

Ruben Ohana

Research Fellow, Flatiron Institute. PhD in Machine Learning from École Normale Supérieure.
Building interdisciplinary approaches to optimize ML algorithms. Exploring applications of AI for scientific discovery.

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Positions

Research Fellow - Flatiron Institute (Simons Foundation)

New York City, USA

SUPERVISORS: **R. M. Gower**, **M. Eickenberg**

Oct. 2022 - Current

- Development and training of large machine learning models to tackle complex scientific challenges through the [Polymathic AI collaboration](#) [14,15,16].
- Supervision and development of a project on diffusion models for cosmological data [17].
- Development of a new deep learning optimizer MoMo, less sensitive to learning rate tuning [12].
- Design of an algorithm to generate optically Gaussian random projections without optical holography [13].
- Organization of internal workshops on how to build Large Language Models.

PhD internship - Criteo AI Lab

Paris, France

SUPERVISORS: **L. Ralaivola**, **A. Rakotomamonjy**

Dec. 2021 - March 2022

- Development of a PAC-Bayesian framework for Sliced-Wasserstein distances [11].
- Development of Complex-to-real random features for tensor sketches [3].

Education

PhD in Machine Learning - École Normale Supérieure

Paris, France

SUPERVISORS: **F. Krzakala** (EPFL), **A. Rudi** (INRIA), **L. Daudet** (LIGHTON)

Oct. 2019 - Sept. 2022

Axis of Research:

- Reservoir computing for chaotic time-series prediction [5].
- Improving Adversarial Robustness and Privacy of Neural Networks [7,8, 10].
- Improvement of Optical Computing algorithms [4,9,10, P1].
- Alternative training methods to backpropagation [6,7,8,10].
- (Optical) Random features and kernel methods [3,4,5].

MSc (Master 2) in Mathematics (Statistics & Machine Learning)

Paris, France

SORBONNE UNIVERSITÉ

2018 - 2019

MSc (Master 2) in Physics (Condensed Matter & Quantum Physics)

Paris, France

ÉCOLE NORMALE SUPÉRIEURE, SORBONNE UNIVERSITÉ

2017 - 2018

Diplôme d'ingénieur (major: Physics, minors: Biology & Chemistry)

Paris, France

ÉCOLE SUPÉRIEURE DE PHYSIQUE ET DE CHIMIE INDUSTRIELLES (ESPCI PARIS)

2014 - 2018

Internships

LPENS, Ecole Normale Supérieure

Paris, France

SUPERVISOR: **F. Krzakala**

May 2019 - Nov. 2019

Kernel approximation using optical random features obtained with OPUs [4].

LIP6, Sorbonne Université

Paris, France

SUPERVISOR: **D. Markham**

April 2018 - June 2018

Study of quantum contextuality (generalized Bell inequalities) in quantum information networks [2].

LIGO laboratory, Massachusetts Institute of Technology (MIT)

Cambridge, USA

SUPERVISOR: **P. Fritschel**

May 2017 - July 2017

- Implementation of the optical set-up for noise characterization of the ytterbium fiber laser.
- Characterization of the frequency noise, relative intensity noise, polarization noise of the laser - data analysis.

Quantum Solid State Physics Group, NTT Basic Research Labs

Atsugi, Japan

SUPERVISOR: **H. Irie**

July 2016 - December 2016

Theoretical and experimental study of the Quantum Spin Hall Effect in InAs/(In)GaSb quantum wells [1].

Languages/Computer Science

English Fluent.

French Mother tongue.

Programming Python, Pytorch, Slurm, Multi-GPU training with Deepspeed and Lightning.

Publications

[17] *Removing Dust from Cosmic Microwave Background Observations with Diffusion Models*. D. Heurtel, B. Burkhart, R. Ohana[†], B. Régaldou[†]. [arXiv](#). [Oral @ NeurIPS 2023 ML and the Physical Sciences Workshop](#).

[16] *Multiple Physics Pretraining for Physical Surrogate Models*. [Polymathic AI](#), [arXiv](#). [Best paper award & Oral @ NeurIPS 2023 AI for Science Workshop](#).

