

# Ruben Ohana

Second year PhD Student in Machine Learning at Ecole Normale Supérieure, INRIA & LightOn

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## Education

### Ecole Normale Supérieure (LPENS & DIENS), INRIA & LightOn

Paris, France

PHD STUDENT - SUPERVISORS: FLORENT KRZAKALA, ALESSANDRO RUDI, LAURENT DAUDET

Dec. 2019 - Nov. 2022

- Development of large-scale kernel methods/algorithms based on random features.
- Study of random recurrent Neural networks such as Reservoir Computing and links with kernels methods.
- Use of the Optical Processing Unit to develop fast algorithms using large random matrices.
- Use and development of mathematical tools in nonparametric estimation to determine the efficiency and speed of these algorithms.
- Side projects on Adversarial attacks and Optimal Transport.

### Sorbonne Université (ex-UPMC)

Paris, France

MASTER 2 MATHEMATICS AND APPLICATIONS IN STATISTICS

2018 - 2019

- Relevant courses: Convex optimization, Linear models in high dimension, Statistical learning, Machine learning algorithms, Non-parametric estimation, Monte-Carlo methods, Geometrical inference, Statistical graph theory, Compressed sensing, Online convex optimization, Deep learning, Reinforcement learning.

### Ecole Normale Supérieure de Paris (ENS)

Paris, France

MASTER 2 ICFP (INTERNATIONAL CENTER FOR FUNDAMENTAL PHYSICS), CONDENSED MATTER TRACK

2017 - 2018

- Relevant courses: Statistical physics, Information inference and networks, Complex systems: from physics to social sciences, Symmetries and quantum field theory, Advanced quantum mechanics, Condensed matter theory, Quantum information.

### Ecole Supérieure de Physique et de Chimie Industrielles (ESPCI ParisTech)

Paris, France

MASTER-LEVEL *Diplôme d'ingénieur*, MAJOR IN PHYSICS

2014 - 2018

- Relevant courses: Statistics and modelization, Physics of Signals, Complex Systems, Big Data, Numerical analysis, Statistical thermodynamics, Mathematical methods.

## Internships

### LPENS, Ecole Normale Supérieure

Paris, France

APPROXIMATIONS OF KERNELS AT THE SPEED OF LIGHT USING THE OPU OF LIGHTON (PI: FLORENT KRZAKALA)

May 2019 - Nov. 2019

- Use of approximations of kernels processed by the Optical Processing Unit (OPU) of LightOn.
- Search for the use of these kernel approximations in other machine learning algorithms.
- Looking for mathematical bounds on the accuracy of these kernels generated by the OPU.

### LIP6, Sorbonne Université

Paris, France

CONTEXTUALITY FOR QUANTUM INFORMATION NETWORKS (PI: DAMIAN MARKHAM)

April 2018 - June 2018

- Search for dimension witnesses for contextuality and development of contextuality tests.
- Use of the Cabello/Severini/Winter graph formalism to represent contextual tests and derive bounds to contextual inequalities.

### MIT LIGO laboratory, Massachusetts Institute of Technology (MIT)

Cambridge, USA

NOISE CHARACTERIZATION OF THE YTTERBIUM-DOPED FIBER LASER FOR LIGO (PI: PETER FRITSCHEL)

May 2017 - July 2017

- Implementation of the whole optical set-up for noise characterization of the laser.
- Characterization of the frequency noise, relative intensity noise, polarization noise of the laser - data analysis.
- Following of the lectures *Gravitational waves and effective field theory methods to model binaries*.

### Quantum Solid State Physics Group, NTT Basic Research Laboratories

Atsugi, Japan

QUANTUM SPIN HALL EFFECT IN  $\text{InAs}/(\text{In})\text{GaSb}$  DOUBLE QUANTUM WELLS (PI: HIROSHI IRIE)

July 2016 - December 2016

- Implementation of an experimental set-up, data acquisition and analysis - experimental proof of a topological gap in our samples.
- Establishment and analysis of a model for understanding the Subnikov-de Haas oscillations of our double quantum wells.

## Publications

[1] *Adversarial Robustness by Design through Analog Computing and Synthetic Gradients*. R. Ohana\*, A. Cappelli\*, J. Launay, L. Meunier, I. Poli, F. Krzakala, [Arxiv](#) (Submitted to CVPR 2021)

[2] *The dynamics of learning with feedback alignment*. M. Refinetti\*, S. d'Ascoli\*, R. Ohana, S. Goldt, [Arxiv](#) (Submitted to ICML 2021)

[3] *Reservoir Computing meets Recurrent Kernels and Structured Transforms*. R. Ohana\*, J. Dong\*, M. Rafayelyan, F. Krzakala, [Arxiv](#) (Oral 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](#) (accepted at ICASSP 2020)

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

[6] *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](#), [abs/2002.12503](#). / [PhysRevB.101.075433](#)

## Academic Projects

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**ENGIE Challenge Data (rank: 33/185)** Predict wind power production from wind turbine operational data (supervised learning). Data preprocessing, feature engineering and model selection.

**Scientific Team Project (ESPCI, 18 months)** Assembly of an electrospray and study of the nano-drops on a liquid (water or oil) collector, as well as the different modes of the spray. Video of the project available [here](#).

## Languages/Computer Science

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**English** Fluent - Degrees: BULATS (level C1, June 2013), TOEIC (965/990, March 2017).

**French** Mother tongue.

**Computer skills** Training and inference using Neural Networks in **Python and Pytorch**. Matlab, R, Arduino, Quantum Espresso, Labview.

## Extracurricular Activity

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**Association** President of the Langevinium (1 year), the laboratory for students of the ESPCI: implementation of a superconductive train self-propelled by liquid nitrogen, showing of many scientific experiments at the *Collège de France* and the *Grand Palais*.

**Music** Harp (11 years of practice, *Diplôme de fin d'études du Conservatoire de Rueil-Malmaison*, 1st Medal), music theory.

**Teaching** Private tutoring (mathematics, quantum physics, chemistry, music theory) to students from various levels.