JEFS - Journées Écoulements & Fluides - Saclay

Report of Contributions

Contribution ID: **7** Type: **Présentation orale**

Interactions multi-échelles en convection de Rayleigh Bénard avec une plaque rugueuse

Tuesday, June 18, 2024 9:50 AM (20 minutes)

Turbulent convection is a spontaneous physical process in natural environments and many industrial systems. However, most of these systems are not ideal in terms of underlying surfaces and involve specific topography or small-scale roughness. Interactions between plate roughness and nearby flow can induce changes in turbulence scales [1]. In addition, when the side walls of a cavity confine the flow or when it is enclosed by two large-scale horizontal walls, a large-scale circulation (LSC) is established in the fluid volume [2]. This work aims to reveal how the LSC changes small flow structures by considering either a cavity flow or a fluid layer of reduced size, particularly when a plate is rough.

This study considers three types of bottom plates: smooth plate and two plates with evenly distributed roughness elements. Three confined cavities and three periodic fluid domains are modeled using direct numerical simulations at constant Ra and Pr, considering the different types of plates as indicated above.

Primary authors: Mr CARBONNEAU, Nathan (Lab. Interdisciplinaire des Sciences du Numérique); Mr SALORT, Julien (LP, ENS Lyon); SERGENT, Anne (LISN / Sorbonne Université)

Presenter: Mr CARBONNEAU, Nathan (Lab. Interdisciplinaire des Sciences du Numérique)

Session Classification: Présentations

Track Classification: Convection and Buoyancy-Driven Flows

Contribution ID: **8** Type: **Présentation orale**

Rise and fall of a multicompoent droplet in a surrounding fluid.

Tuesday, June 18, 2024 12:20 PM (20 minutes)

We present numerical results of the simulation of a multicomponent droplet in water. Due to diffusion the mass density of the initially light droplet increases. As a result after an initial ascencion the droplet starts to fall.
Here we show that the interplay between diffusion and flow leads to unexpected effects that affect significantly the motion of the droplet.

Primary author: HENRY, Herve (Laboratoire PMC, CNRS, Ecole Polytechnique. IP Paris)

Presenter: HENRY, Herve (Laboratoire PMC, CNRS, Ecole Polytechnique. IP Paris)

Session Classification: Présentations

Contribution ID: **9** Type: **Présentation orale**

La turbulence d'ondes internes de gravité : un modèle pour la dynamique océanique à petite échelle ?

Tuesday, June 18, 2024 10:10 AM (20 minutes)

Il est depuis longtemps proposé que la dynamique océanique à petite échelle est pilotée par celle des ondes internes de gravité. Décrire physiquement ces petites échelles, qui ne sont pas résolues dans les modèles océaniques, constituerait un levier majeur d'amélioration des paramétrisations dans les simulations du climat. Dans ce contexte, la théorie la plus prometteuse est celle de la turbulence d'ondes. Sa mise en œuvre dans le cas des ondes internes de gravité s'est toutefois révélée complexe et reste inaboutie.

Dans cet exposé, en partant de la formulation classique de la théorie, nous dérivons une version simplifiée de l'équation cinétique de la turbulence d'ondes internes de gravité. Cette équation nous permet de prédire des lois d'échelle pour les spectres spatiaux et temporels de l'énergie qui sont en accord avec les exposants typiquement mesurés dans les océans. La clé de notre description est l'hypothèse que les transferts d'énergie sont dominés par une classe d'interactions résonantes non locales, connues sous le nom de triades de « diffusion induite » et qui conservent le rapport entre la fréquence des ondes et leur nombre d'onde vertical.

Primary author: CORTET, Pierre-Philippe (Laboratoire FAST, Université Paris-Saclay & CNRS)

Co-author: LANCHON, Nicolas (Laboratoire FAST, Université Paris-Saclay & CNRS)

Presenter: CORTET, Pierre-Philippe (Laboratoire FAST, Université Paris-Saclay & CNRS)

Session Classification: Présentations

Contribution ID: **10** Type: **Présentation orale**

Combining an a priori space-time separated model-order reduction technique to the Particle Finite Element Method

Monday, June 17, 2024 2:20 PM (20 minutes)

The Particle Finite Element method is a fluid solver based on Lagrangian finite elements combined with efficient re-meshing algorithms. It was shown to be effective in a large amount of applications, especially in the case of free surface fluids flows or fluid-structure interactions. Up to now, this method has never been paired up with any model-order reduction technique because of the difficulties linked to the re-meshing schemes. This remains however, an important area of research to uncover as it could drastically reduce the computational cost of the method. In this work, we focus on an a priori reduction method called Proper Generalized Decomposition (PGD) with a space-time decomposition. The PGD does not require any knowledge of past solutions and builds the reduced model iteratively. To deal with moving mesh and remeshing, a new expanded formulation is introduced. Particular efforts have to be made to ensure both correct mesh and solution interpolation at the re-meshing instances and adequate update of the mesh after every new mode calculation. The proposed technique has been validated with simple tests showing very promising results.

