# JEFS - Journées Écoulements & Fluides - Saclay

# Rapport sur les résumés

ID de résumé : **72**

# Model Reduction for Fluid-Structure Interaction Involving Moving Surfaces

## Contenu

Fluid-structure interaction (FSI) is a complex multiphysic coupling to implement:

- The two physics are often considered strongly coupled;
- The formalism of each physics differs (Lagrangian/Eulerian);
- Large deformations are present in the fluid and often in the solid;
- Very fine meshing is required to accurately capture certain phenomena (stress concentration, vortices);
- Complex and time-varying boundary conditions;
- The problem is inherently nonlinear for the fluid part and potentially for the solid.

To date, modelling a complex FSI system (airbag deployment, wind turbine dynamics, behaviour of an underwater pipeline, etc.) requires a massive mobilisation of computational resources, whilst producing results whose quality often leaves room for improvement. The aim is to propose an innovative approach, which is both accurate and computationally efficient, to numerically represent some FSI cases that are sufficiently separable to use a priori model order reduction techniques. Finally the extended PGD method [BEC25], a piecewise formulation for problems with a time evolving expanding spatial domain, will eventually be adapted for FSI problems involving moving surfaces.

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**Type de contribution:** Présentation orale / Oral presentation

**Statut:** ACCEPTÉ

Déposé par **ALAGOZ, Eren** <eren.alagoz@ens-paris-saclay.fr> le **lundi 11 mai 2026**

ID de résumé : **73**

# Iterative Nonlinear Reconstruction of Free-surface Topography using Telecentric Imaging

## Contenu

The free-surface Synthetic Schlieren (FS-SS) method, originally proposed by Moisy et al. (2009), is a high-resolution, refraction-based optical technique used to measure the instantaneous elevation of liquid interfaces. Traditional FS-SS typically relies on three approximations —small paraxial angles, small slopes and small amplitudes —to establish a linear relationship between the gradient of the surface elevation and the apparent displacement field of a refracted pattern imaged through the surface. In this work, we propose three nonlinear extensions of the FS-SS method specifically designed for telecentric imaging systems. By leveraging a telecentric lens to eliminate paraxial distortions, we simplify the optical model and derive a hierarchy of nonlinear free-surface reconstruction algorithms. These schemes progressively incorporate higher-order refraction terms and depth dependent corrections, extending the validity of FS-SS into regimes characterized by large amplitude-to-depth ratios and steep surface gradients. Notably, these advancements are achieved at a low computational cost, requiring only a few iterations to converge.

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ID de résumé : **74**

# On the gravity-driven flow of Herschel–Bulkley fluids in a syringe and on the jetting-dripping transition

## Contenu

Many food and pharmaceutical products present a yield stress, conditioning their flow. In this study, experiments and simulations quantified the effect of yield stress on gravity-driven flow in a syringe. This flow assesses the consistency and swallowing safety of drinks. The jetting-to-dripping transition at the outlet is discussed and an expression is proposed for a critical Weber number below which dripping occurs. Rheological maps describe the interplay between rheological properties, and the volume remaining after 10s, which determines the IDDSI consistency classification. The analysis shows the dominant role of viscous dissipation for fluids classified as IDDSI levels 2 and 3, whereas yield stress has a stronger influence on less viscous fluids (level 1). Finally, a dimensionless Hydrostatic-Yield time (HY) is proposed, explaining experimental and simulation results through a mastercurve. These findings provide insights into gravity-driven flow in a syringe and the jetting-to-dripping transition. They could contribute to improving the formulation and safety of drinks for people with swallowing disorders and improving popular protorheology methods, like the syringe flow test.

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ID de résumé : **75**

# Dynamics of a Fiber in a Dense Granular Flow

## Contenu

Fiber reinforcement of granular materials is a cost-effective strategy widely used in applications ranging from coastal erosion protection to eco-construction materials and fiber-reinforced concretes. The efficiency of such reinforcement strongly depends on the mixing process and on the resulting spatial distribution and orientation of fibers within the granular matrix. To better identify the parameters controlling fiber distribution and orientation, we investigate experimentally the dynamics of a single fiber immersed in a dense granular flow. We systematically explore the influence of both flow conditions and fiber properties on fiber transport and orientation. We show that the center-of-mass dynamics of the fiber can be described by an effective diffusion process characterized by a diffusion coefficient that depends on the fiber length relative to the grain size. In addition, we analyze the angular dynamics of the fiber and demonstrate that fibers preferentially align with the flow direction, with longer fibers exhibiting stronger alignment. These fundamental results constitute a first step toward rationalizing the mixing processes in grain–fiber mixtures.

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**Type de contribution:** Présentation orale / Oral presentation

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ID de résumé : **77**

# Singular drainage of liquid films on saddle topographies

## Contenu

We investigate the late-time drainage on a substrate featuring a saddle point in the framework of lubrication theory. Unlike stationary points of strictly negative mean curvature, where the film is known to thin in a self-similar fashion (as the inverse of the square root of time), here, the balanced converging and diverging geometry near the saddle point (of vanishing mean curvature) make the pure drainage problem, accounting only for the tangential components of gravity, singular. Indeed, the thickness at the saddle point decreases in time more slowly than the common self-similar evolution. Through a boundary-layer analysis, we unveil a time-evolving hydrostatic ridge in the film, which regularises the singular behaviour of the similarity profiles. A quasi-stationary matching procedure results in a prediction for the film thickness evolution at the saddle point, which we compare with laboratory experiments.

