Turbulence and Mixing in Fluid Dynamics

Report of Contributions

https://indico.global/e/9661

Contribution ID: **1** Type: **not specified**

Intermittency and Dissipation

Thursday, 15 January 2026 10:30 (1 hour)

Intermittency is a remarkable feature of three-dimensional turbulence for which we still lack explanation from first principles. It will be shown how a dissipation with a non-trivial lower-dimensional part induces a quantitative intermittent regularity of the weak solution. The result is in fact more general than that.

Presenter: DE ROSA, Luigi (Gran Sasso Science Institute)

Contribution ID: **2** Type: **not specified**

Generic small scale creation in Perfect fluids

Thursday, 15 January 2026 17:30 (1 hour)

In this talk I will present a recent result in collaboration with Thomas Alazard (CNRS-École Polytechnique) showing generic growth of sobolev norms of the vorticity in the 2d Euler equations.

Presenter: SAID, Ayman (CNRS-LMR)

Contribution ID: **3** Type: **not specified**

Uniqueness of the 2D Euler equation on rough domains

Monday, 12 January 2026 17:30 (1 hour)

We consider the 2D incompressible Euler equation on a bounded simply connected domain. We give sufficient conditions on the domain so that for all bounded initial vorticity, the weak solutions are unique. Our sufficient conditions allow us to prove uniqueness for a large subclass of $C^{1,\alpha}$ domains and convex domains. Previously uniqueness for general bounded initial vorticity was only known for $C^{1,1}$ domains with possibly a finite number of acute angled corners. The fundamental barrier to proving uniqueness below the $C^{1,1}$ regularity is the fact that for less regular domains, the velocity near the boundary is no longer log-Lipschitz. We overcome this barrier by defining a new change of variable which we then use to define a novel energy functional. This is joint work with Andrea Nahmod.

Presenter: AGRAWAL, Siddhant (University of Colorado Boulder)

Contribution ID: **4** Type: **not specified**

Long-wave instabilities of general shear flows for 2D viscous fluids

Monday, 12 January 2026 10:30 (1 hour)

In 1959, Kolmogorov proposed to study the instability of the shear flow (sin(y),0) in the vanishing viscosity regime in tori of different aspect ratios. This question was later resolved by Meshalkin and Sinai in the ‘60s. Generalizing their picture, we focus on instability properties for general shear flows (U(y),0) and we show that they always exhibit a long-wave instability mechanism. This confirms previous findings by Yudovich in 1966 and is established through two independent approaches: one via the construction of Kato’s isomorphism and one via normal forms. In both cases, unlike in many other applications of these methods, the corresponding operators are not small perturbations of a given simpler operator. This is a joint work with M. Colombo, P. Ventura and R. Montalto.

Presenter: DOLCE, Michele (EPFL)

Contribution ID: **5** Type: **not specified**

Kinetic wave equations and turbulence

Thursday, 15 January 2026 09:00 (1 hour)

Wave Turbulence arises in nonlinear wave or dispersive equations in a chaotic regime. It shares many features with hydrodynamic turbulence, but there is a decisive difference: the ensemble dynamics are expected to be described by a kinetic equation. This gives a link between the Hamiltonian system and the turbulent behavior which opens the door to a mathematical analysis. I will present the general ideas and the latest developments.

Presenter: GERMAIN, Pierre

Contribution ID: **6** Type: **not specified**

Stability of multiple Lamb dipoles

Tuesday, 13 January 2026 16:30 (1 hour)

Classical variational approach of maximizing the kinetic energy under constraints provides nonlinear stability of the maximizing vortex configuration in various settings, but this approach fails to handle the situations where the vorticity is concentrated at multiple points in the fluid domain. This is simply because such configurations are not even local kinetic energy maximizers, even when we restrict the admissible class using all known coercive conserved quantities. We present results on nonlinear stability of superpositions of several Lamb dipoles, obtained by combining classical variational principle with dynamical bootstrapping schemes. This is based on several joint works with Ken Abe, Kyudong Choi, Guolin Qin, and Yao Yao.

Presenter: JEONG, In-Jee

Contribution ID: **7** Type: **not specified**

Stability of stratified density under incompressible flows

Friday, 16 January 2026 09:00 (1 hour)

In this talk, I will discuss asymptotic stability in the incompressible porous media equation in a periodic channel. It is well known that a stratified density, which strictly decreases in the vertical direction, is asymptotically stable under sufficiently small, smooth perturbations. We achieve optimality in the regularity assumptions on the perturbation and in the convergence rate. We apply a similar idea to the Stokes transport system. Instead of relying on the linearized equations, we directly address the nonlinear problem, and the decay of solutions will be obtained from the gradient flow structure of the equation.

