JEFS - Journées Écoulements & Fluides - Saclay

Rapport sur les contributions

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ID de Contribution: **40** Type: **Présentation orale**

Modeling Tsunamis from Dynamic Earthquake Sources: A High-Order Spectral Solver

mardi 24 juin 2025 14:40 (20 minutes)

Despite progress in tsunami modeling, the role of earthquake dynamics in tsunami generation remains underexplored, as traditional models typically assume instantaneous seabed displacement. This study investigates the impact of dynamic rupture processes on tsunamigenesis, a multiscale problem involving high-frequency seismic waves and slower tsunami waves. We introduce a high-order spectral tsunami solver based on the Fourier Continuation (FC) method, which minimizes numerical dispersion, making it well-suited for long-distance and long-time wave propagation. The solver applies to the nonlinear shallow water equations, extended to include time-dependent seabed motion. Building on prior 1D studies of the 2018 Sulawesi tsunami, we develop a fully 2D version capable of modeling realistic earthquake-driven tsunamis. Numerical experiments demonstrate high-order convergence, efficiency, and accuracy through comparisons with high-order finite difference methods and validation against benchmark cases and observational data. This approach offers a promising tool for improved hazard assessment and early warning systems.

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Classification de Session: Présentations

ID de Contribution: **41** Type: **Présentation orale**

Fragmentation of a Cohesive Granular Aggregate Upon Impact

mardi 24 juin 2025 12:00 (20 minutes)

When solid grains are mixed with a small amount of liquid, they can form a cohesive aggregate, held together by capillary bridges. Upon impacting a solid surface, such a granular aggregate fragments into multiple pieces. The number and size of these fragments depend on the initial kinetic energy of the aggregate as well as the properties of the grains and the interstitial liquid.
We conduct experiments to measure the number and size distribution of fragments following impact, varying impact velocity, grain size, and liquid properties such as surface tension and viscosity. Our findings show that the fragmentation behavior can be rationalize using a Weber number based on the grain diameter. These results provide insights on the energy transfer and dissipation processes that occur during the impact of the aggregate.

Auteur principal: DARBOIS TEXIER, Baptiste (Laboratoire FAST, CNRS, Université Paris-Saclay)

Co-auteur: M. FUENTEALBA, Juan Francisco (Universidad Central de Chile (UCEN))

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Classification de Session: Présentations

ID de Contribution: **42** Type: **Présentation orale**

Large scale analysis of the von Kármán Sodium experiment using Proper Orthogonal Decomposition

mardi 24 juin 2025 16:20 (20 minutes)

Dynamo instability, i.e the amplification of a residual magnetic field by a fluid flow, is generally assumed to be the mechanism behind the emergence of large scale magnetic fields in the universe. In 2006, the von Kármán Sodium (VKS) experiment was able for the first time to produce a dynamo through a highly turbulent flow of liquid sodium driven by two counter-rotating impellers in a cylindrical cavity. A key ingredient for success was the use of appropriate boundary conditions.

We performed a study of this successful setup in the case of a symmetric forcing where the impellers counter-rotate at same frequency and therefore the velocity is on average an axisymmetric quadrupole. To this end, simulations were carried in both the growth and saturated dynamo regimes by SFEMaNS which we will analyze by means of Proper Orthogonal Decomposition (POD) applied to the velocity and magnetic fields. This analysis will show that most of the energy can be captured by a small number of POD modes.

Auteurs principaux: Mme NORE, Caroline (LISN); BOUSQUET, Rémi (LISN); BOTEZ, Victor

Orateur: BOTEZ, Victor

Classification de Session: Présentations

ID de Contribution: **43** Type: **Présentation orale**

Surface wave amplification of a falling liquid film by a perforation

mardi 24 juin 2025 09:50 (20 minutes)

Falling liquid films are utilized in many technological systems to intensify mass and heat transfers. These systems usually involve thin liquid films flowing over complex surfaces with topographical features such as corrugations and perforations. The present study focuses on a falling liquid film flowing over a single circular perforation and the possibility of liquid surface wave amplification by the perforation for enhanced heat and mass transfer across the liquid-vapor interface. For the purpose, a vertical flat sheet with the perforation is solely supplied with liquid on its front. The behavior of the waves traveling on the surface of the falling film is examined when the film free surface is periodically forced at the inlet. We observe that for specific frequencies, the waves are more amplified when crossing the perforation. This amplification is related to the excitation and the resonance of sinuous waves traveling on the liquid curtain that closes the perforation. Further, the frequency spacing between resonance peaks scales as the inverse of the perforation diameter. Last, the resonance frequencies shift to higher values when the perforation diameter is increased.