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**Type de contribution:** Présentation orale / Oral presentation

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ID de résumé : **78**

# Coulage de flotteurs capillaires par des vagues

## Contenu

Les microplastiques et autres polluants à la surface de l'océan, bien que généralement plus denses que l'eau, peuvent flotter grâce aux forces capillaires. Néanmoins, l'effet des vagues ou de la turbulence peut rompre cet équilibre de flottaison et conduire à leur immersion. Nous avons étudié la dynamique de disques de laiton placés dans un canal à houle, et notamment l'amplitude minimale de vague nécessaire pour faire couler un disque en fonction de son rayon, sa masse surfacique et de la longueur d'onde. Nous avons ainsi pu établir un critère dépendant des caractéristiques du disque, et notamment de son immersion d'équilibre en absence de vagues, en bon accord avec les expériences.

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**Statut:** ACCEPTÉ

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ID de résumé : **79**

# A Reduced Order Model for predicting the dynamics of the Rayleigh-Taylor Instability

## Contenu

We study the dynamics of key quantities relevant to RANS modeling of the planar Rayleigh–Taylor instability, averaged along homogeneous directions (1D profiles). Our work relies on a database of 484 DNS of resolution 1048 x 2048 × 2048 points, spanning a wide range of initial conditions. This dataset serves to build a generalized and interpretable Reduced Order Model (ROM) using Proper Orthogonal Decomposition (POD). The reduced representation is then used to train a physics-informed neural network (PINN) with the residual-based attention framework and SSBroyden optimizer, predicting the temporal evolution of the POD modes from the initial conditions. By combining POD spatial modes with the surrogate model for their temporal dynamics, we reconstruct the full spatio-temporal evolution from the initial conditions.
We seek analytical representations of the ROM via sparse identification of nonlinear dynamics and inference of initial conditions from observations to predict the system's full evolution.

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**Statut:** ACCEPTÉ

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ID de résumé : **80**

# Physics-Informed Neural Network Augmentation of Turbulence Models for the Rayleigh–Taylor Transition

## Contenu

Reynolds-averaged Navier–Stokes (RANS) turbulence models are known to perform poorly in predicting the dynamics of Rayleigh–Taylor mixing when turbulence is not fully developed, particularly during the transition from an initially perturbed interface. We investigate the use of data-driven strategies to enhance a simple k–epsilon–S model for this transitional regime. The turbulence model is first embedded within a surrogate physics-informed neural network (PINN), which enables the identification of corrective terms accounting for both parametric errors arising from model calibration and structural errors associated with missing physical processes. The learned corrections are then projected onto the model state variables and relevant flow indicators, leading to explicit analytical modifications of the closure. The resulting fully interpretable corrected model is assessed against an extensive database of direct numerical simulations (DNS) of Rayleigh–Taylor flows. This framework enables improved predictions of the mixing-layer growth during the transition to turbulence and provides a systematic quantification of model uncertainties in the description of Rayleigh–Taylor mixing.

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ID de résumé : **81**

# Flexible fiber dynamics in porous media

## Contenu

The transport of flexible fibers through complex environments, such as porous and structured media, occurs in a variety of systems like textile microplastics in soils. Additionally, particle sorting or separation using structured media, such as pillar arrays, is essential to many processes, such as biological analysis or environmental assessment. However, due to their deformability and elongated shapes, fibers can exhibit complex trajectories and intricate dynamics in tortuous flows. Here we combine model microfluidic experiments and numerical simulations to investigate the dynamics of flexible fibers in pillar arrays. We report a non-monotonic migration dynamics with fiber length, identifying a distinct ”band-pass”sorting mechanism. We investigate the effect of geometrical parameters (porosity, incident flow angle) and mechanical parameters (fiber deformability) on this band pass effect. We define an operational domain in which this effect occurs, and identify the conditions for optimal separation. Our findings not only help in the design of efficient separation and filtration technologies, but also shed light on the dynamics of deformable objects in tortuous environments.

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ID de résumé : **82**

# Ablation flow sensitivity to ablator density perturbations in ICF

## Contenu

The hydrodynamic stability of ablation flows is a key issue in laser-driven inertial confinement fusion (ICF) where a sufficiently symmetric implosion of a spherical capsule is expected to achieve thermonuclear burn. More recently, experimental and simulation results have pointed out that ablator internal perturbations could account for degraded capsule performances, emphasizing the need for a comprehensive understanding of associated perturbation growth mechanisms. In the present work, we apply a method of non-modal linear stability analysis for determining optimal density perturbations within a capsule ablator . The chosen base flow is relevant to the radiative ablation of a capsule shell during the transit of the first shock-wave within the ablator. Optimal longitudinal distributions of linear density perturbations that maximize the ablation front distortion at different times prior to the shock breakout are obtained for transverse wavelengths between 1 and 100 μm and longitudinal wavelengths in the full range 0.1-100 μm. Ablation front sensitivity is maximum for the longest transverse wavelengths with entropy perturbation amplification as the dominant destabilizing mechanism.