Primary author: BECKERMANN, Max (Centralesupelec)

Co-authors: Mr BARBARULO, Andrea (Centralesupelec); Prof. CREMONESI, Massimiliano (Politecnico di Milano)

Presenter: BECKERMANN, Max (Centralesupelec)

Session Classification: Présentations

Contribution ID: **11** Type: **Présentation orale**

Swimming dynamics and efficiency in diatom chain colonies

Monday, June 17, 2024 4:00 PM (20 minutes)

Diatoms are among the most abundant microorganisms found in both oceanic and freshwater environments worldwide. While some species drift passively with ambient currents, others employ various strategies for movement or self-propulsion. One species in particular, called Bacillaria Paxillifer, forms colonies of stacked rectangular cells that slide along each other while remaining parallel. This unique collective motion leads to beautiful and nontrivial trajectories at the colony scale. By using a numerical method developed to simulate articulated bodies in Stokes flows, we show that the swimming speed of such microorganisms changes non-monotonically with the sliding delay between pairs of cells. The observed swimming efficiency as a function of the number of oscillations along the colony exhibits several local maxima, contrary to what is commonly observed in flagellate microorganisms. In addition, the optimal cell aspect ratio found with our simulation matches those observed in real diatom chain.

Primary authors: DELMOTTE, Blaise; LE DREFF, Julien (LadHyX)

Presenter: LE DREFF, Julien (LadHyX)

Session Classification: Présentations

Contribution ID: **12** Type: **Présentation orale**

Algal bioconvection in confined dispersed media

Monday, June 17, 2024 3:40 PM (20 minutes)

Active particles are inherently out-of-equilibrium systems, able to uptake energy from their environment and convert it to motion.
For example, Chlamydomonas Reinhardtii (CR) is a micro-swimmer whose orientation can be dictated by a light gradient in its environment (phototaxis). It is known that a collective motion triggered due to the phototaxis of a population of CR generates a nonlinear phenomenon: bioconvective structures that affect the fluid medium [1].

The purpose of this experimental study is to control the motion of algae swarms and resulted bioconvective vortices in order to achieve a guided transportation of microscopic objects submerged in the algal suspension. High concentrations of algae and microparticles were confined in a small square Hele-Shaw cell surrounded by a series of LED, allowing us to apply different well-controlled gradients of light stimulus in a quasi-2D horizontal domain.
It was shown that the microparticles can be transported to a target zone by controlling the displacement of algal bioconvective structures.

[1] J. Dervaux, M. Capellazzi Resta, and P. Brunet, Nature Phys 13, 306–312 (2017).

Primary author: NICOLAZO-CRACH, Victoria (Laboratoire FAST)

Co-authors: Mr LAROUSSI, Taha (LadHyx); Mr BOUVARD, Julien (LadHyx); Dr AMSELEM, Gabriel (LadHyx); JARRAHI, Mojtaba (université Paris-Sud)

Presenter: NICOLAZO-CRACH, Victoria (Laboratoire FAST)

Session Classification: Présentations

Contribution ID: **13** Type: **Présentation orale**

Rheology of a granular medium mixed to flexible fibers

Monday, June 17, 2024 9:30 AM (20 minutes)

The introduction of a small amount of flexible fibers into a granular medium is an effective and inexpensive technique to reinforce the mechanical resistance of these materials. Although the way fibers affect the volumic fraction of a mixed of beads and fibers and the way fibers affect the flowing properties of the material is much unknown. To fill this gap, we measure the flowing response of a model material made of glass beads (diameter of order 0.3 mm) and polypropylene fibers. These fibers' length is typically centimeters and their diameters are typically of order a few 0.01 mm. To characterize the response of the medium, we use a shear vane geometry, which has been already used to characterize the rheology of pure grains. We impose the rotation speed and measure the torque required to shear the granular material mixed with fibers. It appears that with very few fibers, volumic fraction of fibers of order 0.2%, the stationnary torque is increased by 10%. We also measure the effect of the fiber's aspect ratio on the rheology of the medium. Finally, we attempt to analyse these results within the framework of $\mu(I)$ rheology developed for dry granular flows.

Primary author: WIERZCHALEK, Ladislas (Laboratoire FAST)

Co-author: DARBOIS TEXIER, Baptiste (Laboratoire FAST, CNRS, Université Paris-Saclay)

Presenter: WIERZCHALEK, Ladislas (Laboratoire FAST)

Session Classification: Présentations

Contribution ID: **14** Type: **Présentation orale**

On Poiseuille flow for shear-thickening fluids

Monday, June 17, 2024 10:30 AM (20 minutes)

Shear thickening fluids are liquids that stiffen as the applied stress increases. If many of these types of fluids follow a monotonic rheological curve, some experimental and numerical studies suggest that certain fluids, like cornstarch, may exhibit a non-monotonic, S-shaped rheology. In this work, we experimentally and numerically study the implications of such rheology for the simple Poiseuille flow configuration.

Primary authors: TALON, laurent (Lab. FAST); SALIN, Dominique (FAST)

Presenter: TALON, laurent (Lab. FAST)

Session Classification: Présentations

Contribution ID: **16** Type: **Présentation orale**

Role of melting and solidification in the spreading of an impacting water drop

Tuesday, June 18, 2024 2:20 PM (20 minutes)

When a liquid drop impacts onto a cold enough substrate, a complex interplay occurs between phase change and the spreading dynamics of the liquid film. A better understanding of this configuration has potentially a broad scope of applications, ranging from three-dimensional printing or metallurgy to aircraft icing problematics. In the present paper, we report experiments of water drop impacts on ice or cold metal surfaces, in which both the droplet and the substrate temperatures, as well as the falling height, have been varied. By doing so, ice melting or solidification of the impinging drop can be evidenced. The maximum impact diameter is affected by the presence of phase change, with fusion enhancing the liquid film spreading whereas solidification hampers it. To rationalize these observations, we extend an existing model of effective viscosity, in which the influence of the phase change dynamics on the size and form of the viscous boundary layer is taken into account. This allows us to accurately describe the impact outcome and, more importantly, to relate the present data to a universal law recently developed in the context of isothermal drop impacts.

