Thursday

09:00 – 09:45 Keynote Lecture

Speaker: **Eyink, Gregory**; The Johns Hopkins University, USA.
Title: Stochastic Lagrangian Dynamics of Vorticity in Wall-Bounded Navier-Stokes Turbulence

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09:45 – 10:05

Speaker: **Gibbon, John D.**; Imperial College London, UK.
Title: The Navier-Stokes Bermuda Triangle

10:05 – 10:25

Speaker: **Pumir, Alain**; ENS de Lyon and CNRS, France.
Title: Extremely large velocity gradients in turbulent flows

10:25 – 10:45

Speaker: **Bardos, Claude**; Université de Paris 7- Denis Diderot, France.
Title: A baby version of the Landau damping and a road map to the Quasilinear approximation

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10:45 – 11:15

Tea/Coffee break

11:15 – 11:35

Speaker: **Mailybaev, Alexei**; Instituto Nacional de Matemática Pura e Aplicada - IMPA, Brasil.
Title: Fluid Dynamics on Logarithmic Lattices: Theory and Applications

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11:35 – 11:55

Speaker: **Mininni, Pablo**; Universidad de Buenos Aires, Argentina.
Title: Dual cascades in quantum turbulence

11:55 – 12:15

Speaker: **Volk, Romain**; ENS de Lyon, France.
Title: Lagrangian acceleration time scales in anisotropic turbulence

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12:15 – 12:35

Speaker: **Tuckerman, Laurette**; ESPCI, Paris, France.
Title: Transition to turbulence in wall-bounded shear flows: model Waleffe flow and directed percolation

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12:35 – 14:00

Lunch @ Conference venue

Thursday
(Abstracts)

09:00 – 09:45 Keynote Lecture

Title:
Stochastic Lagrangian Dynamics of Vorticity in Wall-Bounded Navier-Stokes Turbulence

Speaker:
Gregory Eyink[1], Akshat Gupta[2] , Tamer Zaki[1]
1 : Johns Hopkins University
2 : Technische Universität München

Abstract :
The fundamental geometric and Lagrangian properties of vorticity for a smooth Euler solution have been generalized to viscous Navier-Stokes solutions by Constantin & Iyer (2008, 2011) using a stochastic Lagrangian framework. As we show, this theory is best understood within the Kuz'min-Oseledets formulation of Navier-Stokes, in terms of the "vortex momentum" associated to a continuous distribution of infinitesimal vortex rings. This theory provides an infinite set of exact Lagrangian conservation laws for Navier-Stokes vorticity, the "stochastic Cauchy invariants". These are preserved only backward in time, due to the irreversibility of Navier-Stokes dynamics. For wall-bounded flows, these invariants allow a complete representation of interior vorticity in terms of the vorticity generated at a solid wall, as it is advected, stretched and rotated by the flow. Just as in superfluids, this cross-stream transport of tangential vorticity generated at the wall is exactly related to drag and energy dissipation via the Taylor-Josephson-Anderson relation. We exploit the stochastic Cauchy invariants in a numerical implementation using a space-time database of turbulent channel-flow at Re_τ=1000. In contrast to conventional pictures, we show that the process of vortex-lifting in the wall buffer layer, crucial to turbulent drag-generation, is not an abrupt lifting of discrete vortex lines but is instead a distributed event over past space-time and involves intense competition between linear viscous destruction of vorticity and nonlinear Lagrangian chaos that exponentially magnifies & rotates vorticity.

09:45 – 10:05

Title:
The Navier-Stokes Bermuda Triangle

Speaker:
John D. Gibbon; Imperial College London, UK.

Abstract:
When looked at through the eyes of the scaling invariance $u \to \lambda^{-1}u\left(x/\lambda\,; t/\lambda^{2}\right)$ it becomes clear why current methods of analysis naturally yield results on weak solutions, whereas results on full $3D$ NS-regularity are out of reach. Indeed, most of the known results on these can be reduced to two lines. If time permits I will show how this feeds into some numerical simulations.

10:05 – 10:25

Title:
Extremely large velocity gradients in turbulent flows

Speaker:
Alain Pumir; ENS de Lyon and CNRS, France.

Abstract:
Very turbulent flows are characterized by extremely intense velocity gradients, the more so as the flow is more turbulent (in quantitative terms, as the Reynolds number increases). These extreme events raise several important fundamental questions. Using a systematic numerical study of turbulent flows, at extremely high spatial and temporal resolution, I will show that the statistics of very intense velocity gradients obeys simple laws. I will also present our results concerning the structure of the regions of extreme velocity gradients. Finally, I will discuss the implications of the numerical results for flows in the limit of infinite Reynolds number.

10:25 – 10:45

Title:
A baby version of the Landau damping and a road map to the Quasilinear approximation

Speaker:
Claude Bardos; Université de Paris 7- Denis Diderot, France.

Abstract:
The quasi linear approximation is a basic tool in Plasma Physic. People relate it to the Landau Damping with the belief that the material included in Mouhot-Villani may contribute to a better understanding and more complete proofs.

In Mouhot Villani or Cagliotti Maffei one shows, that $F (x,v,t)$ the solution of the Vlasov equation converges weakly for $t\rightarrow \infty$ to an x independent function $\overline {F }(v)$ and that the difference $$F(x-vt,v,t)-\overline {F }(v)$$ converges to 0 in $L^\infty (\TT \times \R^d).$ Hence the Electric field goes also goes to 0.

Here instead of letting $t\rightarrow 0$ I will consider the problem for a finite time $0\le t\le T<\infty$ and introduce (in agreement with physic) a scaling parameter $\epsilon \rightarrow 0$.