Auteurs principaux: Dr SATHYANATH, Rahul (Postdoctoral researcher, LGPM, CentraleSupélec); Dr DUVAL, Hervé (Professor, LGPM, CentraleSupélec, Université Paris-Saclay)

Co-auteurs: Dr RAMAMONJY, Aina (PRONOE, Station F, 5 Parv. Alan Turing, Paris); M. CASAL-INHO, Joel (LGPM, CentraleSupélec, Université Paris-Saclay)

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Classification de Session: Présentations

ID de Contribution: **44** Type: **Présentation orale**

Event-Based Cameras for Multiple Scale (and Cost-Effective !) PIV Applications

lundi 23 juin 2025 14:40 (20 minutes)

Particle Image Velocimetry (PIV) and Particle Tracking Velocimetry (PTV) are critical techniques for flow visualization in experimental fluid mechanics. However, the implementation of these methods often requires expensive equipment and generates vast quantities of data.

Recently, a new type of camera, known as an "event-based camera"or "neuromorphic camera,"has become available. Unlike conventional cameras, event-based cameras do not record images but instead detect changes in intensity at each pixel asynchronously and independently. This novel approach drastically reduces data volume while achieving an equivalent acquisition rate of 10 kHz. Additionally, these cameras are significantly more affordable, costing approximately ten times less than traditional PIV systems.

In our study, we develop experimental methods and algorithms designed for event-based cameras to measure 2D Eulerian velocity fields. This approach demonstrates the potential of event-based cameras as an efficient, cost-effective alternative for flow visualization in fluid dynamics research.

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Classification de Session: Présentations

ID de Contribution: **45** Type: **Présentation orale**

Simulation numérique 3D turbulente de bulles de Taylor

lundi 23 juin 2025 09:30 (20 minutes)

Les bulles de Taylor sont des poches de gaz allongées occupant la quasi totalité d'une conduite. Elles peuvent être utilisées à dessein ou subites dans de nombreux systèmes industriels. On les observe typiquement dans les écoulements à poches, dont l'étude passe souvent par l'analyse spécifique des bulles de Taylor. Elles ont été largement étudiées aux échelles millimétriques et décimétriques. Notre étude se concentre sur une échelle intermédiaire, susceptible de présenter des applications, notamment dans le domaine du nucléaire.
Le code TRUST/TrioCFD avec la méthode Front-Tracking est utilisé pour modéliser l'évolution d' une bulle de Taylor. L'objectif de l'étude est de mieux comprendre la dynamique du film et du sillage, d'établir un lien entre la forme de la bulle et les pertes de charge, ainsi que d'évaluer l'influence de la géométrie de la conduite à travers des corrélations fondées sur le diamètre hydraulique. Nous présenterons ici des premiers résultats obtenus dans une configuration à section carrée.

Auteurs principaux: M. BURLOT, Alan (CEA Paris Saclay); EYSSERIC, Baptiste (CEA Paris Saclay); M. MACHICOANE, Nathanaël (LEGI); M. NOP, Raksmy (CEA Paris Saclay)

Orateur: EYSSERIC, Baptiste (CEA Paris Saclay)

Classification de Session: Présentations

ID de Contribution: **46** Type: **Présentation orale**

Self-diffusion of single fibers immersed in a sheared granular medium

mardi 24 juin 2025 12:20 (20 minutes)

Granular materials are collections of grains, larger than 100 μm, that interact through collisions or solid friction. They encompass a wide variety of materials and are present in many industrial sectors and natural phenomena (mining, landslides, etc.). In all of them, mechanical processes such as segregation, percolation, and diffusion take place when subjected to an external shear force. Of all of them, the diffusion process of spherical grains is currently a topic of intense research. However, the diffusion of non-spherical particles, and particularly of single fibers in sheared granular medium still presents a lack of research. Therefore, in this work, we experimentally study the diffusivity of a single fiber immersed in a sheared granular flow. Through the calculation of the mean-squared displacement (MSD), we extract the diffusion coefficient of the fiber under different experimental conditions. We observe that the diffusion is influenced by the fiber length, the grain diameter, and the shear rate imposed on the system. We demonstrate that the normalized diffusion coefficient of the fiber is proportional to the ratio of the fiber length and the grain diameter.

Auteurs principaux: M. SEGUIN, Antoine; M. DARBOIS-TEXIER, Baptiste; M. CHAGUA ENCARNACION, kennedy nexon

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Classification de Session: Présentations

ID de Contribution: **47** Type: **Présentation orale**

Boundary conditions for yield stress fluids in porous media: statistical properties and universality class

lundi 23 juin 2025 11:20 (20 minutes)

The flow of yield stress fluids in porous media is interestingly complex due to the interplay between the medium's heterogeneity and non-linear rheology. For instance, a nonlinear Darcy law emerges as the number of flow paths increases with the applied pressure difference.
In this talk, we will discuss how the boundary conditions influence the flow field. Unlike the Newtonian case, the type of boundary condition applied to the system has a significant effect on the flow over a large distance. We will therefore discuss how this distance is controlled by the directed polymer problem, which minimises the energy of a path in a random field and was introduced by Kardar, Parisi and Zhang in 1987.

