Fluid•DTU Summer School - Complex Motion in Fluids

Abstracts book

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Abstract ID : 0

Detachment of a dense granular suspension droplet

Understanding the flow of dense granular suspensions under different flow conditions is of great importance for applications as food processing, cosmetics or even geophysical flows.We investigate the flow behaviour of a dense granular suspension by the use of a model experiment: the detachment of a droplet. The suspensions are prepared at high packing fractions and consist of spherical non-Brownian particles density matched with the suspending fluid. We vary the volume fraction from \phi=18% to \phi=53%. We performed experiments with various grain diameters and syringe radii.

The motion near the final pinch off accelerates strongly, making the break up localised both in space and time and independent of the initial conditions. We compare the flow behaviour of the suspensions to viscous oils near the singularity point with a fast camera (3000pps). The effective viscosity of the suspension and the viscosity of the pure oils are matched. We first observe a viscous regime in good agreement with the behaviour of oil of the same viscosity. Deviation from this behaviour is observed at later stages of the detachment. The change in behavior between the two regimes is shown to depend on the grain diameter. Very close to the pinch, the behavior corresponds to the motion of the suspending fluid. Transitions between these three different regimes are discussed.

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Track classification :

Contribution type : Oral

Abstract ID : 1

Minimum Contact Area Shapes of Static Pendant Drops

A new class of statically stable minimum-energy shapes for both two-dimensional and axisymmetric pendant liquid drops suspended from a solid surface are found. These shapes display a minimum in the contact-area (MCA) with the solid surface, and subtend a different angle there from the Young angle. The MCA shapes would need a non-ideal surface to sustain themselves. The present procedure also obtains the Young-contact-angle class of solutions without imposing the contact angle explicitly. One limb of this class, which was thought to be unstable, is shown to become stable above a certain height after undergoing an exchange of stability with the new class of solutions. Thus (i) pendant drops of small volume display two stable shapes, both with Young's contact angle, (ii) drops of intermediate volume display two stable shapes, one with Young contact angle and the other is the MCA shape, (iii) drops of larger volume, up to a maximum, display only the MCA shape. In addition, for a small range of volumes, Kelvin drops may be sustained, which contain infinitely many of the above stable shapes. The one-parameter energy minimization approach adopted is simpler to implement than earlier approaches. Maximum heights and other geometric features are discussed.

summary :

I would like to do both oral presentation and a poster presentation of this.

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Track classification :

Contribution type : Oral

Abstract ID : 11

Breakdown of the scallop theorem for dense swimmers

According to the scallop theorem, a swimmer executing a time-reversible (or "reciprocal") motion cannot propel itself in the limit of zero Reynolds number. How much inertia is necessary for a reciprocal motion to become propulsive? Here we study the breakdown of the scallop theorem for dense swimmers, for which only particle inertia is significant. We apply Lorentz's reciprocal theorem to derive general differential equations that govern the locomotion kinematics of a dense swimmer. We then apply these results to several spatially-asymmetric swimmers and show that they are able to propel themselves at any arbitrarily small value of the particle Reynolds number, even in the absence of fluid inertia.

summary :

Oral presentation.

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Track classification :

Contribution type : Oral

Abstract ID : 12

Hairpin vortices in transitional pipe flow

The transition to turbulence in a pipe is often investigated experimentally by using a small-volume-flux jet through a side-wall. The transition is thought to be switch-like, where a turbulent puff is either created or not, at the point of injection, with a well-defined probability distribution of occurrence.

Here we show that the transition to a turbulent puff by injection of a jet through a side-wall can be refined to a strict sequence of events: Breakdown of the jet to a series of hairpin vortices; breakdown of the hairpin vortices to a turbulent puff. The hairpin vortices can be created at Re as low as ~1200, and their breakdown is governed by the distance they impinge across the parabolic profile. For Re<1750, the vortices collapse to form a transient disordered state, whereas for Re>1750 the hairpins breakdown to create a turbulent puff.

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Track classification :

Contribution type : Oral

Abstract ID : 13

The Interplay between Roughness and Air Effects on the Splashing Impact upon Microstructured Surfaces

We experimentally investigate the splashing mechanism of a millimeter-sized ethanol drop impinging on a structured solid surface, comprised of regular micro-pillars. By increasing impact velocity we can tune the impact outcome from a deposition to a splash, where tiny droplets are emitted as the liquid sheet spreads laterally. We measure the splashing threshold for different micropatterns and find that the arrangement of the pillars significantly affects the splashing outcome. Our top-view observations of impact dynamics reveal that trapped air is responsible for the splashing. Finally, by lowering the pressure of the surrounding air we show that we can suppress the splashing.