Primary author: Dr SARLIN, Wladimir (LadHyX, CNRS & Ecole Polytechnique)

Co-authors: Dr HUERRE, Axel (Laboratoire Matière et Systèmes Complexes (MSC) CNRS & Université Paris Cité); JOSSERAND, Christophe (LadHyX, CNRS & Ecole Polytechnique); Mr XU, Julien (LadHyX, CNRS & Ecole Polytechnique); Dr GRIVET, Rodolphe (LadHyX, CNRS & Ecole Polytechnique); Dr SÉON, Thomas (Institut Franco-Argentin de Dynamique des Fluides pour l'Environnement (IFADyFE), CNRS & UBA, CONICET, Buenos Aires, Argentine)

Presenter: Dr SARLIN, Wladimir (LadHyX, CNRS & Ecole Polytechnique)

Session Classification: Présentations

Contribution ID: **17** Type: **Présentation orale**

Virial Theorem and Its Applications in Instability of Two-Phase Water-Wave

Monday, June 17, 2024 11:40 AM (20 minutes)

We analyze the dynamics of two layers of immiscible, inviscid, incompressible, and irrotational fluids through a full nonlinear system. Our goal is to establish a virial theorem and prove the polynomial growth of slope and curvature of the interface over time when the fluid below is no denser than the one above. These phenomena, known as Rayleigh-Taylor instability and Kelvin-Helmholtz instability, will be proved for a broad class of regular initial data, including the case of 2D overlapping interface.

Primary author: YANG, Haocheng (ENS Paris-Saclay)

Presenter: YANG, Haocheng (ENS Paris-Saclay)

Session Classification: Présentations

Contribution ID: **18** Type: **Présentation orale**

Drag reduction in the side-by-side motion of intruders in a granular medium

Monday, June 17, 2024 9:50 AM (20 minutes)

Various practical situations involve the movement of several objects in a granular medium, such as animal locomotion or civil engineering applications. In this work, we study the interaction between objects and measure the drag experienced by a pair of spherical intruders moving side-by-side into grains at constant depth and constant velocity. We quantify the influence of the separation distance between the spheres and their depth below the granular surface. When the intruders are far apart, they do not interact and the average drag felt by each of them corresponds to that of a single intruder. However, for a small separation between the intruders, the mean drag is reduced, confirming the existence of a cooperative effect that facilitates motion. In addition, the relative drag reduction is observed to increase with burial depth. We propose a model for the drag reduction of a pair of intruders based on the breakup of contact chains caused by the shear generated by the neighbouring intruder. These results provide new insights into the interaction between solid objects that move together in grains, as in the case of animal locomotion in sand or the growth of plant roots in soil.

Primary authors: SEGUIN, Antoine; DARBOIS TEXIER, Baptiste (Laboratoire FAST, CNRS, Université Paris-Saclay); Mr DE CARVALHO, Douglas (Universidade Estadual de Campinas (UNICAMP)); Mr FRANKLIN, Erick (Universidade Estadual de Campinas (UNICAMP)); Mr BERTHO, Yann (FAST, Université Paris-Saclay)

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

Session Classification: Présentations

Contribution ID: **19** Type: **Présentation orale**

The key role of inertia in the Plateau-Rayleigh instability for liquid-vapour water system

Monday, June 17, 2024 11:20 AM (20 minutes)

Liquid/vapour water flows are encountered in several fields, such as in Proton Exchange Membrane Fuel Cell (PEMFC), a promising technology to electrify the energy system. In PEMFC, electricity is produced by recombining oxygen and hydrogen fed via gas channels. Water is also generated and should be evacuated via the channels. As the temperature is low (60-80℃), water is observed both as liquid and vapour, creating a two-phase flow in the capillary-size GFC. Formation of liquid plugs is then possible due to the Plateau-Rayleigh instability. While lubrication theory is commonly used to describe it, in such liquid/vapour water systems, due to the moderate viscosities, the inertial terms of the Navier-Stokes equations may become significant. Understanding the role played by inertia in the plug formation is the aim of this work. TRUST-TrioCFD/Front-Tracking code is used to perform 2D-axisymmetrical simulations of plug formation. A linear stability analysis is performed to demonstrate the role of inertia at the inception of the instability and Front-Tracking simulations are used to observe its later stages. This work will be pursued by investigating the effects of an imposed flow.

Primary author: RYKNER, Matthieu (CEA/SGLS/LCAN)

Co-authors: Mr BRUNETON, Adrien (CEA/SGLS/LCAN); Dr MATHIEU, Benoît (CEA/LITEN/LMPS); SAIKALI, Elie (CEA/LIMSI); Dr NIKOLAYEV, Vadim (CEA/SPEC/SPHYNX)

Presenter: RYKNER, Matthieu (CEA/SGLS/LCAN)

Session Classification: Présentations

Contribution ID: **20** Type: **Présentation orale**

Simulation des premiers instants de la balistique d' un obus avec une méthode de maillages mobiles.