[15] *xVal: A Continuous Number Encoding for Large Language Models*. [Polymathic AI](#), [arXiv](#). [NeurIPS 2023 AI for Science Workshop](#).

[14] *AstroCLIP: Cross-modal pre-training for Astronomical Foundation Models*. [Polymathic AI](#), [arXiv](#). [NeurIPS 2023 AI for Science Workshop](#).

[13] *Linear Optical Random Projections Without Holography*. R. Ohana, D. Hesslow, Daniel Brunner, S. Gigan, K. Müller, [arXiv](#), [Optics Express](#).

[12] *MoMo: Momentum Models for Adaptive Learning Rates*. F. Schaipp, R. Ohana, M. Eickenberg, A. Defazio, R. M. Gower, [arXiv](#).

[11] *Shedding a PAC-Bayesian Light on Adaptive Sliced-Wasserstein Distances*. R. Ohana*, K. Nadjahi*, A. Rakotomamonjy, L. Ralaivola, [arXiv](#), [ICML 2023](#).

[10] *Photonic Differential Privacy with Direct Feedback Alignment*. R. Ohana*, H. Ruiz*, J. Launay*, A. Cappelli, I. Poli, L. Ralaivola, A. Rakotomamonjy, [arXiv](#), [NeurIPS 2021](#).

[9] *Photonic co-processors in HPC: using LightOn OPUs for Randomized Numerical Linear Algebra*. D. Hesslow, A. Cappelli, I. Carron, L. Daudet, R. Lafargue, K. Müller, R. Ohana, G. Pariente, I. Poli, [arXiv](#).

[8] *Adversarial Robustness by Design through Analog Computing and Synthetic Gradients*. A. Cappelli*, R. Ohana*, J. Launay, L. Meunier, I. Poli, F. Krzakala, [arXiv](#), [ICASSP 2022](#).

[7] *ROPUST: Improving Robustness through Fine-tuning with Photonic Processors and Synthetic Gradients*. A. Cappelli, J. Launay, L. Meunier, R. Ohana, I. Poli, [arXiv](#).

[6] *The dynamics of learning with feedback alignment*. M. Refinetti, S. d'Ascoli, R. Ohana, S. Goldt, [arXiv](#), [ICML 2021](#).

[5] *Reservoir Computing meets Recurrent Kernels and Structpurple Transforms*. R. Ohana*, J. Dong*, M. Rafayelyan, F. Krzakala, [arXiv](#), [Oral Presentation at NeurIPS 2020](#).

[4] *Kernel computations from large-scale random features obtained by Optical Processing Units*. R. Ohana., J. Wacker, J. Dong, S. Marmin, F. Krzakala, M. Filippone, L. Daudet, [arXiv](#), [ICASSP 2020](#).

[3] *Complex-to-Real Random Features for Polynomial Kernels*. J. Wacker, R. Ohana, M. Filippone, [arXiv](#), [AISTATS 2023](#).

[2] *Experimental Approach to Demonstrating Contextuality for Qudits*. A. Sohbi, R. Ohana, I. Zaquine, E. Diamanti, D. Markham, [arXiv](#), [Physical Review A](#).

[1] *Impact of epitaxial strain on the topological-nontopological phase diagram and semimetallic behavior of InAs/GaSb composite quantum wells*. H. Irie, T. Akiho, F. Couedo, R. Ohana, K. Suzuki, K. Onomitsu, K. Muraki, [arXiv](#), [Physical Review B](#).

Patent [P1]: *Method and System for machine learning using optical data* I. Poli, J. Launay, K. Müller, G. Pariente, I. Carron, L. Daudet, R. Ohana, D. Hesslow. 2021, [US Patent](#).

PhD Manuscript: *Leveraging (Physical) Randomness in Machine Learning Algorithms*, R. Ohana, [HAL Science](#).

Reviewer in International conferences: NeurIPS 21-2023, ICML 21-23, ICLR 23, Nature Comms., ALT, JMLR.