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Track classification :

Contribution type : Oral

Abstract ID : 14

Stability of the vortex street: Exploring the “Domm system”

Vortex wakes are very common both in nature and in a wide variety of engineering applications. The structure and dynamics of a wake can have a significant effect on the object forming it as well as on other objects with which the wake interacts. An analytical approach to modeling wakes is to use the point-vortex model with periodic boundary conditions in the direction of the wake. In 1956 Domm was the first to use this approach in order to re-derive the stability criterion of von K´arm´an for a vortex street. Domm considered four point vortices in a periodic strip, all of the same absolute magnitude, two of either sign. Within this four-degree-of-freedom system Domm identified the vortex street configurations and performed a linear and non-linear stability
analysis of them. He found the von K´arm´an criterion as a necessary condition for absence of linear instability. Going to second order in the perturbations around the vortex street configuration, he then showed that even when this condition is met, the vortex street is still non-linearly unstable. Our interest in this system was heightened when we realized that the variables Domm used in his discussion are, in fact, canonical and provide a canonical reduction of the problem from four to two degrees of freedom. Indeed, the variables Domm used in his analysis are the same variables that Eckhardt & Aref (1988) used in a general symplectic reduction of the four-vortex problem on the infinite plane. The Domm system gives a comprehensive understanding of the nonlinear dynamics of group perturbations to a vortex street configuration. We have found analytically that the only translating relative equilibria of the four vortices in the Domm system are the vortex streets that one already finds for two opposite vortices in a periodic strip. We have also found by numerical exploration that, when perturbed, a vortex street configuration will disintegrate into two vortex pairs that escape to infinity. This process is extremely sensitive to the initial perturbation suggesting that a form of chaos is involved. We have used the insight provided by the canonical variables to construct perturbations that preserve both linear impulse and the value of the Hamiltonian. Earlier explorations by Dolaptschiew and Schmieden did not always conserve these integrals of motion in the perturbations considered. We are interested in understanding the global dynamics of this four-vortex problem hoping that it will shed more light on more complicated vortex wake patterns than the traditional two-vortices-per strip configurations, e.g., that it will allow us to understand the so-called “2P” wake modes.

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Track classification :

Contribution type : Oral

Abstract ID : 17

Simulations of the selective transport through the membranes

The research focuses on the selective transport of nonionic particles through the nanometer scale pore. The ratio between pore diameter and particle size plays important role in estimation transport properties. The selective diffusion can lead to the negative diffusion. Additionally the different types of the particles would interact differently with the membrane wall, resulting in the changes in rotational diffusion and in the selective separation. The study was done using molecular dynamics simulations using the extended Lennard-Jones potential - Gay-Berne potential to obtain various shapes of the particles. The membrane interaction can lead to nanoscale devices such as molecular separator or diffusive pump.

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Track classification :

Contribution type : Oral

Abstract ID : 18

Theoretical and experimental investigations of acoustophoretic forces near resonance in microchannels

The use of ultrasound standing waves for particle manipulation and separation has received renewed interest and widespread use in the past decade since its application in the emerging field microfluidics. In many silicon-based separation devices the so-called acoustic radiation force is utilized by establishing half-wavelength transverse pressure modes in microchannels containing aqueous solutions of the particles to be separated.

In the present theoretical and experimental work we study the acoustophoretic forces near resonance in straight microchannels. In particular we observe and analyze the motion of individual polystyrene microbeads subject to acoustophoretic forces. As a function of the applied ultrasonic frequency we find that the acoustic energy density extracted from the motion of the beads exhibit Lorentzian shaped resonance peaks. We determine the acoustic energy density inside the water-filled microchannel as well as the Q-factor of the resonance. The measured and theoretically predicted line shapes and peak amplitude are in good agreement.