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Co-auteurs: HANSEN, Alex (PoreLab, NTNU, Norway); ROSSO, Alberto (LPTMS-CNRS)

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Classification de Session: Présentations

ID de Contribution: **48** Type: **Présentation orale**

Relation between macroscopic and microscopic contact angles of sessile droplets on patterned surfaces

lundi 23 juin 2025 10:10 (20 minutes)

The physical parameter quantifying the wetting behaviour of a droplet on solid surfaces is the contact angle. Several types of contact angles can be defined, mainly the apparent (or macroscopic) contact angle at the scale of the droplet, and the local (or microscopic) contact angle locally estimated at a given point of the contact line between the surface, the droplet, and the air surrounding it. This latter contact angle is difficult to measure experimentally, hence, many studies focus on the apparent contact angle. This work aims to determine how the apparent and the local contact angles can be related. To that end, we conducted numerical experiments on three-dimensional droplets at rest on flat heterogeneous surfaces consisting of a hydrophilic base patterned with hydrophobic square-shaped defects. The simulations were performed with our in-house multiphase code implementing a phase-field lattice-Boltzmann method. For a fixed value of drop diameter to pattern period ratio, we investigated the influence of the defect size to pattern period ratio on both the apparent and local contact angles. It was shown that a connection indeed exists between these two types of contact angles.

Auteur principal: DUPUY, Magali (CentraleSupélec)

Co-auteurs: DUVAL, Hervé (CentraleSupélec); GIORGI, Marie-Laurence (CentraleSupélec)

Orateur: DUPUY, Magali (CentraleSupélec)

Classification de Session: Présentations

ID de Contribution: **49** Type: **Présentation orale**

High-Fidelity CFD Analysis of Transitional Flow Dynamics in a Dual-Bell Nozzle

mardi 24 juin 2025 14:00 (20 minutes)

This study investigates unsteady flow behavior and transition dynamics in a dual-bell nozzle (DBN) at a nozzle pressure ratio (NPR) of 10 using high-fidelity simulations with the k-omega SST Detached Eddy Simulation (DES) model in OpenFOAM. The baseline (no-injection) case is benchmarked against the cold-flow experiments of Léger et al. (2020). The mesh is refined near walls to resolve key boundary and shear layer features. Flow expands cleanly in the base nozzle (TIC) section. Near the inflection point, a separation bubble forms in the constant-pressure extension, consistent with experiments. Vortical structures emerge in the shear layer, showing early signs of Kelvin–Helmholtz instabilities. These interact with the bubble, causing low-frequency axial motion of the separation point and wall pressure fluctuations. The unsteady behavior resembles side-load dynamics reported in tests, likely driven by shear-layer instabilities and acoustic feedback. These preliminary results validate the DES approach and enhance understanding of flow separation and transition in DBNs to support the development of control strategies like radial secondary injection for improved altitude adaptation.

Auteurs principaux: Dr CHPOUN, Amer (LMEE –Université Paris-Saclay -Evry); Dr SELLAM, Mohamed (LMEE –Université Paris-Saclay -Evry); ALAJANGI, Pruthvi Raj (LMEE –Université Paris-Saclay -Evry)

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Classification de Session: Présentations

ID de Contribution: **50** Type: **Présentation orale**

Reduced order modeling and control of a fluidic pinball wake: An experimental investigation

lundi 23 juin 2025 12:20 (20 minutes)

Over the past decade, fluidic pinball has emerged as a valuable benchmark for studying flow control strategies (Deng(2020)). The cylinder rotation rates serve as the control inputs and the velocity sensors in the wake provide the outputs. Despite its geometric simplicity, the wake behind the fluidic pinball exhibits complex interactions of multiple frequencies and nonlinear dynamics, making it an excellent test case for the development and evaluation of control laws.
While numerous numerical studies have been performed at low Reynolds numbers, experimental literature is limited, mainly due to the associated engineering challenges. This study presents the findings from low-speed wind tunnel experiments conducted on the fluidic pinball in the turbulent regime ($1000 \leq Re \leq 3000$). Planar two-component particle image velocimetry (PIV) captures the velocity field, while hot-wire anemometry provides high-resolution velocity time traces in the wake. Complete characterization of the coherent structures and their dynamics in the wake is proposed for both the stationary pinball and the flow with open-loop control.

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Classification de Session: Présentations

ID de Contribution: **51** Type: **Présentation orale**

Numerical Modeling of Premixed Combustion and Flame Acceleration of Li-ion Battery Thermal Runaway Gases

lundi 23 juin 2025 15:40 (20 minutes)

Li-ion battery safety is linked to fire and explosion hazards, due to flammable gases produced by the thermal runaway reactions that can accumulate in a confined environment.
To represent large-scale problems, typically a deflagration inside a Battery Energy Storage System container and its potential transition to detonation, the strategy relies on a numerical model relying on the knowledge of laminar flame speed depending on local pressure and temperature, turbulence, and flame wrinkling. The methodology consists of revisiting existing correlations, established in the specific case of H2/air premixed combustion, extending them to more complex mixtures as typical battery thermal runaway gases may contain.
The case study is a premixed flame/shock interaction in a 2D semi-closed channel, with obstacles after the shock has interacted with the flame and accelerated it to enhance the generation of vortices. A comparison of the large-scale simulation model with a reference accurate solver shows a correct agreement between the estimated flame speeds despite the inherent limitations of correlation models in flame propagation and biases on flame speed estimation induced by the test case.