For random electric field one obtains a complete proof while for self consistent potential many things become simpler and in the understanding of the quasilinear approximation striking similarities appears.

Joint work in progress with NICOLAS BESSE

10:45 – 11:15

Tea/Coffee break

11:15 – 11:35

Title: Fluid Dynamics on Logarithmic Lattices: Theory and Applications

Speaker: **Alexei Mailybaev**[1], Ciro Campolina[1] , Dmitry Agafontsev[2]
1 : Instituto Nacional de Matemática Pura e Aplicada
2 : P.P. Shirshov Institute of Oceanology

Abstract:

We present a new approach to constructing toy models for fluid dynamics with the distinctive property of preserving the full infinitely dimensional symmetry group, i.e., all inviscid invariants. The idea is to define a proper calculus in a reduced space (a logarithmic lattice), such that all equations and manipulations become formally equivalent to the ones in fluid dynamics. We show that a sequence of models can be produced with the increasing resolution. As an application we study the blowup problem for the ideal Boussinesq equations for 2D natural convection. We show that the blowup in this system is chaotic, anomalously multiscale, and robust to the choice of a simplified model. These conclusions are compared with the high-resolution DNS for original equations.

11:35 – 11:55

Title: Dual cascades in quantum turbulence

Speaker: **Pablo Mininni**; Universidad de Buenos Aires, Argentina.

Abstract:
Dual cascades are observed in classical turbulent flows when their equations of motion conserve more than just one ideal invariant. The dual direct cascade of energy and of helicity in three-dimensional (3D) hydrodynamics, and the coexistence of an inverse cascade of energy and a direct cascade of enstrophy in two-dimensional (2D) hydrodynamic turbulence are two examples. In this talk I will present evidence of the presence of dual cascades in quantum turbulence described by the Gross-Pitaevskii equation. In 3D helical quantum turbulence a dual cascade of energy and of helicity can develop, in good agreement with the classical phenomenology of Brissaud, Frisch, Leorat, Lesieur and Mazure. But perhaps more surprisingly, under certain conditions in quantum turbulence an inverse cascade of energy can coexist with a direct cascade. For thin 3D domains, of for quasi-2D flows in cubic domains, a critical transition separates a 3D regime with a direct cascade of energy from a 2D regime with an inverse cascade of energy and a small transfer of energy to small scales.

11:55 – 12:15

Title:
Lagrangian acceleration time scales in anisotropic turbulence

Speaker:

Romain Volk[1], Peter Huck[2] , Nathanael Machicoane[2]
1 : Laboratoire de Physique de l'ENS Lyon
CNRS : UMR5672, École Normale Supérieure (ENS) - Lyon
2 : University of Washington - Department of Mechanical Engineering, Seattle, WA, USA

Abstract:

We present experimental Lagrangian measurements of tracer particle acceleration auto-correlation functions in an anisotropic and inhomogeneous flow spanning the typical range of experimentally accessible Reynolds numbers. The large scale forcing of the flow creates a stagnation point topology where straining motion governs the anisotropic velocity and acceleration fluctuations. We show that the time scales of the acceleration components remain anisotropic at high Reynolds numbers and that they are related to the dissipative time scale by the Lagrangian structure function scaling constants C0 and a0. The scaling relation proposed herein is supported by observations using experimental Lagrangian trajectory data sets and analytical calculations using a jointly-Gaussian two-time stochastic model. Examination of acceleration power spectra show that acceleration fluctuations become isotropic in the dissipative range which suggests that the acceleration time scale is not only determined by small scales, but also by large and anisotropic scales whose contributions are substantial, even in the high Reynolds number limit.

12:15 – 12:35

Title:
Transition to turbulence in wall-bounded shear flows: model Waleffe flow and directed percolation

Speaker:

Laurette Tuckerman[1], Matthew Chantry[2] , Dwight Barkley[3]
1 : PMMH-CNRS-ESPCI-UPD
PMMH
75005 Paris, France - France
2 : Department of Atmospheric, Oceanic and Planetary Physics [Oxford]
3 : Warwick Mathematics Institute

Abstract:

Experiments and numerical simulations have shown that transitional turbulence in wall-bounded shear flows is not statistically homogeneous, but composed of long oblique turbulent bands, if the domains are sufficiently large to accomodate them. These bands have been observed in in plane Couette, plane Poiseuille flow, counter-rotating Taylor-Couette flow, torsional Couette flow, and annular pipe flow. At their upper Reynolds-number threshold, they appear with a regular spatial wavelength as laminar regions

carve out gaps in otherwise uniform turbulence. At the lower threshold, turbulent bands sparsely populate otherwise laminar domains and complete laminarization takes place via their disappearance.
In consequence, the spatial domains in which transition must be studied must be much larger than the gap. We have achieved this by simulating a modified version of plane Couette flow, in which the rigid walls are replaced by stress-free boundaries and the resolution is drastically truncated. This Model Waleffe Flow nonetheless displays the same sequence of transitional states as wall-bounded Couette flow, i.e. transient spots, regular turbulent-laminar bands, and uniform turbulence. This shows these phenomena are very robust and that the walls and their associated boundary layers do not play a role in producing them: the necessary ingredients are only shear and confinement. MWF is sufficiently economical to allow numerical simulations with very large horizontal dimensions (4096 x 4096 or 8192 x 2048 in gap units) and over very long times (10^6 advective time units). These simulations demonstrate that the transition to turbulence is continuous, via band extinction, and is in the universality class of directed percolation in two spatial dimensions.

12:35 – 14:00

Lunch @ Conference venue