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Track classification :

Contribution type : Oral

Abstract ID : 20

Integrability and Chaos in Body-Vortex Interactions

We explore the class of dynamical systems consisting of a body, N point vortices, and one or more passive particles in an ideal, unbounded, planar fluid. The body is represented by a closed curve and is free to move in response to the fluid motion. The vortices have fixed strengths and are intended to model vortices that have been shed by the body or elsewhere in the flow field. The flow at any given time and position is determined by the instantaneous vortex and body positions together with the instantaneous velocity of the body.
The equations of motion for this kind of system are reasonably well in hand. They can be analyzed using techniques from the theory of dynamical systems with a finite number of degrees of freedom. The simplest such system, a single point vortex and a circular body, is integrable. If we add vortices, or change other features of the system such as the body shape, the motion may become chaotic. Various solutions are shown and analyzed with an emphasis on the transition to chaos and its physical meaning. This class of systems provides a rich family of few-degree-of-freedom systems that capture essential fluid-body interaction physics.

Primary authors : Mr. RøNBY, Johan (DTU Mathematics)

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Presenter :

Track classification :

Contribution type : Oral

Abstract ID : 21

Fluid forces and vortex wakes of a flapping foil

Periodic vortex wakes are found many places in nature. Examples include the well known von Kármán vortex wake behind cylindrical structures in a free stream and the thrust-indicating inverted von Kármán wake behind swimming fish. This talk presents a combined experimental (soap film tunnel) and numerical (particle vortex method) investigation of the vortex wakes behind a simple model fish, i.e., a rigid fin flapping in a two dimensional free stream. We vary frequency and amplitude of the oscillations and observe von Kármán wakes, inverted von Kármán wakes and wakes in which two vortex pairs form per oscillation period. We find good agreement between the wake types determined numerically and in the experiment, and we map out the wake types in a plane spanned by frequency and amplitude. Numerically we obtain the fluid forces and moments acting on the foil and we discuss the drag-thrust transition in relation to changes in the wake structure. Finally, we investigate the correspondence between the time-dependent fluid forces and vortex formation near the round leading edge and vortex shedding at the sharp trailing edge.

Primary authors : Mr. SCHNIPPER, Teis (DTU Physics)

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Track classification :

Contribution type : Oral

Abstract ID : 22

Bio-mimicking fluid transport in plants

Osmotically driven flows in microchannels are studied experimentally and theoretically. The propagation of a front of sugar solutions has been measured using dye and particle tracking in 0.20 mm wide and 0.05, 0.10 and 0.20 mm high polymer-based microchannels. Each of these microchannels was separated by a semipermeable membrane from a reservoir containing pure water. We find that the sugar front travels with constant speed, and that this speed is proportional to the concentration of the sugar solution and inversely proportional to the depth of the channel. The theoretical predictions agree well with the measurements.

Our motivation for studying osmotically driven flows are, that these are believed to be responsible for the translocation of sugar in plants. Also, we suggest that our channel design can be used as the driving mechanism in integrated micropumps with no movable parts.

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Presenter : Mr. HARTVIG JENSEN, Kåre (DTU Nanotech)

Track classification :

Contribution type : Oral

Abstract ID : 23

A Model for Plant Cell Morphogenesis Based on Biopolymer Rheology

The growth of plant, fungal, and bacterial cells depends critically on two processes: the deposition of new wall material at the cell surface and the mechanical deformation of this material by forces developed within the cell. To understand how these two processes contribute to cell growth, we have undertaken an experimental and theoretical investigation of tip growth
morphogenesis. Tip growth is a fast and robust elongation process observed in many specialized cells such as root hairs, fungal hyphae, and pollen tubes. Our work has revealed that simple mechanical principles can explain many of the key features of tip growth. Cells are modeled as thin shells that deforms plastically and to which new wall material is added. The profile of cell surface expansion predicted by the model was compared to experimental data and was shown to be surprisingly accurate. The same expansion profile is observed in many types of tip-growing cells and even in tubular rubber balloons thus suggesting that it is a generic mechanical feature of elongating finger-like structures. We have also investigated the control of the rate of cell elongation and shown that a simple feedback loop can account observed temporal fluctuations in the tip velocity. An elegant model of tip growth morphogenesis emerges from these results. Cell growth appears to be essentially a mechanical process that is controlled, at the cellular level, by the internal turgor pressure of the cell and a graded deposition of new wall material.