Monday, June 17, 2024 3:00 PM (20 minutes)

Pour améliorer la portée d'un obus, on ajoute à son culot un chargement de propergol solide (base-bleed) qui, lorsqu'il brûle, génère un écoulement dans le sillage de l'obus lors de la phase de balistique extérieure. Cet écoulement modifie la recirculation au culot de l'obus, ce qui réduit sa trainée. Lorsque l'obus sort du canon (balistique intermédiaire), une importante dépressurisation des gaz présents dans le canal central du base-bleed peut amener le propergol à s'éteindre. Plusieurs outils numériques sont alors développés pour caractériser la dépressurisation des gaz. Pour simuler la mise en mouvement de l'obus (balistique intérieure) et la balistique intermédiaire, on utilise une méthode de Maillages Chevauchants Conservatifs (MCC). Un maillage mobile découpe à chaque itération un maillage de fond fixe. On développe également un modèle de balistique intérieure 0D qui, couplé au code CEDRE de l'ONERA et à la méthode MCC, permet de mettre en mouvement l' obus de manière réaliste. Finalement, on simule la balistique intermédiaire afin de retrouver une structure d'écoulement en accord avec la littérature pour pouvoir estimer l'intensité de la dépressurisation au culot de l'obus.

Primary authors: GUERMONPREZ, Gabin (DMPE, ONERA, Université Paris Saclay, F-91123 Palaiseau, France); Mr GAILLARD, Thomas (DMPE, ONERA, Université Paris Saclay, F-91123 Palaiseau, France); Mr DUPAYS, Joël (DMPE, ONERA, Université Paris Saclay, F-91123 Palaiseau, France); Mr ANTHOINE, Jérôme (ONERA / DMPE, Université de Toulouse, F-31055 Toulouse, France); Mr DEMARTHON, Romain (DGA Techniques Terrestres, Rocade Est –Echangeur de Guerry, 18021 Bourges Cedex)

Presenter: GUERMONPREZ, Gabin (DMPE, ONERA, Université Paris Saclay, F-91123 Palaiseau, France)

Session Classification: Présentations

Contribution ID: **21** Type: **Présentation orale**

Turbulent Convection: Numerical Modeling and Physics Enhanced Machine Learning.

Monday, June 17, 2024 2:00 PM (20 minutes)

Complex phenomena, such as turbulence, require the use of laborious and resource-intensive algorithms. This incurs significant costs in terms of storage space and computation time. Machine and deep learning techniques are introduced to tackle such challenges, offering solutions such as reduced models, simulation acceleration, and data compression.
Physics-Informed Neural Networks (PINNs) harness the power of neural networks by incorporating PDE residuals into the learning loss terms. Consequently, they present significant tuning challenges, particularly in balancing the various loss terms, wether it be PDE residual losses or labeled data losses. In our work, we explore optimal loss balancing through automatic scaling of various relaxation loss coefficients to accelerate the learning process.
The model is then applied to infer hidden variables, such as the 3D temperature field from partial knowledge of the velocity field, which poses numerous challenges.

Primary authors: MRINI, Soufiane; SERGENT, Anne (UPMC / LIMSI); LUCOR, Didier (CNRS)

Presenter: MRINI, Soufiane

Session Classification: Présentations

Contribution ID: **22** Type: **Présentation orale**

Collection d'ondes induites en canal par le mouvement impulsionnel d'un piston

Tuesday, June 18, 2024 10:30 AM (20 minutes)

Nous présentons ici les différentes formes de vagues pouvant être générées par le mouvement impulsionnel d'un piston dans un canal, en variant la vitesse du piston et sa course, ainsi que la hauteur d'eau. Nous nous intéressons en particulier aux premiers instants de formation du bourrelet d'eau induit par l'avancée du piston, tant en amplitude qu'en forme. A faible accélération du piston, une théorie existante d'écoulement potentiel permet de décrire les ondes produites, tandis qu'un modèle de ressaut quasi-stationnaire est proposé pour les vagues obtenues lorsque le nombre de Froude associé au problème devient grand.

Primary authors: SARLIN, Wladimir (LadHyX, Ecole Polytechnique); Mr NIU, Zhaodong (Ladhyx, Ecole Polytechnique); Dr SAURET, Alban (UCSB, United States); GONDRET, Philippe (Laboratoire FAST); MORIZE, Cyprien (Laboratoire FAST, Université Paris-Saclay)

Presenter: MORIZE, Cyprien (Laboratoire FAST, Université Paris-Saclay)

Session Classification: Présentations

Contribution ID: **23** Type: **Présentation orale**

Noise sustained versus self-sustained structures in rotor-stator flow

Monday, June 17, 2024 12:20 PM (20 minutes)

Rotor-stator flows are known to exhibit instabilities in the form of circular and spiral rolls. While the spirals are known to emanate from a supercritical Hopf bifurcation, the origin of the circular rolls is still unclear. A quantitative scenario for the circular rolls as a response of the system to external forcing is suggested. Two types of axisymmetric forcing are considered: bulk forcing (based on the resolvent analysis) and boundary forcing using direct numerical simulation. The linear gain curve shows strong amplification at non-zero frequencies following a pseudo-resonance mechanism. The optimal energy gain is found to grow rapidly with the Reynolds number (based on the rotation rate and interdisc spacing H) in connection with huge levels of non-normality. Presented results suggest that the circular rolls observed experimentally are the combined effect of the high forcing gain and the roll-like form of the leading response of the linearised operator. For sufficiently strong forcing amplitudes, the nonlinear response is consistent with the self-sustained states found recently for the unforced problem.

Primary authors: GESLA, Artur (Sorbonne Université, LISN-CNRS); DUGUET, Yohann (LISN-CNRS); LE QUÉRÉ, Patrick (LISN-CNRS); MARTIN WITKOWSKI, Laurent (Université Lyon 1)

Presenter: GESLA, Artur (Sorbonne Université, LISN-CNRS)

Session Classification: Présentations

Contribution ID: **24** Type: **Présentation orale**

Interaction entre un jet et une mousse.