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Classification de Session: Présentations

ID de Contribution: **52** Type: **Présentation orale**

Continuation-based pseudospectral PDE solvers for problems in fluid dynamics and fluid-structure interactions

mardi 24 juin 2025 15:40 (20 minutes)

We highlight recent developments of a "Fourier continuation" method for the numerical analysis of parabolic/hyperbolic partial differential equations (PDEs) with complex boundary conditions. The framework relies on a discrete extension approach for the high-order trigonometric interpolation of non-periodic functions (mitigating the notorious Gibb's "ringing effect"), enabling construction of FFT-speed solvers that can provide efficient resolution while faithfully preserving the dispersion/diffusion characteristics of the underlying continuous operators. We discuss treatment of variable-coefficient systems, curved geometries, Neumann-like (e.g., flux) boundary conditions, nonlinear/nonstationary coupling, and high-order PDEs (e.g., for immersed boundary lattice Boltzmann methods). The resulting solvers are accurate by means of relatively coarse discretizations; incur little-to-no numerical dispersion or diffusion errors; carry mild (linear) CFL constraints on time integration (less restrictive spectral radii than other pseudospectral methods); and can be efficiently parallelized.

The efficacy of these tools is demonstrated through collaborative problems in biofluids and geophysics.

Auteur principal: Dr AMLANI, Faisal (CNRS, Laboratoire de Mécanique Paris-Saclay (LMPS; U Paris-Saclay/ENS Paris-Saclay/CentraleSupélec/CNRS))

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Classification de Session: Présentations

ID de Contribution: **53** Type: **Présentation orale**

Two-fluid Compressible Flows with Multiresolution-based Mesh Adaptation

lundi 23 juin 2025 09:50 (20 minutes)

The study of two-phase boiling flows is of considerable interest due to its crucial role in optimizing thermal performance across various industrial applications. However, the accurate numerical simulation of such flows remains challenging. In this work, we present a two-phase compressible solver based on the finite volume method, which maintains good accuracy in the low Mach regime. A sharp-interface phase change model enables precise prediction of heat transfer between liquid and vapor. The solver is coupled with a multiresolution-based mesh adaptation (MR) strategy to reduce the computational cost. Different benchmark tests for interface deformation, low Mach behavior, and boiling heat transfer are performed on fixed meshes and adaptive meshes.

Auteurs principaux: WU, Gen (LISN, Université Paris-Saclay); GRENIER, Nicolas (LISN / Université Paris Saclay)

Co-auteur: NORE, Caroline (LISN)

Orateur: WU, Gen (LISN, Université Paris-Saclay)

Classification de Session: Présentations

ID de Contribution: **54** Type: **Présentation orale**

Magnetic field reversals in numerical simulations of the Von Karman Sodium experiment

lundi 23 juin 2025 14:20 (20 minutes)

We have considered several geometries and numerical configurations to model and simulate the Von Karman Sodium (VKS) experiment. The most striking result is that the addition of an immobile sodium layer around the cylinder containing the sodium flow enables magnetic field reversals. In the Von Karman Sodium experiment, a statistically stationary magnetic field is first created by the rotation of iron blades, and driven by the von Karman flow, before another branch becomes accessible, leading to periodic or erratic reversals of the magnetic field. The access conditions and dynamics of the system on the inversion branch appear to depend strongly on the modeling of the impellers in our simulations, which are the main source term of the flow, both for the velocity and magnetic fields. We will present some recent results from simulations using the SFEMaNS code, and analyses based on POD.

Auteurs principaux: NORE, Caroline (LISN); BOUSQUET, Rémi (LISN); BOTEZ, Victor (LISN)

Orateur: BOUSQUET, Rémi (LISN)

Classification de Session: Présentations

ID de Contribution: **55** Type: **Non spécifié**

Getting out of a tight spot: Cooperative unclogging of hydrogel particles in disordered porous media

lundi 23 juin 2025 11:40 (20 minutes)

The transport of deformable particulates through porous media underlies a broad range of processes in biomedicine, energy, and sustainability. Despite its ubiquity and importance, it is still not possible to predict —for a suspension of particulates of a given size, mechanical properties, and injection conditions in a porous medium of a given geometry — what the spatial distribution of particulates and changes in local flow rates will be. We address this gap in knowledge using network model simulations. Our results provide a way to connect the complex interplay between particle advection, pore occlusion, subsequent redirection of flow, and flow-induced particle deformation and squeezing through pores to the overall distribution of particles and flow rates. We uncover a surprising cooperative effect: adding more particles enables them to penetrate deeper into the medium. This phenomenon arises because individual particles redirect fluid to adjacent throats, forcing nearby particles through tight pores that they would otherwise clog. Altogether, these results help to establish a quantitative framework that connects microscopic particle mechanics to macroscopic transport behavior.

