exams required for admission to French "Grandes Écoles", with a strong focus on mathematics and physics courses.
- 2011 **Scientific Baccalauréat**, *Lycée Saint-Genès, Bordeaux, France*.

Lead and Major Contributions

- 2024 **“Listening to the Noise: Blind Denoising with Gibbs Diffusion”**.
D. Heurtel-Depeiges*, C. C. Margossian, R. Ohana, & B. Régaldo-Saint Blancard; [arXiv:2402.19455](#).
(* Supervised student)
- 2023 **“Removing Dust from CMB Observations with Diffusion Models”**.
D. Heurtel-Depeiges*, B. Burkhart, R. Ohana, & B. Régaldo-Saint Blancard; ML4PS Workshop at NeurIPS 2023 (spotlight talk). [arXiv:2310.16285](#). (* Supervised student)
- 2023 **“Simulation Based Stacking”**.
Y. Yao*, B. Régaldo-Saint Blancard*, & J. Domke; to appear in AISTATS 2024. [arXiv:2310.17009](#).
(* Joint first authors)
- 2023 **“SimBIG: Galaxy Clustering Analysis with the Wavelet Scattering Transform”**.
B. Régaldo-Saint Blancard, C. Hahn, S. Ho, J. Hou, P. Lemos, E. Massara, C. Modi, A. Moradinezhad Dizgah, L. Parker, Y. Yao, & M. Eickenberg; [Physical Review D](#). [arXiv:2310.15250](#).
- 2023 **“SimBIG: Cosmological Constraints from Non-Gaussian and Non-Linear Galaxy Clustering”**.
C. Hahn, P. Lemos, L. Parker, B. Régaldo-Saint Blancard, M. Eickenberg, S. Ho, J. Hou, E. Massara, C. Modi, A. Moradinezhad Dizgah & D. Spergel; under review in Nature Astronomy. [arXiv:2310.15246](#).
- 2023 **“Multiple Physics Pretraining for Physical Surrogate Models”**.
M. McCabe, B. Régaldo-Saint Blancard, L. Holden Parker, R. Ohana, M. Cranmer, A. Bietti, M. Eickenberg, S. Golkar, G. Krawezik, F. Lanusse, M. Pettee, T. Tesileanu, K. Cho & S. Ho; AI4Science Workshop at NeurIPS 2023 (spotlight talk + best paper award). [arXiv:2310.02994](#).
- 2023 **“Statistical Component Separation for Targeted Signal Recovery in Noisy Mixtures”**.
B. Régaldo-Saint Blancard & M. Eickenberg; [Transactions on Machine Learning Research](#). [arXiv:2306.15012](#).
- 2022 **“Generative Models of Multi-channel Data from a Single Example - Application to Dust Emission”**.
B. Régaldo-Saint Blancard, E. Allys, C. Auclair, F. Boulanger, M. Eickenberg, F. Levrier, L. Vacher & S. Zhang; [The Astrophysical Journal](#). [arXiv:2208.03538](#).
- 2022 **“Single frequency CMB B-mode inference with realistic foregrounds from a single training image”**.
N. Jeffrey, F. Boulanger, B. D. Wandelt, B. Regaldo-Saint Blancard, E. Allys & F. Levrier; [Monthly Notices of the Royal Astronomical Society: Letters](#). [arXiv:2111.01138](#).
- 2021 **“A new approach for the statistical denoising of *Planck* interstellar dust polarization data”**.
B. Regaldo-Saint Blancard, E. Allys, F. Boulanger, F. Levrier & N. Jeffrey; [Astronomy & Astrophysics](#). [arXiv:2102.03160](#).
- 2021 **“Statistical exploration of halo anisotropic clustering and intrinsic alignments with the mass-Peak Patch algorithm”**.
B. Regaldo-Saint Blancard, S. Codis, J. R. Bond & G. Stein; [Monthly Notices of the Royal Astronomical Society](#). [arXiv:2101.01455](#).
- 2020 **“Statistical description of dust polarized emission from the diffuse interstellar medium”**.
B. Regaldo-Saint Blancard, F. Levrier, E. Allys, E. Bellomi & F. Boulanger; [Astronomy & Astrophysics](#). [arXiv:2007.08242](#).
- 2019 **“The RWST, a comprehensive statistical description of the non-Gaussian structures in the ISM”**.
E. Allys, F. Levrier, S. Zhang, C. Colling, B. Regaldo-Saint Blancard, F. Boulanger, P. Hennebelle & S. Mallat; [Astronomy & Astrophysics](#). [arXiv:1905.01372](#).

