Master 2: ***International Centre for Fundamental Physics***

INTERNSHIP PROPOSAL

(One page maximum)

Laboratory name: LISN, Université Paris-Saclay
CNRS identification code: UMR 9015
Internship director'surname: G Charpiat, S Chibbaro, L Mathelin
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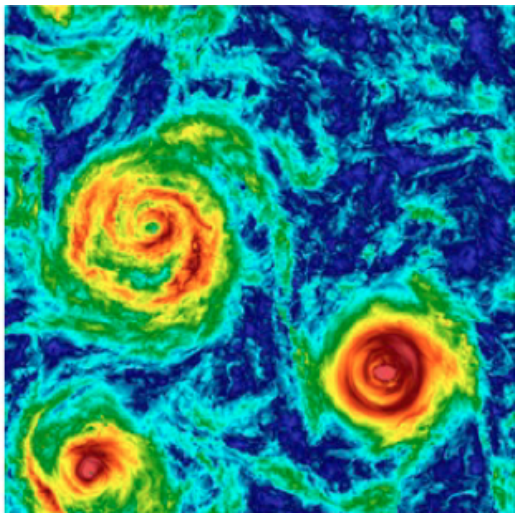
Web page: Scholar profiles for Charpiat and Chibbaro
Internship location: LISN, Saclay

Thesis possibility after internship: YES
Funding: NO (maybe) If YES, which type of funding:

Deep Learning extreme events in complex systems



In the last decade, machine learning (ML), and more specifically deep neural networks (DNN), have thoroughly renewed the research perspectives in many fields like Natural Language Processing and Computer Vision.
The introduction of ML approaches in physical systems remains a challenge to overcome the lack of confidence, acceptability, guarantees and explainability This project aims at developing new Machine Learning techniques tailored to the modelling and inference of turbulence as a prototype of high-dimensional complex physical systems described by partial differential equations (PDEs)
For chaotic systems, instead of trying to make long-term predictions as accurate as possible on a given dataset of simulations, we will try to get at least the statistics correct. That is, when generating many trajectories, do we produce vortices at different spatial scales with the right probabilities? Does our learned system ``look like'' the real system in some statistical sense?
This is a key point. Turbulence is multi-scale and that is reflected by a lack of self-similarity which leads to an increased probability of having very strong events at the smallest scales (as in figure). We are interested notably to these rare events.
To tackle such an objective, we will face several challenges, including:
(i)finding a suitable neural network architecture; (ii) properly designing a training criterion or ML procedure, to train toward predicting the right statistics.

The project is strongly interdisciplinary with an interplay of applied mathematics, statistical physics, fluid mechanics and informatics Depending on the skills of the candidate, different tracks can be explored.

Condensed Matter Physics: YES Soft Matter and Biological Physics: YES
Quantum Physics: NO Theoretical Physics: YES