Tuesday, June 18, 2024 2:40 PM (20 minutes)

Si un jet liquide entre dans un bain liquide avec une rugosité ou une vitesse suffisante, il peut entraîner de l'air sous forme de bulles. Si des surfactants sont présents dans la solution, ces bulles seront suffisamment stables pour former une couche de mousse à la surface. Le jet va alors interagir avec cette couche de mousse. Pour étudier cette situation, nous avons réalisé des cuves quasi 2D, dans lesquelles une mousse monodisperse est perturbée par un jet liquide. Nous présenterons les résultats de ces expériences, en nous concentrant sur deux régimes en particulier : celui où le jet forme une nuée de petites bulles dans la mousse, et celui où le jet draine les films des bulles. Nous classifions ces résultats dans un diagramme de phase où la vitesse et le rayon du jet, l'épaisseur de la cuve, et la taille des bulles sont variés.

Primary authors: SALONEN, Anniina (LPS); RIO, Emmanuelle (LPS); GAICHIES, Théophile (LPS)

Presenter: GAICHIES, Théophile (LPS)

Session Classification: Présentations

Contribution ID: **25** Type: **Présentation orale**

Approche d'une sphère vers une paroi dans une suspension dense

Tuesday, June 18, 2024 9:30 AM (20 minutes)

La rhéologie des suspensions denses de particules a été principalement étudiée dans des configurations de cisaillement simple. La validité de ces résultats pour prédire l'écoulement de suspensions dans des configurations plus complexes reste à établir. Dans ce contexte, nous étudions expérimentalement la dynamique d'une sphère qui sédimente dans une suspension et s'approche d'une paroi horizontale. À faible nombre de Reynolds et proche de la paroi, nous observons que la dynamique de la sphère dans une suspension diffère de celle dans un fluide newtonien. La théorie de la lubrification impose que la vitesse de chute d'une sphère évolue linéairement avec la distance par rapport à la paroi horizontale, avec une vitesse d'impact nulle. Dans le cas d'une suspension, la vitesse de sédimentation d'une sphère évolue de manière non linéaire et nous mesurons une vitesse d'impact non nulle. Nous avons caractérisé cette non-linéarité et la vitesse d'impact en fonction des paramètres étudiés. Nos données suivent une loi d'échelle unique. L'aspect non linéaire de la dynamique d'approche de la sphère ne peut pas être abordé avec une description continue de la suspension.

Primary author: ZIDI, Koceila (Université Paris-Saclay, Laboratoire FAST, 91405, Orsay, France)

Presenter: ZIDI, Koceila (Université Paris-Saclay, Laboratoire FAST, 91405, Orsay, France)

Session Classification: Présentations

Contribution ID: **26** Type: **Présentation orale**

Droplet dynamics in parallel plate capillary channels

Tuesday, June 18, 2024 3:00 PM (20 minutes)

Spray are more effective in dissipating heat compared to forced air convection. However, in heat exchangers, there is one drawback: harmful water films can obstruct the airflow through the fins during spray injection. Consequently, the study investigates the clogging processes related to water films generated by the spray.

Numerical methods using the Volume Of Fluid (VOF) approach were employed to model the water-air interface. The heat exchanger is represented by two parallel plates, namely two thins, as a channel and treated as an embedded boundary. A single droplet of variable size represents spray droplet aggregates at the channel entry, slides down the plates.

The outcome of the droplet penetration is contingent upon factors such as the gap width between plates, droplet size, and contact angle. In this context, overcoming an energy barrier is crucial for droplet penetration. The energy required, influenced by capillarity, makes hydrophobic surfaces challenging to penetrate. Furthermore, hydrophilic surfaces complicate droplet exit. Drop break-up and crossing time are analyzed to identify the delicate balance of parameters essential in preventing channel clogging.

Primary author: THOMAS, Damien (Sorbonne Université)

Co-authors: Dr ZALESKI, Stéphane (Sorbonne Université); Dr LACOUR, Stéphanie (INRAE)

Presenter: THOMAS, Damien (Sorbonne Université)

Session Classification: Présentations

Contribution ID: **27** Type: **Présentation orale**

Stability and resolvent analysis of a turbulent separation bubble

Monday, June 17, 2024 12:00 PM (20 minutes)

We study the modal (self-excited) and non-modal (amplifier) dynamics of a mean turbulent separation bubble (TSB) forming over a flat plate via an artificial adverse pressure gradient. The flow configuration is in direct comparison to recent DNS and experimental studies. We reconstruct the two-dimensional turbulent mean-flow using the Reynolds-Averaged Navier Stokes (RANS) equations closed with a Spalart-Allmaras model. Linear stability analysis of the mean-flow reveals that the TSB is globally unstable to a steady three-dimensional mode which leads to a spanwise breakdown of the separated flow. The linear response of the TSB to harmonic forcing is then studied using resolvent analysis. At high frequencies ($St \sim 0.5$), the response reveals the non-modal amplification of structures related to the shedding of the shear-layer. At the low-frequency range, the response exhibits a low-pass filter behaviour, selectively amplifying frequencies up to a certain cut-off value and showing a peak at $St \sim 0.02$. This frequency is consistent with the well-documented bubble 'breathing' phenomenon that induces a periodic expansion and contraction of the separated flow.