Primary authors : Mr. ROJAS, Enrique (Harvard University, USA)

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Presenter :

Track classification :

Contribution type : Oral

Abstract ID : 24

Electrokinetically induced ion-depletion across un-biased electrodes in nanochannels

Using numerics and experiments we study the concentration of a tracer dye (BODIPY) dissolved in an electrolyte (phosphate buffer) driven through a lab-on-a-chip nanoslit channel (0.5 um by 250 um by 9000 um) by electroosmosis. We analyze how the concentration drops across an un-baised center electrode (of Pt) as a function of the external voltage (50 V - 150 V) driving the flow. Furthermore, we study the impact of varying the equilibrium concentrations of tracer dye and electrolyte salt (1 uM - 10 mM). Our numerical results agree with the experimental observations as we see: (i) a concentration drop in the dye across the un-biased electrode, (ii) the drop increases with increasing applied voltage, (iii) the drop is affected by the concentration of buffer and dye, and (iv) high concentration enrichment of dye on the un-biased electrode. Furthermore, we use our numerical results to give insight into the dynamics of the concentration drop phenomenon.

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Presenter : Mr. BæKBO ANDERSEN, Mathias (DTU Nanotech)

Track classification :

Contribution type : Oral

Abstract ID : 25

A model for the prediction of slip for highly confined fluids

We present a derivation to predict the slip velocity for a system of fluid atoms confined by atomistic walls. The derivation is based upon Newton's second law for a slab located at the wall-fluid boundary. Two constitutive relations are formed to account for the forces acting on the slab. The first relation is based on the local Navier idea relating the frictious force to the center of mass velocity of the slab. The second relation uses the simple Newtonian law of viscosity. In the case of the wall frictional force, we demonstrate how to extract the relevant friction coefficient using equilibrium molecular dynamics. Finally, it shown that non-equilibrium molecular dynamics simulations agree very well with the theoretical predictions for several different atomic systems.

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Presenter :

Track classification :

Contribution type : Oral

Abstract ID : 27

Aerodynamic characteristics of a twodimensional Re = 300

Dragonfly fascinate by exceptional maneuverability during flight. The locomotion of these fourwingedinsects characterize flapping (Wang et al. 2007) as well as gliding flight (Kesel 2000). In comparison to flight at high Reynolds numbers (>10^5), the shape of profiles at low Reynolds numbers, (e.g. in case of micro air vehicles) exhibit different geometry (Srinath et al. 2008). Can a dragonfly wing serve as model for technical application? This work is concerned with the flow around a two dimensional dragonfly wing at Re = 300 and angles of attack between 0° and 30° using numerical simulation. In spite of the different geometry, velocity and pressure fields of the dragonfly profile and a flat plate exhibit qualitatively a similar topology. The topology of streamlines of dragonfly wing and flat plate differ in the small, steady state leading edge vortex, fixed in the first upper cavity. The comparison of the pressure fields indicates this as one reason for the 5% higher lift coefficient of the dragonfly profile at angles smaller than 25°.

References

A.B. Kesel, J. Exp. Biol. 203, 31253135 (2000).
Z.J. Wang and D. Russel, Phys. Rev. Lett. 99, 148101 (2007)

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Track classification :

Contribution type : Oral

Abstract ID : 28

Topology optimization of microfluidic systems

Many Lab-on-a-chip systems operated in continuous mode can be described by steady-state, deterministic models. Under these conditions the systems can be topology optimized using a recent implementation of the method in the commercial numerical software Comsol. This implementation is capable of optimizing fully nonlinear systems. We present the following examples of topology optimized microfluidic systems: Microfluidic catalytic reactors, induced-charge electro-osmotic micropumps, and artificial gland models.

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Track classification :

Contribution type : Oral

Abstract ID : 3

Unpredictable Tunneling of a Classical Wave-Particle Association

A droplet bouncing on a vibrated bath becomes a ''walker'' moving at constant velocity on the interface
when it couples to the surface wave it generates. Here the motion of a walker is investigated when it
collides with barriers of various thicknesses. Surprisingly, it undergoes a form of tunneling: the reflection or transmission of a given incident walker is unpredictable. However, the crossing probability decreases exponentially with increasing barrier width. This shows that this wave-particle association has a nonlocality sufficient to generate a quantumlike tunneling at a macroscopic scale.