Contributory and Supporting Roles

- 2024 **“SimBIG: Cosmological Constraints using Simulation-Based Inference of Galaxy Clustering with Marked Power Spectra”**.
E. Massara, C. Hahn, M. Eickenberg, S. Ho, J. Hou, P. Lemos, C. Modi, A. Moradinezhad Dizgah, L. Parker & B. Régaldo-Saint Blancard; [arXiv:2404.04228](#).

- 2024 **“SimBIG: Cosmological Constraints from the Redshift-Space Galaxy Skew Spectra”**.
J. Hou, A. Moradinezhad Dizgah, C. Hahn, M. Eickenberg, S. Ho, P. Lemos, E. Massara, C. Modi, L. Parker & B. Régaldou-Saint Blancard; to appear in *Physical Review D*. [arXiv:2401.15074](#).
- 2023 **“SimBIG: Field-level Simulation-Based Inference of Galaxy Clustering”**.
P. Lemos, L. Parker, C. Hahn, S. Ho, M. Eickenberg, J. Hou, E. Massara, C. Modi, A. Moradinezhad Dizgah, B. Régaldou-Saint Blancard, & D. Spergel; *Physical Review D*. [arXiv:2310.15256](#).
- 2023 **“SimBIG: The First Cosmological Constraints from the Non-Linear Galaxy Bispectrum”**.
C. Hahn, M. Eickenberg, S. Ho, J. Hou, P. Lemos, E. Massara, C. Modi, A. Moradinezhad Dizgah, L. Parker, B. Régaldou-Saint Blancard; *Physical Review D*. [arXiv:2310.15243](#).
- 2023 **“xVal: A Continuous Number Encoding for Large Language Models”**.
S. Golkar, M. Pettee, M. Eickenberg, A. Bietti, M. Cranmer, G. Krawezik, F. Lanusse, M. McCabe, R. Ohana, L. Parker, B. Régaldou-Saint Blancard, T. Tesileanu, K. Cho & S. Ho; AI4Science Workshop at NeurIPS 2023. [arXiv:2310.02989](#).
- 2023 **“AstroCLIP: Cross-Modal Pre-Training for Astronomical Foundation Models”**.
F. Lanusse, L. Parker, S. Golkar, M. Cranmer, A. Bietti, M. Eickenberg, G. Krawezik, M. McCabe, R. Ohana, M. Pettee, B. Régaldou-Saint Blancard, T. Tesileanu, K. Cho & S. Ho; AI4Science Workshop at NeurIPS 2023; [arXiv:2310.03024](#).
- 2023 **“Sensitivity Analysis of Simulation-Based Inference for Galaxy Clustering”**.
C. Modi, S. Pandey, M. Ho, C. Hahn, B. Régaldou-Saint Blancard, B. Wandelt; under review in *Monthly Notices of the Royal Astronomical Society*. [arXiv:2309.15071](#).
- 2023 **“Separation of dust emission from the Cosmic Infrared Background in Herschel observations with Wavelet Phase Harmonics”**.
C. Auclair, E. Allys, F. Boulanger, M. Béthermin, A. Gkogkou, G. Lagache, A. Marchal, M.-A. Miville-Deschênes, B. Régaldou-Saint Blancard & P. Richard; *Astronomy & Astrophysics*. [arXiv:2305.14419](#).
- 2022 **“Towards a non-Gaussian Generative Model of large-scale Reionization Maps”**.
Y. Lin, S. Hassan, B. Régaldou-Saint Blancard, M. Eickenberg & C. Modi; ML4PS Workshop at NeurIPS 2022. [arXiv:2210.14273](#).
- 2022 **“SimBIG: A Forward Modeling Approach To Analyzing Galaxy Clustering”**.
C. Hahn, M. Eickenberg, S. Ho, J. Hou, P. Lemos, E. Massara, C. Modi, A. Moradinezhad Dizgah, B. Régaldou-Saint Blancard & M. Abidi; *Proceedings of National Academy of Sciences*. [arXiv:2211.00723](#).
- 2022 **“SimBIG: Mock Challenge for a Forward Modeling Approach to Galaxy Clustering”**.
C. Hahn, M. Eickenberg, S. Ho, J. Hou, P. Lemos, E. Massara, C. Modi, A. Moradinezhad Dizgah, B. Régaldou-Saint Blancard & M. Abidi; *Journal of Cosmology and Astroparticle Physics*. [arXiv:2211.00660](#).
- 2022 **“Cosmological Information in the Marked Power Spectrum of the Galaxy Field”**.
E. Massara, F. Villaescusa-Navarro, C. Hahn, M. Abidi, M. Eickenberg, S. Ho, P. Lemos, A. Moradinezhad Dizgah & B. Régaldou-Saint Blancard; *The Astrophysical Journal*. [arXiv:2206.01709](#).
- 2022 **“Wavelet Moments for Cosmological Parameter Estimation”**.
M. Eickenberg, E. Allys, A. Moradinezhad Dizgah, P. Lemos, E. Massara, M. Abidi, C. Hahn, S. Hassan, B. Régaldou-Saint Blancard, S. Ho, S. Mallat, J. Anden & F. Villaescusa-Navarro; [arXiv:2204.07646](#).
- 2021 **“A method to statistically characterize turbulent data with physically motivated parameters, illustrated on a centroid velocity map”**.
J.-B. Durrive, P. Lesaffre, T. Ghosh & B. Régaldou-Saint Blancard; [arXiv:2101.07205](#).
- 2019 **“Automatic detection of Interplanetary Coronal Mass Ejections from in situ data: a deep learning approach”**.
G. Nguyen, N. Aunai, D. Fontaine, E. Le Pennec, J. Van den Bossche, A. Jeandet, B. Bakkali, L. Vignoli & B. Régaldou-Saint Blancard; *The Astrophysical Journal*. [arXiv:1903.10780](#).

