Master trainee and/or PhD position

Building random fields for the large scales of turbulent flows with large deviation theory and functional renormalization group approaches.

Supervised by *Freddy BOUCHET*. This project possibly involves a collaboration with Gregory Eyink (John Hopkins University, Baltimore, USA) and Léonie Canet (UGA, Grenoble, France).
Where: École Normale Supérieure de Lyon - Laboratoire de physique (ENSL-CNRS, Lyon, France).

Scientific description: Constructing effective random velocity fields which describe properly the statistics of turbulent flows is extremely important. On one hand, this would answer some fundamental issues [1] about turbulence theory. On the other hand, from the point of view of applications, this would lead to effective models of the large scales of turbulent flows in which the small-scale turbulence has been parameterized from first principle. This would be a huge step forward for engineer or climate applications, for example.

Using large deviation theory, we recently obtained a large deviation characterization of effective field theories for interacting particle systems [2,3]. In parallel, new approaches in functional nonperturbative renormalization group approaches led to impressive results for the description of turbulent cascades [4]. The aim of this project will be to participate to a theoretical team project, whose aim is to use those new ideas in order to construct effective random velocity fields for turbulent flows. Various configurations will be explored, some with clear expected results for instance in two-dimension, others more challenging but with an expected huge scientific impact for instance in 3D.

This project is clearly a theoretical one. It will require technical skills in statistical mechanics and turbulence, that a candidate with a strong theoretical background could learn along the way. It will also require the use of numerical tools to actually compute some of the functions that characterize the statistical field theories.

[1] G. Eyink, Review of the Onsager Ideal Turbulence Theory, *arXiv:1803.02223* (2018).
[2] F. Bouchet, Is Boltzmann's equation reversible? A large deviation perspective on the irreversibility paradox, *to be submitted to J. Stat. Phys.,* Please ask me, (2019).
[3] O. Feliachi and F. Bouchet, Large deviations for the Landau and Balescu–Guernsey–Lenard equations, *to be submitted to J. Stat. Phys.,* Please ask me, (2019).
[4] L. Canet, B. Delamotte, and N. Wschebor, Phys. Rev. E **93**, 063101 (2016).

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