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**Type de contribution:** Présentation orale / Oral presentation

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ID de résumé : **83**

# Dynamics and Breakup of Liquid Plugs: The Effect of Viscoelasticity

## Contenu

Mucus is a viscoelastic liquid that coats the walls of the lungs, playing a crucial role in air filtration. In diseases such as cystic fibrosis, COPD, and primary ciliary dyskinesia, excessive mucus production and altered rheological properties lead to the formation of mucus plugs. The effect of mucus viscoelasticity on the rupture of these plugs—typically cleared by coughing—has been little studied.

This work presents a simplified experimental investigation of liquid plug dynamics in a tube under oscillatory forcing. Plug rupture occurs due to the deposition of a Bretherton film on the walls. We focus on how viscoelastic properties affect the rupture process, including the conditions and timescales involved. Preliminary observations suggest that viscoelasticity introduces non-monotonic differences in the breakup mechanisms and plug dynamics, with the most pronounced effects occurring at intermediate viscoelastic properties.

These experiments aim to shed light on the complex interplay between fluid rheology and plug stability, offering a step toward better understanding mucus clearance failures in diseased airways.

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**Type de contribution:** Présentation orale / Oral presentation

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ID de résumé : **84**

# Observation du régime développé de la turbulence faible d'ondes d'inertie sur la plateforme Coriolis

## Contenu

L'influence d'une rotation d'ensemble sur la turbulence constitue un des ingrédients clés de la dynamique des écoulements géo et astrophysiques. Une des conséquences de cette rotation est la propagation d'une classe d'ondes spécifiques, appelées ondes d'inertie, dans le volume du fluide. Au sein de la turbulence en rotation, ces ondes et les structures tourbillonnaires classiques de la mécanique des fluides peuvent cohabiter et interagir de différentes manières. Parmi celles-ci, le régime de turbulence faiblement non-linéaire aussi appelé turbulence d'ondes a reçu des prédictions analytiques et, bien qu'ayant fait l'objet de nombreuses études expérimentales, n'a pu qu'être approché jusqu'ici.
Nous présenterons des expériences réalisées dans une cuve de 2,5m de haut et 2,15m de diamètre mise en rotation sur la plateforme tournante Coriolis à Grenoble. Ces dimensions ainsi qu'un générateur d'ondes à grande échelle ont permis d'atteindre des valeurs de nombres sans dimension records. Nous présenterons les premiers résultats de cette campagne, incluant notamment un spectre spatial de l'énergie en accord sur plus d'une décade avec la prévision théorique de la turbulence d'ondes.

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ID de résumé : **85**

# Numerical approximation of incompressible multiphase flows with pseudo spectral methods

## Contenu

The approximation on incompressible flows with variable density and viscosity has many applications in engineering and geosciences (e.g. liquid metal batteries, aluminum production). First, we describe briefly some motivations, classic numerical methods used to the incompressible Navier-Stokes equations with variable density, and the main challenges we face when using pseudo-spectral methods. Second, we will introduce a novel artificial compressibility techniques which, unlike projection method, does not require to solve a Poisson problem to update the pressure and enforce the incompressibility constraints. The momentum, equal to the product of the density and velocity, and the pressure are chosen as primary unknowns which leads to a time independent mass matrix. We will discuss theoretical aspects (stability and convergence) of the proposed methods and its validation over various benchmarks.

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**Type de contribution:** Présentation orale / Oral presentation

**Statut:** ACCEPTÉ

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ID de résumé : **86**

# Flow patterning at near-zero Reynolds number

## Contenu

Microfluidic devices have revolutionized flow control at small scales. Programming localized flow patterns remains challenging. Here, we introduce a new approach to generate programmable and localized flow in microfluidic chips: We use a deformable chip, whose flexible ceiling of the microfluidic channel deforms downward. We leverage this system to break the temporal and spatial symmetries of the periodic flow in the microfluidic channel and produce a net fluid flow.

We investigate the influence of a cylindrical obstacle in this configuration. The vertical ceiling displacement generates a circumferential flow localized around the obstacle. Flow velocity and direction can be tuned by adjusting the phase delay of the actuators, or actuation frequency or amplitude. The flow can be described using an unsteady Hele-Shaw cell model.

This phenomenon represents a form of Stokes drift in which the obstacle converts sequential ceiling deformations into rotational flow. Finally, we show that this principle may be extended to more complex flow patterns by varying further the shape or number of the obstacles, or by combining this flow with an externally-controlled Poiseuille flow.