Presenter: PARK, Jaemin (Yonsei University)

Contribution ID: **8** Type: **not specified**

Lyapunov Exponents and Mixing in DiPerna-Lions Flows

Wednesday, 14 January 2026 10:30 (1 hour)

In 2003, Bressan proposed a conjecture on the mixing efficiency of incompressible flows, which remains open. This talk surveys progress toward resolving Bressan's mixing conjecture and presents a new result confirming its asymptotic validity for time-periodic velocity fields. We accomplish this by adapting dynamical systems tools to the non-smooth framework of DiPerna-Lions flows. Furthermore, we discuss links to bounds on metric entropy and extensions of the Ruelle inequality.

Presenter: BRUÈ, Elia

Contribution ID: **9** Type: **not specified**

Unstable vortices and sharp nonuniqueness for the forced SQG equation

Tuesday, 13 January 2026 17:30 (1 hour)

In this talk, we present a non-uniqueness result for the forced SQG equation in supercritical Sobolev spaces. A key step is the construction of smooth, compactly supported vortices that exhibit nonlinear instability. This is joint work with Á. Castro, D. Faraco, and M. Solera.

Presenter: MENGUAL, Francisco

Contribution ID: **11** Type: **not specified**

Viscous evolution of a point vortex in a half-plane

Monday, 12 January 2026 09:00 (1 hour)

As a model for vortex-wall interactions, we consider the two-dimensional incompressible Navier-Stokes equations in a half-plane with no-slip boundary condition and point vortices as initial data. We concentrate on the paradigmatic example of a single vortex in an otherwise stagnant fluid, which is already quite challenging from the mathematical point of view. As a warm-up, we prove that this system has a unique global solution for all values of the Reynolds number, which can be defined in this context as the ratio of the circulation of the vortex to the kinematic viscosity of the fluid. The solution we construct has finite energy for all positive times, and converges to zero in energy norm as time goes to infinity. Our ultimate goal is to understand the motion of the vortex center in the vanishing viscosity limit, but this question is very difficult due to the vortex-induced boundary layer separation, a phenomenon that is well documented in the physical literature. This talk is based on an ongoing work with Anne-Laure Dalibard (Sorbonne Université).

Presenter: GALLAY, Thierry

Contribution ID: **12** Type: **not specified**

Talk

Contribution ID: **13** Type: **not specified**

Exponential mixing on the sphere via zonal flows

Monday, 12 January 2026 11:30 (30 minutes)

We construct an incompressible velocity field on the two dimensional unit sphere by alternating two zonal flows with random amplitudes. We show that the time evolution of any mean-free initial data passively advected by the velocity field is exponentially mixed in time.

This is a joint work with Marc Nualart.

Presenter: DEL ZOTTO, Augusto

Contribution ID: **14** Type: **not specified**

Non-admissibility of Spiral-like strategies in Bressan's Fire Conjecture

Monday, 12 January 2026 15:00 (1 hour)

In this talk we will introduce Bressan's Fire Conjecture: it is concerned with the model of wild fire spreading in a region of the plane and the possibility to block it using barriers constructed in real time. The fire starts spreading at time $t = 0$ from the unit ball $B_1(0)$ in every direction with speed 1, while the length of the barrier constructed within the time t has to be lower than σt, where σ is a positive constant (construction speed). If $\sigma \leq 1$ Bressan proved that no barrier can block the spreading of the fire, while if $\sigma > 2$ there exists always a strategy that confines the fire. In 2007 Bressan conjectured that if $\sigma \leq 2$ then no barrier can block the fire. In this talk we will prove Bressan's Fire Conjecture in the case barriers are spirals. Moreover, we will give the construction of the optimal spiral, showing that any spiral can block the fire if $\sigma \geq 2.6144..$ (critical speed for spirals).

This is a joint work with Stefano Bianchini.

Presenter: ZIZZA, Martina

Contribution ID: **15** Type: **not specified**

Concentration-cancellation for mixed sign vortex sheets via sparseness

Monday, 12 January 2026 16:30 (1 hour)

A famous result of Delort (1991) establishes the concentration-cancellation phenomenon for approximating solutions of 2D Euler equations with a vortex sheet whose vorticity maximal function has a log-decay of order $1/2$. Moreover, this result is optimal in the setting of vortex sheets with distinguished sign. Without distinguished sign, DiPerna and Majda (1987) showed that if the log-decay assumption is strictly larger than 1 then the lack of concentration (and hence energy conservation) holds. Then the gap problem for mixed sign vortex sheets asks: concentration-cancellation vs. energy conservation in the remaining log-range $(1/2, 1]$?

Presenter: DOMÍNGUEZ, Óscar

Contribution ID: **16** Type: **not specified**

Talk

Contribution ID: **17** Type: **not specified**

Talk

Contribution ID: **18** Type: **not specified**

Overhanging solitary water waves

Tuesday, 13 January 2026 09:00 (1 hour)

In this talk we consider the classical water wave problem for an incompressible inviscid fluid occupying a time-dependent domain in the plane, whose boundary consists of a fixed horizontal bed together with an unknown free boundary separating the fluid from the air outside the confining region.

