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 to Nov. 2021 **Ph.D. in Astrophysics**, *Laboratoire de Physique de l'École Normale Supérieure, ENS Paris, France*, Supervisors: F. Levrier, F. Boulanger.
Data-driven statistical 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 to Jun. 2018 **Research Internship in Astrophysics**, *Laboratoire de Radioastronomie (LRA/LERMA), 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 to Jul. 2017 **Research Internship in Cosmology**, *Canadian Institute for Theoretical Astrophysics, 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 to Aug. 2016 **Software Engineer Internship**, *Thales, Manchester, UK.*
Network diagnostics on London underground infrastructure.

Oct. 2014 to Apr. 2015 **Intern at Association Le Rocher (Charitable Association)**, *Les Mureaux, France.*
Social work in the sensitive neighborhoods of Les Mureaux.

Education

Oct. 2018 to Nov. 2021 **Ph.D. in Astrophysics**, *Laboratoire de Physique de l'École Normale Supérieure, ENS Paris, France*, Supervisors: F. Levrier, F. Boulanger.
Data-driven statistical 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**, *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. Ingénieur Polytechnicien program. Majors: Physics and Mathematics.

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.*

List of Publications

Google Scholar

Lead or Major Contribution

2024 **"Listening to the Noise: Blind Denoising with Gibbs Diffusion"**.
D. Heurtel-Depeiges*, C. C. Margossian, R. Ohana & B. Régaldo-Saint Blancard; ICML 2024. 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; AISTATS 2024. arXiv:2310.17009. (* Joint first authors)

2023 **"Galaxy Clustering Analysis with SimBIG and 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; accepted 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 or Supporting Role

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. Régaldo-Saint Blancard; 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. Regaldo-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. Régaldo-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. Régaldo-Saint Blancard, T. Tesileanu, K. Cho & S. Ho; AI4Science Workshop at NeurIPS 2023. arXiv:2310.02989.

2023 **"AstroCLIP: A Cross-Modal Foundation Model for Galaxies "**.
L. Parker, F. Lanusse, S. Golkar, L. Sarra, M. Cranmer, A. Bietti, M. Eickenberg, G. Krawezik, M. McCabe, R. Ohana, M. Pettee, B. Régaldo-Saint Blancard, T. Tesileanu, K. Cho & S. Ho; Monthly Notices of the Royal Astronomical Society. arXiv:2310.03024.

2023 **"Sensitivity Analysis of Simulation-Based Inference for Galaxy Clustering"**.
C. Modi, S. Pandey, M. Ho, C. Hahn, B. Régaldo-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. Régaldo-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. Régaldo-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. Régaldo-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. Régaldo-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. Régaldo-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. Régaldo-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. Regaldo-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. Regaldo-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 and projects supervision.

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 May 2024 **Noah Amsel**, *2^{nd}-year PhD student in Computer Science at New York University.*
Summer intern within the Polymathic Initiative. Co-supervision with Alberto Bietti.

since May 2024 **Hidalgo Mudonhi**, *Sophomore student at Alabama A&M University.*
Summer intern at Flatiron Institute. Co-supervision with Chirag Modi.

since Apr. 2024 **Sébastien Pierre**, *4^{th}-year student of École Polytechnique, France.*
Summer intern at Flatiron Institute, then guest researcher. Co-supervision with Michael Eickenberg.

Apr. 2023 - May 2024 **David Heurtel-Depeiges**, *3^{rd}-year student of École Polytechnique, France.*
Summer intern at Flatiron Institute, then guest researcher. Led to 2 publications. Co-supervision with Ruben Ohana.

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.