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**Type de contribution:** Présentation orale / Oral presentation

**Statut:** ACCEPTÉ

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ID de résumé : **87**

# Numerical Study of a Pintle Injector for an H2/Air Rotating Detonation Combustor

## Contenu

Rotating Detonation Combustors (RDC) possess a theoretical capacity to increase the engine thermodynamic efficiency compared to the deflagration combustion. Achieving real pressure gain with an experimental RDC remains unattainable because of loss factors depending on the chamber and injector designs, suggesting the need to characterize and further optimize their performance. Large Eddy Simulation of a pintle H2/Air injector are performed using inputs from a hot-fire test performed at TU Berlin for the H2POWRD project. First, a cold-flow injection simulation in a chamber angular sector shows good mixing capabilities of the injector. To model the refill process between successive detonation passages, a transient reinjection simulation is performed using the post-detonation state from a simplified rotating detonation simulation as initial condition. This reinjection simulation demonstrates the back-flow effect past the detonation and the parasitic deflagration that occurs when the injected fresh propellants are put in contact with the combustion products. This study provides an analysis of the injector performance and can act as a reduced model of a full RDC with rotating detonation.

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**Type de contribution:** Présentation orale / Oral presentation

**Statut:** ACCEPTÉ

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ID de résumé : **88**

# Multiple coexisting states of viscous sheet folding

## Contenu

In this work, we investigate the role of inertia in the periodic folding of thin viscous sheets. We employ a mathematical framework inspired by concepts from discrete differential geometry (DDG) to track the motion of the sheet midsurface and capture the shape and dynamics of sheet folding in regimes with non-negligible inertia. We observe that the folding frequency undergoes sudden transitions between distinct states as inertial effects become significant, and identify the underlying mechanism as a resonance occurring when the folding frequency at the bottom becomes commensurate with the natural frequency of the oscillating distributed pendulum.

In addition to explaining the coexistence of multiple frequency states observed in experiments, we also explore the strongly inertial regime, where inertia dominates over gravity, and validate the proposed scaling laws in previously unexplored folding regimes. Finally, we present a regime diagram in the control-parameter space, identifying the different folding regimes, namely the kinematic (forced-folding), gravitational, inertio-gravitational, and inertial regimes.

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**Co-auteurs:** DIETZE, Georg (CNRS, FAST); Dr RIBE, Neil (Laboratoire FAST (CNRS UMR 7608), Universite Paris-Saclay, Orsay)

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**Type de contribution:** Présentation orale / Oral presentation

**Statut:** ACCEPTÉ

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le **lundi 25 mai 2026**

ID de résumé : **89**

# Physics of Paragliding: Field Measurements and Trajectory Reconstruction of Spiral Descents

## Contenu

Paragliding is a relatively young adventure sport, popularized 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 such as the spiral descent. A spiral descent is characterized by the helical trajectory of both the pilot and the wing around a shared axis. The maneuver poses unique dangers; even without brake input, the pilot can remain trapped in a continuous spiral, descending at approximately 20 m/s. Measuring the position and orientation of a paraglider during such flight phases raises significant challenges regarding GPS precision and robustness against centrifugal acceleration. This study details how centimeter-level precision GPS and inertial measurement units (IMUs), combined with video recordings and sensor fusion techniques, enable the accurate reconstruction of the paraglider's trajectory and attitude during a spiral descent. The methodology we present will be broadly applicable to large scale in-vivo measurements of complex unsteady dynamics.

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**Orateur:** VALDECASA, Esteban (LadHyX)

**Type de contribution:** Présentation orale / Oral presentation

**Commentaires:**

Bonjour, J'enseigne les après-midi à l'école d'été FDSE. Pourriez-vous me programmer pour le matin ? De plus, si l'autre présenation sur le parapente (Gabriel Thebault) pouvait être juste avant la mienne ça serait plus fluide pour l'audience mais c'est optionnel. Merci beacoup et à bientôt, Esteban.

**Statut:** ACCEPTÉ

Déposé par **VALDECASA, Esteban** <esteban.valdecasa@polytechnique.edu> le **mardi 26 mai 2026**

ID de résumé : **90**

# Etude numérique comparative des bulles de Taylor en conduites circulaires et carrées

## Contenu

Les bulles de Taylor sont de grandes poches de vapeur immergées présentes dans des conduites ou des microcanaux. Elles apparaissent lors du régime d'écoulement diphasique à bouchons au sein de nombreux systèmes industriels et médicaux. Il est donc essentiel de comprendre leur comportement pour limiter leurs effets indésirables et optimiser les performances des systèmes. Jusqu' à présent, ces bulles ont principalement été étudiées dans des conduites à section circulaire ; notre travail porte quant à lui sur leur comportement dans des conduites à section carrée. Ces travaux présentent un intérêt particulier pour les caloducs oscillants, où l'influence de la géométrie des capillaires sur les performances reste encore mal comprise.

Le code TRUST/TrioCFD avec la méthode Front-Tracking est utilisé pour modéliser l'évolution d' une bulle de Taylor. Nous présenterons des analyses sur plusieurs caractéristiques essentielles des bulles de Taylor, telles que leur vitesse, l'épaisseur du film liquide, les contraintes pariétales ainsi que les pertes de pression.

