Workshop "TURBIN – Turbulence & Intermittency"

Villeurbanne (France) – 28 february 2022

Book of abstracts

- **Laurent Chevillard**
  Intermittency in three-dimensional fluid turbulence, and its modeling using random fields.

  Abstract:
  I will first quickly review experimental and numerical observations of the intermittency phenomenon, and move towards its probabilistic modeling using so-called fractional (i.e. monofractal) Gaussian fields, and their generalizations to a multifractal setup while introducing a multiplicative chaos. If some time is left, I will then show how to define some aspects of these realistic random fields as statistically stationary solutions of some evolutions, governed by partial differential equations stirred by a smooth random force term. This last part is joint work with G. Apolinário and J.-C. Mourrat.

- **Laure Saint-Raymond**
  Internal waves : a linear energy cascade

  Abstract:
  Stratification of the density in an incompressible fluid is responsible for the propagation of internal waves. In domains with topography, these waves exhibit interesting properties. In particular, in response to a macroscopic forcing, they generate oscillations at all scales, leading to a cascade phenomenon. At the mathematical level, this behavior can be analyzed in the inviscid case with tools from spectral theory and microlocal analysis.

- **Simon Thalabard**
  Anomalous exponents in local models of turbulence

  Abstract:
  I will outline outgoing efforts to analyze the blow-up properties arising in a parametric class of local turbulence models with two conservation laws. In a regime relevant in particular to the physics of 4-wave resonant systems, blow-up apparently occurs in finite time through an apparent inverse cascade process, with faint but unequivocal anomalous scaling. I will discuss how this anomaly ties to the presence of a global bifurcation within an associated 4D dynamical system. This connection allows to extract the scaling exponents from systematic numerical continuation techniques. It also suggests that "anomalous" scaling is there a generic feature; in other words, the absence and not the presence of anomalies is the abnormal behavior.

- **Luis Vega**
  Intermittency and the Talbot effect

  Abstract:
  Intermittency is a physical phenomenon for which there is still no precise mathematical definition and which appears in different fields, particularly in the field of fluid turbulence. It is therefore relevant to find good examples that mathematically can be understood in detail. In the talk I will present several of these examples that have in common the so-called Talbot effect. Intermittency is in all of them a consequence of how irrational numbers are approximated by rational ones.

- **François Vigneron**
  On some properties of the curl operator and their consequences for the Navier–Stokes system

Abstract:
We investigate some geometric properties of the curl operator, based on its diagonalization and its expression as a non–local symmetry of the pseudo–derivative $(-\Delta)^{1/2}$ among divergence–free vector fields with finite energy. In this context, we introduce the notion of spin–definite fields, i.e. eigenvectors of $(-\Delta)^{-1/2}$ *curl*. The two spin–definite components of a general 3D incompressible flow untangle the right–handed motion from the left–handed one.
The non–linearity of Navier–Stokes has the structure of a cross–product. In the case of a finite–time blow–up, both spin–definite components of the flow will explode simultaneously and with equal rates, i.e. singularities in 3D are the result of a conflict of spin, which is impossible in the poorer geometry of 2D flows. We investigate the role of the local and non–local determinants $det\ (curl\ u,\ u,\ (-\Delta)^{\theta} u)$, which drive enstrophy and are responsible for the regularity of the flow or the emergence of singularities or quasi-singularities. As such, they are at the core of turbulence phenomena.