Primary author: SARRAS, Konstantinos (ONERA)

Co-authors: Prof. HANIFI, Ardeshir (KTH Royal Institute of Technology); Dr MARQUET, Olivier (ONERA)

Presenter: SARRAS, Konstantinos (ONERA)

Session Classification: Présentations

Contribution ID: **28** Type: **Présentation orale**

Solidification de gouttes impactant une surface liquide

Tuesday, June 18, 2024 2:00 PM (20 minutes)

La solidification lors d'impact de goutte sur différents substrats permet d'accéder à une large variété de morphologies.
L'utilisation d'un substrat liquide amène à considérer son épaisseur et la combinaison des paramètres physiques de la goutte et du substrat.

Nous présentons ici une étude expérimentale sur la solidification de gouttes d'alcane impactant un bain d'eau salée.
Les gouttes solidifiées obtenues passent d'une forme de disque à celle d'un bol et cette transition a été caractérisée pour deux alcanes, différentes vitesses et différents chocs thermiques.
Nous décrivons cette transition en comparant les temps caractéristiques d'impact et de solidification, et nous montrons que l'échelle de temps pertinente est associée à la formation d'une fine couche solide entre la goutte et le bain.

Primary authors: BERRY, Marion; JOSSERAND, Christophe (LadHyX, CNRS & Ecole Polytechnique); SALONEN, Anniina; BOULOGNE, François (Laboratoire de Physique des Solides, CNRS, Université Paris-Saclay)

Presenter: BERRY, Marion

Session Classification: Présentations

Contribution ID: **29** Type: **Présentation orale**

Direct Numerical Simulation of single bubble dynamics in nucleate pool boiling with micro-region modeling and thermal coupling to a solid wall

Tuesday, June 18, 2024 11:20 AM (20 minutes)

In this study, we perform two-dimensional, axisymmetric simulations to investigate the growth and departure of a single bubble, with a particular focus on the conjugate heat transfer between the fluid and the heating wall. A multiscale modeling approach is employed to account for nanoscale effects near the liquid-vapor-solid triple contact line (CL). At the macro scale, the interface dynamics are captured using the front-tracking method with the open-source code TRUST/TrioCFD. This macro scale algorithm is coupled with a sub-grid micro-region model, driven by the wall superheating at the CL, which predicts the macroscopic apparent contact angle and heat fluxes.

To validate our modeling approach, we conduct quantitative comparisons using data from the RUBI experiment and simulation results from pioneering work. Subsequently, the boiling cycle is simulated with our model. Notably, significant temperature variations near the nucleation site during bubble expansion and contraction affect the thermal boundary layers in both fluid and solid domains, highlighting the need to resolve conjugate heat transfer in simulated cases.

Primary authors: WEI, Linkai (Université Paris-Saclay, CEA, Service de Thermo-hydraulique et de Mécanique des Fluides); Dr BOIS, Guillaume (Université Paris-Saclay, CEA, Service de Thermo-hydraulique et de Mécanique des Fluides); NIKOLAYEV, Vadim (Université Paris-Saclay, CEA, SPEC, CNRS)

Presenter: WEI, Linkai (Université Paris-Saclay, CEA, Service de Thermo-hydraulique et de Mécanique des Fluides)

Session Classification: Présentations

Contribution ID: **30** Type: **Présentation orale**

Utilisation de la microfluidique pour la filtration et la séparation de bactéries motiles

Monday, June 17, 2024 4:20 PM (20 minutes)

Séparer les bactéries d'un fluide pour les trier, les concentrer ou assainir est un enjeu crucial dans les domaines de la santé et de la microbiologie. Notre étude démontre que le couplage entre l'écoulement du fluide et le mouvement des bactéries (la rhéotaxie), qui génère un flux transversal à l'écoulement, peut être utilisé pour accomplir ces opérations. Afin de garantir un contrôle optimal des écoulements et une visualisation précise des bactéries et de leurs trajectoires, les expériences sont réalisées à l'aide de puces microfluidiques.
Nos expériences permettent de quantifier les effets de la rhéotaxie, de décrire la physique du phénomène et d'évaluer les possibilités offertes par cette nouvelle stratégie de filtration.

Primary authors: Mr GARGASSON, Adam (FAST, CNRS, Université Paris-Saclay); Ms GIRARD, Angéline (FAST, CNRS, Université Paris-Saclay); DOUARCHE, Carine; Dr MALLOGI, Florent (CEA/LIONS); Dr MERGAERT, Peter (I2BC); Mr LATROCHE, Reyane (FAST, CNRS, Université Paris-Saclay); AURADOU, harold

Presenter: Mr GARGASSON, Adam (FAST, CNRS, Université Paris-Saclay)

Session Classification: Présentations

Contribution ID: **31** Type: **Présentation orale**

Analyse en composantes principales (POD) des grandes échelles de l'écoulement de von Kármán turbulent

Monday, June 17, 2024 2:40 PM (20 minutes)

L'écoulement de von Kármán, étudié depuis les années 1990, est devenu un système canonique dans l'étude de la turbulence. L'écoulement est produit par deux turbines entrainant un fluide dans un cylindre fermé, et permet expérimentalement d'atteindre des nombres de Reynolds élevés efficacement. Muni de données LES 3D à Re ≈ 50 000 issu du code SFEMaNS, on détaillera les structures principales de l'écoulement de von Kármán à l'aide de la POD. La dynamique de ces structures montre que la majorité de l'énergie de l'écoulement est régie par un système de faible dimension. Après avoir comparé les modes POD 3D numériques aux modes 2D expérimentaux, on proposera également un protocole de reconstruction de champ 3D, à partir de données PIV expérimentales.