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**Type de contribution:** Présentation orale / Oral presentation

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ID de résumé : **91**

# Improving the predictivity of large-eddy simulations using machine learning guided by high fidelity simulations

## Contenu

Turbulence is encountered in most industrial flows, yet simulating turbulent flows remains computationally challenging due to the wide range of spatial and temporal scales involved. This breadth of scales induces very high computational costs for Direct Numerical Simulations (DNS), driving the development of more affordable approaches such as Large-Eddy Simulations (LES). However, classical LES closure models lack the flexibility to accurately capture subgrid-scale physics across diverse flow regimes.

In recent years, machine learning (ML) has emerged as a promising avenue for data-driven closure models trained on high-fidelity simulation data. In this work, we propose a graph neural network-based LES closure model, where the graph representation naturally handles anisotropic and unstructured user-defined meshes. The model is designed to be equivariant to rotations and reflections, ensuring physically consistent predictions regardless of mesh orientation while reducing the amount of training data required. Special attention is given to non-dimensionalization and normalization of input features, which prove critical to the model's stability and generalizability.

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**Type de contribution:** Présentation orale / Oral presentation

**Statut:** ACCEPTÉ

Déposé par **TRIFA, Marwane** <marwane.trifa@cea.fr> le **mardi 26 mai 2026**

ID de résumé : **92**

# D´eveloppement d’une m´ethode de PTV 3D3C utilisant une seule cam´era & application aux mesures dans un jet d’air puls´e

## Contenu

Les méthodes de PTV 3D3C nécessitent généralement plusieurs caméras à haute vitesse, ce qui est financièrement couteux et génère des quantités importantes de données à traiter. La méthode développée ici n’en nécessite qu’une seule tout en gardant une bonne précision, ce qui facilite les mesures. Elle repose sur une approche par défocalisation, qui consiste à déduire la position des particules suivies dans la direction orthogonale au plan focal à partir de leur taille apparente.
L’efficacité de cette méthode de PTV défocalisée est démontrée en l’appliquant ‘a l’étude d’un jet d’air pulsé ensemencé de gouttelettes d’huile.

**Auteur:** KAYVANTASH, Tony (IFP Energies Nouvelles)

**Co-auteurs:** M. CORDIER, Matthieu (IFP Energies Nouvelles); M. DUVAL, Hervé (LGPM); ZIMMER, Laurent (EM2C)

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**Type de contribution:** Présentation orale / Oral presentation

**Statut:** ACCEPTÉ

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ID de résumé : **93**

# Nonlinear flow-induced deformation of a confined elastic fiber: toward bio-inspired particle filters

## Contenu

Dense fibrous media in contact with viscous flows are ubiquitous in nature and technology, from biological filtration systems to engineered porous filters. Their macroscopic transport properties crucially rely on the deformation of individual flexible fibers, yet the elementary fluid–structure mechanisms governing this coupling remain poorly understood.

Here we investigate experimentally and theoretically the flow-induced bending of an isolated quasi-two-dimensional elastic fiber confined in a viscous channel. By independently varying the fiber thickness and young's modulus, the channel geometry and the imposed flow rate, we systematically quantify the resulting fiber tip deflection. We show that the deformation exhibits a strongly nonlinear dependence on the flow rate and is a function of the geometric and mechanical parameters of the system.

A minimal analytical pressure-drop model that builds upon analytical solutions from simple confined geometries and nonlinear elastic beam theory almost captures the measured deformations. In addition, we identify a dimensionless parameter allowing all experimental and theoretical results to collapse onto a single master curve.

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**Co-auteurs:** M. MICHELIN, sebastien (LadHyX, Ecole Polytechnique de Paris); M. JAMBON-PUILLET, Etienne (LadHyX, Ecole Polytechnique de Paris)

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**Type de contribution:** Présentation orale / Oral presentation

**Statut:** ACCEPTÉ

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ID de résumé : **94**

# Paragliding launch dynamics

## Contenu

Paragliding is a new aeronautical sport popularized in the 1980s where pilots fly using fabric wings with a non-rigid structure. Unlike parachutes, paragliders must be inflated and launched before flight. Although many accidents occur at take-off we know little about the physics behind paraglider launch. We present experimental results collected using a custom test bench that simulates the launching phase with a trolley pulling the wing from a resting position causing it to inflate and get its aerodynamic shape. We simultaneously measure the aerodynamic forces and track the wing's trajectory via video analysis. We investigate the influence of wing parameters on these fluid forces, particularly that of the trim, the variation in line lengths that dictates the wing's angle of incidence. Building upon a previous study that identified a universal launch trajectory for two-dimensional paraglider wings, we use our data to investigate how these findings extend to three dimensions. Our study paves the way for a more quantitative approach to studying unsteady flight regimes in paragliding, and can be useful in the fields of parachuting, kitting, soft robotics and biomimicry.