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Orateur: KAMATH, Sanjana (Department of Chemical and Biological Engineering, Princeton University, Princeton)

Classification de Session: Présentations

ID de Contribution: **56** Type: **Présentation orale**

Bio-convective transport for selective particle sorting

lundi 23 juin 2025 16:20 (20 minutes)

The microswimmer *Chlamydomonas reinhardtii*, a quasi-spheric 10 μm long microalga, is of particular interest for its ability to swim towards or away from light sources, known as phototaxis. When the *C. reinhardtii* concentration becomes high enough, bio-convective structures can appear and affect the surrounding fluid [1,2].

This study shows how the phototactic behavior of microalgae can be harnessed to control the transport of passive particles, converting their random motion into directed transport. We enclose micron-sized particles (from 30 μm to 200 μm in diameter) in microalgae suspensions within a squared centimetric chamber and use LEDs to drive algae accumulation.
This accumulation generates bio-convective flows, which push denser beads away from algae-dense regions while pulling lighter beads toward them. We can effectively direct the transport of these microparticles and sort them.

[1] J. Dervaux et al., *Nature Phys* **13**, 306–312 (2017)
[2] J. Arrieta et al., *PRL* **123**, 158101 (2019)

Auteurs principaux: NICOLAZO-CRACH, Victoria (Laboratoire FAST); Dr LAROUSSI, Taha (LadHyx); Dr BOUVARD, Julien (LadHyx); Dr AMSELEM, Gabriel (LadHyx); Dr JARRAHI, Mojtaba (FAST)

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Classification de Session: Présentations

ID de Contribution: **57** Type: **Présentation orale**

Physics of Paragliding

mardi 24 juin 2025 15:00 (20 minutes)

Paragliding is a relatively young adventure sport, introduced in the early 1980s, that involves flying lightweight, free-flying, foot-launched glider aircraft without a rigid primary structure. This design inherently leads to instability, particularly during unsteady phases of flight.
This study investigates the stability and dynamics of paragliders during spiral descent, a manoeuvre associated with significant safety risks. Spiral descent is characterized by the helical trajectory of both the pilot and the wing around a shared axis. The manoeuvre poses unique dangers, as, even without brake input, the pilot can remain trapped in a continuous spiral, descending at approximately 20 m/s. In this configuration, pilots are subjected to strong centrifugal accelerations, which can lead to disorientation or even loss of consciousness.
This research explores the aerodynamic forces and their interaction with centrifugal and gravitational effects during spiral descent. The curved geometry of the paraglider wing generates complex aerodynamic forces and moments that significantly influence the system's dynamic behaviour. The study highlights the key factors that govern spiral descent dynamics.

Auteur principal: VALDECASA, Esteban (LadHyX)

Co-auteurs: Mme COHEN, Caroline (LadHyX); M. BENZAQUEN, Michael (LadHyX); Mme RAMANANARIVO, Sophie (LadHyX)

Orateur: VALDECASA, Esteban (LadHyX)

Classification de Session: Présentations

ID de Contribution: **58** Type: **Présentation orale**

Orientation préférentielle de flotteurs dans des vagues: effets hydro-élastiques et corrections capillaires

mardi 24 juin 2025 10:10 (20 minutes)

Le mouvement de flotteurs dans un champ de vagues est un problème fondamental d'interaction fluide-structure aux nombreuses applications en ingénierie navale ou pour le transport de polluants. En plus d'une réponse harmonique (réponse de premier ordre), de tels flotteurs exhibent des mouvements de second ordre, en translation (de type dérive de Stokes) mais aussi en rotation. Nous avons étudié récemment la dérive angulaire de flotteurs rigides dans des ondes de gravité, et montré que des flotteurs courts et denses s'orientent préférentiellement selon la direction de propagation des vagues (longitudinal), tandis que des flotteurs longs et légers s'orientent parallèlement aux crêtes (transverse). Nous avons développé un modèle théorique, montrant que cette orientation préférentielle résulte de la compétition entre deux couples moyens opposés, dont l'importance relative dépend de l'immersion variable le long du flotteur. Nous nous intéressons ici à plusieurs extensions de ce résultat, incluant les effets de déformation élastique, et les effets capillaires.