Software

[GitHub: bregaldo](#)

- PyWST** Statistical analysis of 2D data with the (Reduced) Wavelet Scattering Transform.
- PyWPH** Computation of Wavelet Phase Harmonic statistics for 2D data in PyTorch.
- GalWavelets** Computation of Wavelet Scattering Transform statistics for 3D data (including galaxy surveys) in PyTorch.

Teaching

- 2018 to 2021 **Teaching assistant "Numerical methods for differential equations in Physics"**, *ICFP, ENS Paris*.
Master's level course (faculty: L. Tuckerman). Exercises
- 2019 to 2021 **Lecturer *Physique pour tous***, *ENS Paris*.
Physics course intended for a broad non-scientific audience.
- 2014 to 2015 **Educational coordinator for homework assistance program**, *Association Le Rocher, Les Mureaux*.
Organized daily homework sessions for primary and secondary students of Les Mureaux.

Students Supervision

- since Apr. **Sébastien Pierre**, *4th year student of École Polytechnique, France*.
2024 Summer intern at Flatiron Institute.
- since Apr. **David Heurtel-Depeiges**, *3rd year student of École Polytechnique, France*.
2023 Summer intern at Flatiron Institute, then guest researcher. Led to 2 publications.

Selected Talks

- Feb. 2024 **CCA Galaxy Meeting Group**, *Listening to the Noise: Blind Denoising with Gibbs Diffusion*, Flatiron Institute, New York.
- Dec. 2023 **CCB Inference Discussion Group**, *Simulation-Based Inference for Cosmology: Inferring cosmological parameters from the spatial distribution of galaxies*, Flatiron Institute, New York.
- Dec. 2023 **Measure Transport, Diffusion Processes and Sampling Workshop**, *Diffusion Models for Cosmology: Removing Dust from CMB Observations*, Flatiron Institute, New York.
- Nov. 2023 **Hammers & Nails Workshop**, *Towards Foundation Models for Science*, Monte Verita, Ascona, Switzerland.
- Jun. 2023 **Flatiron Wide Machine Learning Meeting**, *Wavelet Scattering Statistics for Astrophysics*, Flatiron Institute, New York.
- Mar. 2022 **CCM Colloquium**, *Describe and model without learning using wavelet scattering-like statistics: an application to Galactic dust emission*, Flatiron Institute, New York.
- Feb. 2021 **Pan-Experiment Galactic Science Group**, *A new approach for the statistical denoising of Planck interstellar dust polarization data*, virtual.
- Oct. 2020 **NenuFAR Cosmic Dawn meeting**, *Statistical description of dust polarized emission from the diffuse ISM*, virtual.
- Jul. 2020 **IMAGINE meeting**, *Statistical description of dust polarized emission from the diffuse ISM*, virtual.
- May 2019 **SF2A/PCMI talk**, *Statistical description of the magnetized interstellar medium*, Université de Nice Sophia-Antipolis, Nice.
- Apr. 2019 **Gotham City Physics X ML talk**, *Statistical description of the polarized interstellar medium*, Flatiron Institute, New-York.
- Feb. 2019 **TEDx talk**, *Un Univers sans limite ?*, TEDxPULV, Pôle Universitaire Léonard de Vinci, Paris-La Défense.

Various Skills and Interests

- Computer skills Programming: Python, C, C++, parallel programming (MPI, multi-threading, DDP), GPU programming (PyTorch).
Environments: Linux, Mac, Windows.
Scientific tools: Mathematica, Matlab/Simulink.
- Languages French (mother tongue), English (fluent), Spanish (basic).
- Side Interests Music, playing piano and guitar (classical, jazz, pop/rock). Running and squash.