**Auteur:** GREGORIO, Elizabeth (LadHyX)

**Co-auteurs:** BENZAQUEN, Michael (LadHyX); COHEN, Caroline (LadHyX); RAMANANARIVO, Sophie (LadHyX); THEBAULT, Gabriel (Aucun); VALDECASA, Esteban (LadHyX)

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**Type de contribution:** Présentation orale / Oral presentation

**Statut:** ACCEPTÉ

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ID de résumé : **95**

# Simulation numérique directe de l'ébullition nucléée dans un mélange binaire H2O-HNO3 avec TrioCFD

## Contenu

La compréhension de l'impact de l'ébullition sur la corrosion est un enjeu industriel important pour les procédés de retraitement du combustible nucléaire usé qui utilisent un mélange d'eau et d'acide nitrique, porté à ébullition. Dans cette thèse, nous développons l'approche numérique pour la simulation de l'ébullition de mélanges binaires.

L'objectif est de caractériser les cycles de nucléation en régime permanent (diamètre et fréquence de départ de bulle) sur une paroi horizontale chauffée, et d'étudier l'évolution des champs couplés de température et de concentration en acide nitrique. L'étude est menée au moyen de la simulation numérique directe (DNS), avec le code TRUST/TrioCFD.

Dans un premier temps, les aspects manquants de la modélisation physique (équilibre thermodynamique à l'interface, changement de phase couplé) sont implémentés. Plusieurs cas-tests à effet séparés ont été réalisés. Ils valident l'implémentation de la saturation de l'interface, et l'algorithme de changement de phase en 1D et en symétrie sphérique. Ces travaux de validation permettent de prévoir des simulations complètes de cycles d'ébullition dans la suite de la thèse.

**Auteur:** QUENTIN DE GROMARD, Maxime (CEA Paris-Saclay)

**Co-auteurs:** Dr BOIS, Guillaume (CEA); Dr NIKOLAYEV, Vadim (CEA)

**Orateur:** QUENTIN DE GROMARD, Maxime (CEA Paris-Saclay)

**Type de contribution:** Présentation orale / Oral presentation

**Statut:** ACCEPTÉ

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ID de résumé : **96**

# Dynamic Instability of Kirigami Sheets in a Uniform Flow

## Contenu

When flexible patterned structures are exposed to fluid flows, they undergo complex shape reconfigurations. Kirigami sheets, surfaces engineered with periodic cutting patterns, couple global macroscopic stretching with local three-dimensional pore opening, which allows for complex fluid-structure interactions. In this work, we experimentally investigate the subcritical instability that arises when a kirigami ribbon is placed in a uniform water flow: above a critical flow speed, the structure spontaneously oscillates laterally and reaches a limit cycle. Through water channel testing, we explore how the system's dynamic response is affected by both the number of cut units and the cutting geometry, which governs the sheet's effective stiffness. Finally, to rationalize these experimental observations, we aim to extend a continuous porous membrane model to capture the dynamic hydroelastic couplings, providing a theoretical framework to accurately predict the onset of the instability.

**Auteur:** CABY, Augustin (LadHyX)

**Orateur:** CABY, Augustin (LadHyX)

**Classification de thématique:** Fluid-Structure Interaction; Instability and Transition

**Type de contribution:** Présentation orale / Oral presentation

**Statut:** DÉPOSÉ

Déposé par **CABY, Augustin** <augustin.caby@polytechnique.edu> le **mercredi 27 mai 2026**

ID de résumé : **97**

# Activity driven flows of dense bacteria suspensions in porous structures

## Contenu

Active fluids are known to sustain fluid flows in time without any external forcing. In porous media, active suspensions such as active filaments or microtubules were shown to enhance flow rate, breaking Darcy's law and inducing mixing without external forces[1–3]. Here, we propose a computational study of dense bacterial suspension flows in porous media. Bacterial suspensions are a class of naturally occuring active fluid. Depending on the cell density and activity, they can display self sustained coherent or chaotic flows in confined environments[4]. We use a continuum framework derived from Fokker–Planck descriptions of bacterial suspensions confined in a channel with different pore scale geometries. This approach allows us to quantitatively map the bacterial suspension mass flow rate as a function of pressure gradient,
pore configuration and activity. Potential applications include the use of active bacterial suspensions and superfluids in
bioremediation applicaitons.
1 Keogh et al. Phys. Rev. Lett., 132, 2024.
2 de Anna et al., Nat. Phys., 17, , 2021.
3 Vélez-Cerón et al. , PNAS, vol. 122, 2025.
4 Wioland et al., Phys. Rev. Lett., 2013.

**Auteur:** TORRENEGRA RICO, Juan David (Centralesupelec, EMC2 Lab-Universite Paris Saclay)

**Co-auteurs:** Prof. AURADOU, Harold (FAT, Paris-Saclay,CRNS); CHABANON, Morgan (CentraleSupélec, Université Paris-Saclay)

**Orateur:** TORRENEGRA RICO, Juan David (Centralesupelec, EMC2 Lab-Universite Paris Saclay)

**Type de contribution:** Présentation orale / Oral presentation

**Statut:** ACCEPTÉ

Déposé par **TORRENEGRA RICO, Juan David** <juan-david.torrenegra-rico@centralesupelec.fr> le **jeudi 28 mai 2026**

ID de résumé : **98**

# Swimming in spatially varying viscosity

## Contenu

Oceans are stratified environments, featuring important and sometimes localised gradients of salinity and temperature, that in turn can profoundly affect their mechanical properties (i.e. density and viscosity). These water bodies host a significant part of the Earth's biomass in the form of microorganisms that swim, feed, and reproduce in such inhomogeneous environments, meanwhile participating in the global food chain but also chemical and nutrient exchanges critical to the ecosystem or climate. Understanding the impact of physical gradients and stratification on their dynamics is therefore critical. To this end, our work focuses on the influence of spatially varying distributions of viscosity on the hydrodynamic signature of small bodies, active or not, and on the modification of their swimming trajectories.