Auteurs principaux: DHOTE, Basile (Laboratoire FAST); HERREMAN, Wietze (Université Paris--Sud - LIMSI CNRS); MOISY, Frederic (Universite Paris-Sud)

Orateur: DHOTE, Basile (Laboratoire FAST)

Classification de Session: Présentations

ID de Contribution: **59** Type: **Non spécifié**

Avalanche of fiber-reinforced granular medium

mardi 24 juin 2025 11:20 (20 minutes)

In the mining industry, piles of extracted materials present a high risk of avalanches, which can cause damage. To avoid these risks, an effective and inexpensive technique is to add a small quantity of flexible fibers that entangle and increase the stability of the granular piles. This fiber-reinforcement technique used in different contexts such as stabilization of sand dunes or coast-line protection against sea erosion.
Although empirical knowledge of fiber stabilization of piles exists, the role of the physical parameters of this problem on avalanche dynamics is largely unknown. To fill this gap, we studied the avalanche dynamics of a model mixture in a rotating drum. In the quasistatic regime, a series of avalanches is observed with a starting angle $\theta\uparrow$ at which the avalanche starts, until it stops down to an angle $\theta\downarrow$. The idea is to
measure those angles for a fiber-reinforced granular medium. We observe effect of fiber volume fraction, fiber length and fiber diameter on the mean values of $\theta\uparrow$, $\theta\downarrow$ and $\Delta\theta = \theta\uparrow - \theta\downarrow$, but also on their distributions.
It appears that with volume fraction of fibers of order 0.3%, there are significant changes in these characteristic properties.

Auteurs principaux: WIERZCHALEK, Ladislas (lab. FAST); GAUTHIER, Georges (lab. FAST); DARBOIS-TEXIER, Baptiste (lab. FAST)

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Classification de Session: Présentations

ID de Contribution: **60** Type: **Présentation orale**

Generation of tsunami waves by low density gravity flow

mardi 24 juin 2025 11:40 (20 minutes)

Although many tsunamis are generated by underwater earthquakes, a significant fraction of them can also be generated by the flow or collapse of a great volume of material from the air into a body of water. We have performed experiments using a rectangular granular column, comprised of monodisperse spherical beads made up of low density materials, released by a sluice gate to collapse in a canal filled up with water at various heights. The amplitude of the generated wave, its wavelength, as well as the dynamics of the granular material such as the velocity of the granular front at the surface of water and the volume of the immersed beads are obtained using image processing. For polypropylene –a material with density similar to ice - results show that in shallow water, the dynamics of the granular medium and of the surface of the water is influenced by the proximity of the bottom of the flume similarly to experiments carried out with a denser material such as glass [1], while in deeper water, the beads do not reach the floor because of their buoyancy, then rise back to the surface after the generation of the leading wave.

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Co-auteurs: MORIZE, Cyprien (Laboratoire FAST, Université Paris-Saclay); GONDRET, Philippe (Laboratoire FAST)

Orateur: KANE, Alexandre (Laboratoire Fast, Université Paris-Saclay)

Classification de Session: Présentations

ID de Contribution: **61** Type: **Non spécifié**

Turbulence-induced vibration of coaxial cylinders

mardi 24 juin 2025 16:00 (20 minutes)

This theoretical study examines the fluid-structure interaction between two coaxial cylinders separated by a Newtonian fluid in a turbulent axial flow. The inner cylinder is modeled as a rigid body mounted on a flexible blade, represented by a Rayleigh beam. We show that vibration modes, frequencies, instability thresholds, and mean-square displacement depend on distinct sets of dimensionless parameters, including the cylinder's aspect ratio and the radius ratio of the fluid gap. By applying models for fluid-elastic forces and turbulent pressure, we establish stability conditions and demonstrate that the mean-square displacement of the structure scales with the square of the Reynolds number. Presented in a fully dimensionless formulation, this work is intended to guide engineers in designing small-scale experiments that simulate pressure vessel vibrations.

Auteurs principaux: M. PLADO COSTANTE, Loucas (CEA); LAGRANGE, ROMAIN (Commissariat à l'Energie Atomique); Dr PUSCAS, Maria Adela (CEA); Dr KOCHER, Maud (EDF)

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Classification de Session: Présentations

ID de Contribution: **62** Type: **Présentation orale**

Active Saffman–Taylor Viscous Fingering

lundi 23 juin 2025 16:40 (20 minutes)

Adding swimming bacteria to a liquid causes its effective shear viscosity to decrease, eventually reaching a regime of zero viscosity. We examined whether this property leads to viscous finger-like displacement fronts like those observed when a less viscous fluid displaces a more viscous liquid. Our study revealed that this system exhibits more complex dynamic characteristics than the classical Saffman–Taylor instability. We discovered that this instability occurs when the bacterial volume fraction exceeds a critical value, and the imposed shear rate is below a critical value, for which the viscosity of the suspension is zero.