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Track classification :

Contribution type : Oral

Abstract ID : 31

Transient Turbulence in Taylor-Couette Flow

Recent studies in pipe flow have brought into question the view that at sufficiently high Reynolds number turbulence is an asymptotic state. Due to their finite size, pipe facilities limit observation times and require researchers to come to their conclusions via statistical methods rather than direct observation. We show that Taylor-Couette flow has a regime that is ideally suited to turbulent lifetime measurements. In this, regime Taylor-Couette flow shares many of the decay characteristics observed in other shear flows (e.g., Poisson statistics and the coexistence of laminar and turbulent patches), while allowing unlimited observation times. We present the first direct observation of the decay of turbulent states in Taylor-Couette flow with lifetimes spanning five orders of magnitude. Our data suggest that characteristic decay times increase super-exponentially with increasing Reynolds number but remain bounded. This suggests that contrary to the prevailing view turbulence may be generically transient.

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Presenter : Mr. BORRERO-ECHEVERRY, Daniel (Georgia Institute of Technology, USA)

Track classification :

Contribution type : Oral

Abstract ID : 32

The role of turbulence in climatic flow

In the very long timescales of natural climate changes the turbulent flow of the atmosphere and oceans plays the role of a random trigger of climatic shifts.

The glacial cycles are attributed to the climatic response of the orbital changes in the irradiance to the Earth. This is in broad terms known as the Milankovitch theory, even though a full undertanding is still lagging. The changes in the climatic forcing are too small to explain the observed climate variations as simple linear responses. Non-linear amplifications of the orbital forcing are necessary to account for the glacial cycles. How this could happen via the internal turbulent fluctuations is shown in an empirical model. From the model it is possible to assess the role of stochastic noise in comparison to the deterministic orbital forcing of the ice ages. The model is based on the bifurcation structure derived from the climate history. It indicates the dynamical origin of the Mid-Pleistocene transition (MPT) from the '41 kyr world' to the '100 kyr world'. The dominant forcing in the latter is still the 41 kyr obliquity cycle, but the bifurcation structure of the climate system is changed. The model suggests that transitions between glacial and interglacial climate are assisted by internal stochastic noise in the period prior to the last five glacial cycles, while the last five cycles are deterministic responses to the orbital forcing.

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Track classification :

Contribution type : Oral

Abstract ID : 38

Experimental Study of the Solid-Liquid Interface in Buffered Nanofulidic Systems

In this work, we experimentally study the behavior of ions at the interface of a silica-based nanofluidic channel and electrolyte solution. During the capillary filling of such systems, protons are released from the wall, reducing the pH of the fluid and effectively titrating the solution at the fluid front. We measure the length of this titrated fluid front with a pH sensitive fluorescent dye (10µM Fluorescein, Molecular probes Inc.) at different electrolyte pH concentrations (acetate buffer, pH 5 and borate buffer, pH 9.2), ionic strengths (10mM and 100mM) and channel heights (150nm and 100nm). By varying these parameters, we effectively change the surface charge of the channel, the electric double layer, and the proton concentration in the fluid, which invariably influence the ratio of the titrated region of the solution to the region of bulk solution. Images of the titrated and fluorescent regions in nanofluidic channels are captured using both brightfield and fluorescent illumination with an epifluorescent microscope (Olympus IX70) coupled to an EMCCD camera (Andor IXON+). We preformed each experiment 3 times, leading to a total of 24 experiments which we analyze by relating the fluorescent intensity measured to the pH of the solution.
From initial experiments, we confirm that the ratio between the length of the titrated fluid front and the bulk fluid front stays consistent with time and is dependent on pH, ionic strength and concentrations. Future work involves a robust characterization of the effect of our various conditions on the composition of the fluid at the solid-liquid interface. We hope our research will elucidate some of the fundamental physical mechanisms involved with the interactions of electrolyte solutions and silica-based surfaces.

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Track classification :

Contribution type : Oral

Abstract ID : 39

Free surface flow of ideal fluids

Consider a time-independent, inviscid flow with a free surface. The free surface is considered a given parameterized surface. Due to the free surface boundary conditions, the Euler equations along the free surface involve only the flow field on the free surface. They constitute an independent set of non-linear PDEs that may be solved without reference to the bulk flow.
This idea can be applied for example to the type of vortex flows observed by Jansson et al., Phys. Rev. Lett. 96, 174502 (2006). The vortex flows reveal themselves through a rotating polygonal deformation of the free surface, which is stationary in a rotating frame of reference. I shall discuss the above ideas and apply them to recent experiments by Raymond Bergmann and Tess Homann on rotating polygon flows.