Primary author: BOUSQUET, Rémi (LISN)

Presenter: BOUSQUET, Rémi (LISN)

Session Classification: Présentations

Contribution ID: **32** Type: **Présentation orale**

A bulk averaging method to upscale non-equilibrium heat transfer in porous media with inertial flow

Monday, June 17, 2024 10:10 AM (20 minutes)

Upscaling non-equilibrium heat transfer in porous systems is important for many engineering applications where thermal efficiency and temperature distribution need to be predicted. For that purpose, the Volume Averaging method allows to write averaged equations that describe macroscopic heat transfer of inertial flows in porous media.

Here, a study of the Volume Averaging model is proposed through numerical simulations of heat transfer in a straight porous channel with uniform flow conditions at the inlet. Results show that this model provides temperature profiles that differ from those obtained with Direct Numerical Simulations when the Péclet number is increased.

In order to improve the accuracy of the model, a similar methodology based on the definition of a volume-averaged bulk temperature is proposed, which is inspired from models for fully developed heat transfer in periodic structures. The performance of this new model is determined on the previous test case for multiple pore Péclet numbers. Finally, further analysis will be conducted to assess the accuracy of the model on porous channels with non-uniform temperature profiles along a cross-section of the domain.

Primary authors: GOYEAU, Benoît (CentraleSupélec, Université Paris-Saclay); TOUBIANA, Ephraïm (Energy and Propulsion Department, Safran Tech); CHABANON, Morgan (CentraleSupélec, Université Paris-Saclay); HOLKA, Quentin (Energy and Propulsion Department, Safran Tech); BENDALI, Yanis (Energy and Propulsion Department, Safran Tech & CentraleSupélec, Université Paris-Saclay)

Presenter: BENDALI, Yanis (Energy and Propulsion Department, Safran Tech & CentraleSupélec, Université Paris-Saclay)

Session Classification: Présentations

Contribution ID: **33** Type: **Présentation orale**

Orientation préférentielle de flotteurs déformables dans des champs de vagues

Tuesday, June 18, 2024 4:20 PM (20 minutes)

Le mouvement d'objets flottants à la surface de vagues est étudié depuis longtemps car il possède plusieurs applications à la fois dans des domaines d'ingénierie navale ou environnementales. Nous avons observé dans un canal à houle que des flotteurs flexibles dérivent et se réorientent au gré des vagues dans une direction préférentielle, parallèle à la direction de propagation de l'onde. Cette étude met en évidence expérimentalement ce phénomène et propose un modèle simple pour expliquer l'origine de cette réorientation.

Primary author: DHOTE, Basile (Laboratoire FAST)

Co-authors: Mr HERREMAN, Wietze (Laboratoire FAST); Mr MOISY, Frédéric (Laboratoire FAST)

Presenter: DHOTE, Basile (Laboratoire FAST)

Session Classification: Présentations

Contribution ID: **34** Type: **Présentation orale**

Two-fluid Compressible Flows with Multiresolution Adaptive Mesh Refinement

Tuesday, June 18, 2024 11:40 AM (20 minutes)

The study of boiling flow is of considerable interest as it plays a crucial role in optimizing thermal performance in various industrial scenarios. Diverse approaches have been proposed to simulate nucleate boiling in the framework of the interface tracking method. However, accurately predicting boiling heat transfer remains challenging due to the involvement of multiscale phenomena. To better understand the contribution of interfacial heat transfer to the overall heat-transfer mechanism, we follow the work of [Z. Zou et al., 2020] on the two-fluid simulations in the low Mach regime. The liquid-vapor interface is captured by the level set method. Our work sets out to couple the sharp-interface heat transfer and phase change modelling with adaptive mesh refinement techniques. An effective adaptive mesh refinement strategy will improve computational efficiency and flexibility without degrading the quality and accuracy of capturing the interface motion and heat flux at the interface. We focus on the multiresolution (MR) adaptive method, which is based on a rigorous mathematical analysis of wavelet theory.

Primary authors: WU, Gen (LISN, Université Paris-Saclay); GRENIER, Nicolas (LISN / Université Paris Saclay)

Co-author: NORE, Caroline (LISN / Université Paris-Saclay)

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

Session Classification: Présentations

Contribution ID: **35** Type: **Présentation orale**

A COUPLING VOF/ LEVEL-SET EMBEDDED BOUNDARY METHOD TO MODEL TWO PHASE FLOWS ON ARBITRARY SOLID SURFACES: APPLICATION TO WETTING AND SOLIDIFICATION

Tuesday, June 18, 2024 12:00 PM (20 minutes)

Multiphase flows interacting with complex solid geometries are challenging and difficult to tackle either experimentally or numerically because of the complexity of the flow coupled with generally heterogeneous solid structures. When phase change is involved, such as in solidification in ice formation, this can be even more complex.
A non trivial coupling of the Volume Of Fluid approach to model the liquid-gas interface and a level-set embedded boundary method to account for the moving solid ice is designed in this work. Following the one-fluid formulation, the dynamics of the two fluids is therefore governed by the incompressible Navier-Stokes equations while we consider non-deformable solid so that the coupling between the fluids and the solid intervenes only through the boundary conditions. Here, the hybrid VOF/level-set embedded boundary is presented in the case of wetting and solidification applications. The original coupling of method is designed to be accurate and second order. The validation examples show that our method is able to deal with various problems such as the wetting in the droplet impact on a fiber and the solidification with the freezing droplet test case.