Auteur principal: AURADOU, Harold

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Classification de Session: Présentations

ID de Contribution: **63** Type: **Présentation orale**

Réduction de modèle pour écoulements à surface libres

mardi 24 juin 2025 10:30 (20 minutes)

Les écoulements à faible nombre de Reynolds avec surface libre représentent un défi majeur en simulation numérique, en raison de l'évolution conjointe de la solution et de l'interface fluide. La Particle Finite Element Method (PFEM) est bien adaptée à ce type de problèmes, car sa formulation lagrangienne permet de suivre naturellement le déplacement de l'interface. Toutefois, son coût de calcul reste élevé, en particulier pour les simulations de grande taille ou l'exploration de vastes espaces de paramètres. Pour y remédier, nous proposons une réduction de modèle (MOR) via la Proper Generalized Decomposition (PGD), qui construit la solution réduite sans aucune connaissance préalable. La difficulté principale réside dans l'absence de maillage fixe de référence, rendant complexe la construction de solution réduite. Notre approche alterne entre la résolution de champs réduits et le calcul de maillages lagrangiens à partir du champ de vitesses. La convergence est atteinte lorsque la vitesse du maillage coïncide avec celle du fluide. Cette méthode se généralise naturellement aux cas multi-paramétriques.

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Orateurs: Prof. BARBARULO, Andrea (CentraleSupélec); BECKERMANN, Max (Centralesupelec)

Classification de Session: Présentations

ID de Contribution: **64** Type: **Présentation orale**

Mixing induced by Faraday surface waves

lundi 23 juin 2025 16:00 (20 minutes)

We investigate how surface waves enhance mixing across the interface of two miscible fluids with a small density contrast. Imposing a vertical, time-periodic acceleration, we excite Faraday waves both experimentally and numerically. In systems with a shallow density gradient, these standing waves advect the interface and can trigger secondary instabilities.
When driven beyond the linear regime, large Faraday crests collapse to form cavities, injecting bubbles and lighter fluid deep into the heavier layer. Together, these mechanisms gradually homogenize the upper layer, diminish the interfacial density jump, and drive the interface downward until it decouples from surface forcing. We report a non-monotonic
mixing rate—first increasing as the interfacial energy barrier lowers, then decreasing as less energy is injected into the weakened surface—revealing a balance between barrier reduction and energy input.

Auteurs principaux: CASTILLO, Andrés (Centre Borelli / ENS Paris Saclay); BRIARD, Antoine (CEA DAM); GRÉA, Benoît-Joseph (CEA DAM)

Orateur: CASTILLO, Andrés (Centre Borelli / ENS Paris Saclay)

Classification de Session: Présentations

ID de Contribution: **65** Type: **Présentation orale**

Mechanism of air entrainment by an oblique jet

lundi 23 juin 2025 10:30 (20 minutes)

Air entrainment is a process in which gas is incorporated into a bath of liquid. It can be observed at various scales, from breaking waves to the pouring of a glass of water. In both situations, the liquid meets the bath at an angle. In this talk, we will present a study of the mechanism of air entrainment by an oblique capillary jet impacting a bath of water. We will begin by describing the shape of the interface formed by this jet. Through a combined experimental and computational study, we will show that the angle between the jet and the bath introduces an asymmetry that is responsible for the formation of a cavity in front of the jet. A Kelvin-Helmholtz instability on the side of this cavity generates perturbations that can lead to the pinch-off of bubbles. Finally, we will discuss the effect of surface-active impurities on this phenomenon.

Auteurs principaux: Prof. SALONEN, Anniina (SIMM); Prof. ANTKOWIAK, Arnaud (Institut Jean le rond D'alembert); Prof. RIO, Emmanuelle (LPS); GAICHIES, Théophile (LPS)

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Classification de Session: Présentations

ID de Contribution: **66** Type: **Présentation orale**

Subgrid-stress experimental analysis based on second order structure functions in grid turbulence

lundi 23 juin 2025 12:00 (20 minutes)

Measurements are carried out in a turbulent flow behind a grid of dimensions: 150 mm X 300 mm with a squared mesh size of M=40mm. A Dantec 55P11 hot-wire is used with a time resolution frequency much smaller than than the Kolmogorov turnover time scale (5%).

Different mean flow speeds are tested from 13 m/s to 20 m/s corresponding to Taylor Reynolds number values between 190 and 360. The measurements are conducted at different streamwise positions between x/M=7.4 and x/M=19.9. A Taylor hypothesis is used to evaluate the second order structure functions scalings with dissipation.

The mean subgrid-stress contribution is observed to be well predicted by the Smagorinsky model with the same coefficient as the one measured in Meneveau (1994) but the Smagorinsky model local fluctuations are completely different to the real subgrid-stress contribution.

An exact decomposition of the subgrid stress based on the exact Germano (2007) equation is analysed with the experimental data and this decomposition is found to split the subgrid-stress into a dissipative and a non-dissipative part. A new mixed LES model formulation is proposed inspired by these results.