**Auteur:** BRANCHER, Paul (LadHyX - Ecole polytechnique)

**Co-auteurs:** Dr ELFRING, Gwynn (University of Brittish Columbia - Mechanical engineering dep.); Dr MICHELIN, Sébastien (LadHyX - Ecole Polytechnique)

**Orateur:** BRANCHER, Paul (LadHyX - Ecole polytechnique)

**Type de contribution:** Présentation orale / Oral presentation

**Statut:** ACCEPTÉ

Déposé par **BRANCHER, Paul** <paul.brancher@polytechnique.edu> le **dimanche 31 mai 2026**

ID de résumé : **99**

# Stability-Based Approaches to Flow–Noise Coupling: From Bluff Bodies to Jets

## Contenu

Reducing noise from aircraft and emerging air mobility systems relies on understanding how turbulent flow structures generate and amplify sound.
I will present two complementary lines of research that explore these mechanisms using experimental data and stability-based modeling. First, I will discuss bluffbody aeroacoustics, focusing on Aeolian tones generated in cylinder wakes. By combining time-resolved PIV and acoustic measurements with global stability analysis and Curle's analogy, I developed a low-order noise prediction framework that captures the role of coherent structures in sound generation.
Second, I will turn to jet noise at high subsonic Mach numbers. Using Large Eddy Simulation data analyzed through stability-based eigenmode projections, I identified the resonance mechanisms responsible for discrete acoustic tones, confirmed scenarios previously hypothesized, and quantified wave reflection processes in turbulent jets.
Together, these studies outline a unified strategy for aeroacoustics research: leveraging experimental and numerical databases with linear modeling and reduced-order analysis to provide predictive insight into flow–noise coupling.

**Auteur:** PRINJA, Robin (Institut polytechnique des sciences avancées)

**Orateur:** PRINJA, Robin (Institut polytechnique des sciences avancées)

**Type de contribution:** Présentation orale / Oral presentation

**Statut:** ACCEPTÉ

Déposé par **PRINJA, Robin** <robin.prinja@ipsa.fr> le **lundi 1 juin 2026**

ID de résumé : **100**

# Invasion of a porous medium saturated by yield-stress fluid: invasion patterns and flow regimes

## Contenu

We investigate flows involving yield-stress fluids in porous media using a pore-network model, a simplified representation of porous media. Dynamic two-phase flows are considered, where a Newtonian fluid is injected into a medium initially saturated with a yield-stress fluid. In this system, yield stress competes with both capillarity and viscous forces, leading to the appearance of multiple new flow regimes.
A breakthrough criterion is derived and three novel flow regimes are studied: a stable-front regime, and two invasion patterns that arise from the presence of the yield stress. When the invading Newtonian fluid is highly viscous, preferential flow paths develop for high yield stress values and lead to the formation of a column-like invasion pattern. In contrast, for lower viscosities, a directed tree structure emerges from the branching of the advancing paths.

**Auteur:** ABITBOL, Nathan (Université Paris-Saclay)

**Co-auteurs:** Prof. HANSEN, Alex (Porelab, Department of physics, NTNU); ROSSO, Alberto (LPTMS-CNRS); TALON, Laurent (Lab. FAST)

**Orateur:** ABITBOL, Nathan (Université Paris-Saclay)

**Type de contribution:** Présentation orale / Oral presentation

**Statut:** ACCEPTÉ

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ID de résumé : **101**

# HYDRODYNAMIC COEFFICIENTS OF SOLID AND PERFORATED HEAVE PLATES AT LOW KC NUMBERS: A TWO-DIMENSIONAL ALE CFD STUDY

## Contenu

Perforated heave plates are widely used to suppress the heave motion of floating offshore wind turbines, yet existing damping models do not disentangle perforation-induced ("hole") and edge-vortex ("edge") damping contributions, preventing scalable physics-based design formulas. As a first step toward the systematic decomposition of these contributions, a two-dimensional ALE finite-volume CFD framewark is developped for oscillating solid and perforated heave plates ($D_p = 0.4(m), e = 0.008(m)$) in Code_Saturne 9.0, over $KC \in [0.1, 1.2]$. CFD Results show that the damping coefficient $C_b$ of the perforated plate consistently exceeds that of the solid plate for low values of $KC$, and become similar at $KC \approx 1.0$. We also plan to share the results of the comparison with the coefficients measured in the experimental research conducted by Francisco, a PhD student at ENSTA Paris. Future work will focus on explaining this convergence through vortex dynamics analysis and on clarifying the role of the free surface.