Primary author: TAVARES, mathilde (Ladhyx, ecole polytechnique)

Co-authors: Dr LIMARE, Alexandre (ArianeGroup); Prof. JOSSERAND, Christophe (Ladhyx, CNRS, Ecole polytechnique)

Presenter: TAVARES, mathilde (Ladhyx, ecole polytechnique)

Session Classification: Présentations

Contribution ID: **36** Type: **Présentation orale**

VPP d'un kitefoil

Tuesday, June 18, 2024 4:00 PM (20 minutes)

Dans le cadre du projet ANR « du Carbone à l'or olympique » nous travaillons avec la Fédération Française de Voile pour les Jeux Olympiques de cet été. Lors de cet événement la moitié des épreuves de voile auront lieu sur des engins sortant de l'eau grâce à des foils, ce qui est nouveau et ouvre des perspectives stimulantes du point de vue de la mécanique des fluides. Comme exemple, je présenterai un modèle de prédiction de vitesse que nous développons pour les engins tractés par une aile de cerf-volant, les kitefoils.

Primary author: RABAUD, Marc (Laboratoire FAST)

Co-author: FERMIGIER, Marc (PMMH)

Presenter: RABAUD, Marc (Laboratoire FAST)

Session Classification: Présentations

Contribution ID: **37** Type: **Présentation orale**

Prediction of transonic buffeting based on aeroelastic global stability analysis

Tuesday, June 18, 2024 3:40 PM (20 minutes)

Recent studies of transonic flows around airfoil have shown, that shock unsteadiness at low frequencies is significantly influenced by the presence of laminar flow regions. The low frequency shock motion called buffet is particularly dangerous, since it induces large lift oscillations, which can provoke an aeroelastic buffeting instability. The present work aims at investigating the onset of aeroelastic buffetting for the free-transitional flow around an OALT25 airfoil by a fluid-structure linear global stability approach within a RANS framework. To that aim, we consider a one equation γ transition model, coupled to the Spalart-Allmaras (Sa-neg) turbulence model and formulate the system of equations in a non-inertial moving reference frame following the airfoil structure. Following, the discretized fluid-structure system is linearized including all model contributions and a normal mode decomposition is injected, leading to a generalized eigenvalue problem. A parametric study will be performed for the OALT25 case to characterize the onset of transonic aeroelastic instabilities by varying structural as well as flow parameters.

Primary author: PLATH, Matthias (ONERA)

Co-authors: Mr TENAUD, Christian (Université Paris-Saclay, CNRS, CentraleSupélec, Laboratoire EM2C); Mr RENAC, Florent (ONERA); Mr MARQUET, Olivier (ONERA)

Presenter: PLATH, Matthias (ONERA)

Session Classification: Présentations

Contribution ID: **38** Type: **Présentation orale**

Impact force of a liquid drop containing a bubble

Tuesday, June 18, 2024 4:55 PM (15 minutes)

Air-in-liquid compound drops can be used to produce foam materials or for the fabrication of Thermal Barrier Coatings. The impact of these compound drops can finally leave an encapsulated bubble onto the target surface, or a thin liquid film, depending the eventual bursting of the bubble. The presence of the bubble in the drop affects the impact dynamics, leading to the formation of a counter jet, or reducing its maximal spreading diameter.

We focus here on the early impact dynamics of an air-in-liquid compound drop onto a solid surface. We perform axisymmetric simulations of the impact with the open source code Basilisk. We first reproduce the capillary and inertial regimes of the impact of a full drop. We then demonstrate that the impact force decreases with the increase of the bubble size. This decrease can be explained by a scaling argument on the impact force, mainly due to a reduction of the impact area over which high pressures are generated during impact.

Primary authors: Mr THALE, Vinod Ashok (International Center for Applied Mechanics, School of Aerospace Engineering, Xi'an Jiaotong University, Xi'an 710049, China); Dr ABOUELSOUD, Mostafa (Mechanical Engineering Department, Faculty of Engineering, South Valley University, Qena 83511, Egypt); Dr CHIZARI, Hossain (Kindeva Drug Delivery, Charnwood Campus, Loughborough, Leicestershire LE11 5SF, United Kingdom); THORAVAL, Marie-Jean (LadHyX, Ecole Polytechnique)

Presenter: THORAVAL, Marie-Jean (LadHyX, Ecole Polytechnique)

Session Classification: Présentations

Contribution ID: **39** Type: **Présentation orale**

Reduced models of turbulence

Tuesday, June 18, 2024 4:40 PM (15 minutes)

Turbulence is ubiquitous in nature. The choice of the theoretical model is particularly important because of its multiscale character. The energy is injected at large scales, coupling phenomena occur at meso-scales, and it is finally dissipated at micro-scales. Kinetic codes include all the physics but they are too heavy to produce simulations in reasonable times. Thus, reduced models are needed.

In this talk, we mainly focus on turbulence in tokamak plasmas. Microinstabilities grow due to spatial gradients, and nonlinearly interact forming turbulence. The turbulent transport is deleterious for the confinement of heat and particles in the tokamak core. Today, the most popular reduced model used for turbulence studies in tokamak plasmas is the gyrokinetic model. Here, we describe some applications of the gyrokinetic model to the multiscale study of turbulence in tokamaks [1]. Other applications of reduced models to turbulence are also mentioned.

References:

[1] A. Biancalani, et al. "Gyrokinetic investigation of Alfven instabilities in the presence of turbulence", Plasma Physics and Controlled Fusion 63, 065009 (2021), https://iopscience.iop.org/article/10.1088/1361-6587/abf256

Primary author: BIANCALANI, Alessandro (Léonard de Vinci Pôle Universitaire, LPP)

Presenter: BIANCALANI, Alessandro (Léonard de Vinci Pôle Universitaire, LPP)

Session Classification: Présentations