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Classification de Session: Présentations

ID de Contribution: **67** Type: **Présentation orale**

Frozen waves in the inertial regime

mardi 24 juin 2025 09:30 (20 minutes)

Interfaces subjected to strong time-periodic horizontal accelerations exhibit striking patterns known as frozen waves. In this study, we experimentally and numerically investigate the formation of such structures in immiscible fluids under high-frequency forcing. In the inertial regime–characterized by large Reynolds and Weber numbers, where viscous and surface tension effects become negligible–we demonstrate that the amplitude of frozen waves scales proportionally with the square of the forcing velocity. These results are consistent with vibro-equilibria theory and extend the theoretical framework proposed by Gréa & Briard (2019) to immiscible fluids with large density contrasts. Furthermore, we examine the influence of both Reynolds and Weber numbers, not only in the onset of secondary Faraday instabilities–which drive the transition of frozen wave patterns toward a homogenized turbulent state–but also in selecting the dominant wavelength in the final saturated regime.

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Classification de Session: Présentations

ID de Contribution: **68** Type: **Présentation orale**

Instabilité d'écoulements turbulents cisaillés

mardi 24 juin 2025 14:20 (20 minutes)

Les motifs grande échelle d'alternance laminaire-turbulent en canal plan
sont typiques du régime transitionnel mais restent mal compris. Nous montrons dans cette étude que ces motifs ont comme origine dynamique une modulation de l'écoulement turbulent. Cette modulation peut être prédite numériquement comme une instabilité linéaire lorsque les fluctuations turbulentes ainsi que cohérentes sont prises en compte dans l'analyse de stabilité. Ce travail a été réalisé dans le cadre d'une collavoration entre le LISN, ENSAM Paris et l'université Polytechnique de Bari (Italie).

Auteur principal: DUGUET, Yohann (LISN-CNRS)

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Classification de Session: Présentations

ID de Contribution: **69** Type: **Présentation orale**

Self-similarity in the magnetic Rayleigh-Taylor instability

lundi 23 juin 2025 14:00 (20 minutes)

The growth of a turbulent mixing layer driven by the Rayleigh-Taylor instability (RTI) is the result of non-linear interactions between structures of different sizes which merge and compete under the effect of buoyancy forces. In the asymptotic self-similar regime, the mixing layer width evolves as the square of time.
In the Boussinesq approximation, it was shown, considering the simplified dynamics of dominant modes at large scales, that the growth rate is closely related to irreversible mixing and anisotropy of the turbulent layer.
These typical features of the RTI are strongly modified in the presence of induced magnetic fields. If a background constant magnetic field B0 is imposed parallel or normal to the initial interface between the fluids at rest, the structures composing the mixing layer are significantly changed compared to hydrodynamics: they can become either much bigger, or thinner and stretched in the vertical direction, respectively.
The magnetic RTI plays a significant role within astrophysical objects like solar prominences, or in Inertial Confinement Fusion. Recently, we have extended the large-scale theory to the magnetohydrodynamics (MHD) framework

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Classification de Session: Présentations

ID de Contribution: **70** Type: **Non spécifié**

Suppression du vent et émission de panaches en convection turbulente rugueuse

mardi 24 juin 2025 16:40 (20 minutes)

Turbulent convection is ubiquitous in both industrial and natural fluid flows. A canonical model is the Rayleigh-Bénard convection (RBC): a fluid layer heated from below and cooled from above. With regards to the geometrical configuration, one or several convection cells can appear, which is called Large-Scale Circulation (LSC). The LSC generates a horizontal wind along the horizontal plates and shears the plumes
emerging from the thermal boundary layer.
Previous studies have shown that the addition of a synthetic shear to the spontaneous LSC wind shear can have a significant effect on the heat transfer. However, the effect of wind shear depletion has never been studied. The aim of this work is to reveal how wind shear alters the flow in cavities by considering either flow in a cavity or in a fluid periodic layer with a horizontal aspect ratio too small for an LSC to be established.

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Orateur: M. CARBONNEAU, Nathan (LISN)

Classification de Session: Présentations

ID de Contribution: **71** Type: **Non spécifié**

Addressing turbulent convection experimental data challenges in PINNs with appropriate physical sampling

lundi 23 juin 2025 15:00 (20 minutes)

Numerical and experimental approaches are becoming more complementary approaches to address highly turbulent regimes, thanks to improvements in computational resources. Nonetheless, experimental results, such as meshless Particle Tracking Velocimetry, are often spatially sparse, somewhat discontinuous, subject to measurement noise and incomplete, while CFD simulations still require intensive resources. To address these issues, we employ Physics-Informed Neural Networks (PINNs), which provide a meshless way to enrich and complement experimental data.
In the case of turbulent convection, our framework allows 3D temperature discovery, denoising, and generating continuous field representations. We propose a spatio-temporal sampling framework to tailor our DNS database to closely resemble experimental measurements. This poses additional challenges to PINNs, particularly in addressing spatial gaps, tracking loss and scarcity of experimental-type labels. Through parallel GPU computations, our analysis focuses on the impact of PDE collocation points density and the effectiveness of smart adaptive spatial PDE sampling.

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Classification de Session: Présentations