**Auteur:** M. MINODA, Kohei (Institut Polytechnique de Paris - ENSTA Paris)

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**Type de contribution:** Présentation orale / Oral presentation

**Statut:** ACCEPTÉ

Déposé par **M. MINODA, Kohei** <kohei.minoda@ensta.fr> le **lundi 1 juin 2026**

ID de résumé : **102**

# POD as the linear limit of autoencoders: a path to interpretable nonlinear reduced order models

## Contenu

Proper orthogonal decomposition (POD) can be viewed as the linear limit of autoencoders. This connection is exploited to construct interpretable nonlinear reduced order models. By introducing learnable polynomial activation functions, the autoencoder can be initialized as an exact POD decomposition, allowing for an optimal linear reconstruction error even before training begins. Initializing autoencoders with POD also accelerates training convergence by an order of magnitude in terms of the number of gradient descent epochs required. The addition of convolutional layers (CNN) reduces reconstruction errors by an order of magnitude, compared to the baseline autoencoder. The learned filters can be interpreted as spatial derivative operators, revealing how additional nonlinear mode couplings are captured. The results are presented for the flow around an oscillating cylinder, in a quasi-periodic regime. It is shown that the best autoencoders completely outperform POD when encoding the first few most energetic modes, while POD remains competitive in the tail of the energy spectrum.

**Auteur:** BOUSQUET, Rémi (LISN)

**Co-auteurs:** M. FAUCHEU, Alex (LISN); Dr LUCOR, Didier (LISN); Prof. NORE, Caroline (LISN)

**Orateur:** BOUSQUET, Rémi (LISN)

**Type de contribution:** Présentation orale / Oral presentation

**Statut:** ACCEPTÉ

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ID de résumé : **103**

# Upper versus lower edge state in subcritical shear flows

## Contenu

Subcritical shear flows are characterised by the competition between two different attractors, namely the laminar and the turbulent regimes. The concept of "lower"edge manifold refers to the basin boundary in state space, separating initial conditions which
relaminarise from those which become turbulent. It has become central in the study of transition to turbulence. Recent studies have also introduced the notion of an 'upper
edge'relevant to control strategies. This manifold separates turbulent trajectories from higher energy initial conditions that relaminarise, thus mediating transition from turbulent to laminar. It stands in contrast to the well-studied
'lower edge'that separates initial conditions which have enough energy to become turbulent from those that do not. In this study, we focus numerically on cylindrical pipe flow, and we adapt the bisection algorithm to the upper edge. We will explore the theoretical connections between these two concepts. In a second part we will discuss computational
optimisation methods for the identification of the weakest perturbations able to force a turbulent flow to relaminarise.

**Auteur:** DUGUET, Yohann (LISN-CNRS)

**Orateur:** DUGUET, Yohann (LISN-CNRS)

**Commentaires:**

joint work with R. Bennett, E. Marensi and A. P. Willis (Univ. Sheffield, UK)

**Statut:** ACCEPTÉ

Déposé par **DUGUET, Yohann** <yohann.duguet@universite-paris-saclay.fr> le **lundi 1 juin 2026**

ID de résumé : **104**

# High-order adaptive multistep coupling scheme for multiphysics applications

## Contenu

In the context of multiphysics simulations, partitioned methods enable the reuse of existing solvers while preserving modularity. However, achieving high-order accuracy in time and providing adaptive time stepping remains a challenge, especially when dealing with strong coupling conditions. We address these issues by developing and analyzing a high-order multistep coupling scheme tailored for multiphysics applications. Contrary to classical staggered coupling schemes, where the coupling terms are held constant between two successive coupling time points, this new technique uses high-order polynomial-in-time predictions of the evolution of the coupling conditions during a coupling time step. An explicit and an implicit variants arise naturally, and error estimates can be built to dynamically drive the coupling timestep. I will present a numerical analysis of convergence and stability of the multistep coupling scheme.

**Auteur:** M. SIMON, Antoine (CMAP)

**Co-auteur:** MASSOT, Marc (CMAP)

**Orateur:** M. SIMON, Antoine (CMAP)

**Statut:** ACCEPTÉ

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ID de résumé : **105**

# Transitioning to the ultimate regime of convection in three-dimensional direct numerical simulations

## Contenu

Rayleigh-Bénard cavity flows consist of boundary layers sheared by a turbulent wind, which itself is generated by buoyant convection, creating a turbulent bulk. Recently, it has been shown that accounting for the wind Reynolds number resolves the apparent contradiction between the large number of experimental results in the literature (Brichet et al., 2025). A universal critical Reynolds number has been identified, which distinguishes two turbulent regimes. This presentation focuses on the second regime, which corresponds to Reynolds numbers greater than 1E4. Based on numerical simulations of water flows for Rayleigh numbers up to 1E12, we explore the nature and the structure of the kinetic and thermal boundary layers, and energy cascades.

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**Type de contribution:** Présentation orale / Oral presentation

**Statut:** ACCEPTÉ

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