We provide the first construction of overhanging gravity water waves having the approximate form of a disk joined to a strip by a thin neck. The waves are solitary with constant vorticity, and exist when an appropriate dimensionless gravitational constant is sufficiently small. Our construction involves combining three explicit solutions to related problems: a disk of fluid in rigid rotation, a linear shear flow in a strip, and a rescaled version of an exceptional domain discovered by Hauswirth, Hélein, and Pacard, the hairpin. The method developed here is related to the construction of constant mean curvature surfaces through gluing.

This result is in collaboration with J. Davila, M. Del Pino, M. Wheeler.

Presenter: MUSSO, Monica (University of Bath)

Contribution ID: **19** Type: **not specified**

The Obukhov–Corrsin spectrum of passive scalar turbulence through anomalous regularization

Tuesday, 13 January 2026 10:30 (1 hour)

The Obukhov–Corrsin spectrum predicts the distribution of Fourier mass for a passive scalar field advected by a "turbulent" velocity field with spatial regularity between 0 and 1 and subject to a time-stationary forcing. We discuss how a form of the Obukhov–Corrsin spectrum holds as a consequence of a sharp anomalous regularization result as well as the proof of this anomalous regularization for a broad class of Kraichnan-type models.

Presenter: KEEFER, Rowan

Contribution ID: **20** Type: **not specified**

Stability and instability of vortices

Tuesday, 13 January 2026 11:30 (30 minutes)

We will present a new criterion to study the non purely-imaginary spectrum of linear Hamiltonian operators. We will apply it to prove linear stability or instability of steady solutions of the Euler equations.

Presenter: CAO LABORA, Gonzalo

Contribution ID: **21** Type: **not specified**

Singularity formation in fluid dynamics

Tuesday, 13 January 2026 15:00 (1 hour)

In this talk, I will talk about some of our recent results regarding singularity formation in incompressible fluid dynamics, including models such as 3 dimensional Euler and Incompressible Porous Media.

Presenter: MARTÍNEZ ZOROA, Luis

Contribution ID: **22** Type: **not specified**

Talk

Contribution ID: **23** Type: **not specified**

Talk

Contribution ID: **24** Type: **not specified**

How Randomness Prevents Super Exponential Mixing in Fluids

Wednesday, 14 January 2026 09:00 (1 hour)

I will present recent work with M. Hairer, T. Rosati, and J. Yi on the maximum rate of mixing in randomly stirred fluids. By analyzing the top Lyapunov exponent for the advection-diffusion and linearized Navier-Stokes equations, we prove that the decay rate cannot be infinitely fast. Our main result establishes a quantitative lower bound on this rate that depends on a negative power of the diffusion parameter.

This finding provides the first rigorous lower bound on the Batchelor scale in stochastically driven systems. To do this, we leverage the concept of "high-frequency stochastic instability," a mechanism where random stirring prevents energy from getting trapped in fine-scale patterns where it would dissipate too quickly.

Presenter: PUNSHON-SMITH, Samuel

Contribution ID: **25** Type: **not specified**

Talk

Contribution ID: **26** Type: **not specified**

Talk

Contribution ID: **27** Type: **not specified**

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Contribution ID: **28** Type: **not specified**

Variational approach to touching dipoles

Thursday, 15 January 2026 11:30 (30 minutes)

In this talk, I will discuss touching dipoles (Sadovskii vortices) in the 2D Euler flows, which are traveling wave solutions whose vorticity support remains in contact with a symmetry axis.
I will explain how a family of touching dipoles arises as maximizers of the kinetic energy under natural constraints. This family includes classical examples such as the Chaplygin-Lamb dipole and Sadovskii vortex patch as particular cases.

Presenter: WOO, Kwan

Contribution ID: **30** Type: **not specified**

Talk

Contribution ID: **31** Type: **not specified**

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Contribution ID: **32** Type: **not specified**

Talk

Contribution ID: **33** Type: **not specified**

Ergodicity for SPDEs driven by divergence-free transport noise

Friday, 16 January 2026 10:30 (1 hour)

We study the ergodic behaviour of the McKean–Vlasov equations driven by common divergence-free transport noise. In particular, we show that in dimension $d \geq 2$, if the noise is mixing and sufficiently strong it can enforce the uniqueness of invariant measures, even if the deterministic part of equation has multiple steady states. This is joint work with Benjamin Gess and Adrian Martini.

Presenter: GVALANI, Rishabh

Contribution ID: **34** Type: **not specified**

Overhanging solitary water waves

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Presenter: MUSSO, Monica (University of Bath)