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Track classification :

Contribution type : Oral

Abstract ID : 4

Interactions between two hydrodynamically coupled circular cylinders (presentation)

Here we study the effect of two circular cylinders that are hydrodynamically coupled in potential flow. We study this by using a framework that solves potential flow problems in multiply connected domains. In this instance we map the fluid domain in the physical plane to the annulus and apply the Villat formula to determine the complex potential and then a generalization to the Blassius formula to determine the forces on the cylinders. Although this is specifically applied to two bodies in potential flow, the framework can be applied to an N-body problem.

One particular configuration that we are interested in is one where the two cylinders are in tandem. Here we attempt to isolate the effect that the forward cylinder has on the aft cylinder by prescribing the motion for the forward cylinder and seeing how the aft cylinder responds. This allows us to isolate the hydrodynamic effect of the induced vibration on the aft cylinder and has various implications in fluid-induced motions and its relation to vortex-induced vibrations.

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Presenter : Mr. TCHIEU, Andrew (California Institute of Technology)

Track classification :

Contribution type : Oral

Abstract ID : 5

Fiber suspensions in wall bounded shear flow

Although still not fully understood fiber suspensions are widely used in areas ranging from turbulence for drag reduction to paper making industry where they bind the heavily viscous fluid. The latter application is what motivates our research and we are interested in studying the fiber velocity under the influence of a wall and also subjected to a shear flow.

Due to the high viscosity of the fluid the problem is modeled using the creeping flow equations and since these equations are linear a boundary integral formulation can be derived to express the fluid surrounding the fibers. The fibers are assumed to be rigid and having a large length/width ratio which calls for a model based on the slender body theory. Previous work on the motion of a fiber under shear flow led to an analytical description of its velocity which bears the name of Jeffrey orbit, but this does not account for wall effects which trigger a deviation in the predicted trajectory. Our work is directed towards quantifying these wall effects.

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Track classification :

Contribution type : Oral

Abstract ID : 6

Effect of temperature on filtration and swimming activity of small aquatic organisms – a viscosity or biological effect?

A number of studies have shown that temperature-dependent viscosity of the ambient water controls or strongly affects bio-mechanical activity such as beat frequency of water pumping cilia in mussels and ascidians, swimming velocity of sperm cells, ciliates and small (micro- and meso-scale) aquatic organisms using cilia or small appendages for propulsion.

The various activities have been studied experimentally in response to both changes in temperature of the seawater and - at constant temperature - to changes in viscosity by additives to seawater. Whenever the activity change is the same for a given viscosity change due to either temperature or additive the response appears to be controlled by the mechanical action of viscosity and not by biological effects. Dimensional analysis suggests that data be examined by a power-law dependence of bio-mechanical activity (a) on kinematic viscosity (ν), i.e. a ~ ν^(−m), which is found to facilitate the interpretation of data.

Results show that the power-law exponent m takes values from less than 0.2 to more than 3 and that the contribution of viscosity to changed activity for a given change in temperature ranges from about 40% to 100% for the activities investigated in the literature and our own studies. The observed differences in response may be ascribed to fundamental differences in propulsion mechanisms and resistance (drag) to motion in different organisms, suggesting the need for improved theoretical models.

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Track classification :

Contribution type : Oral

Abstract ID : 7

Sinking or floating of grains at a liquid surface

The interaction of dehydrated food powders with a liquid surface and the resulting floating or sinking is key to achieve a good dissolution of these powders. This combined modelling and experimental study considers first non-porous grains and then porous grains at the surface of a liquid that does not dissolve them.

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Presenter :

Track classification :

Contribution type : Oral

Abstract ID : 8

Selection Rules in Laplacian Growth

Selection rules (length-scale selection) in natural phenomena are often observed, but, in many circumstances, little understood. Often, this selection can be attributed to the dynamics of some unstable interface, a particularly simple class of which is Laplacian Growth, where the velocity V of an interface is proportional to the gradient of a harmonic function. The most well known case is viscous fingering in Hele-Shaw cells, a phenomenon that emerges when a less viscous fluid (air) is forced into a more viscous fluid (oil) and contained to a narrow region between two glass plates. Because of interfacial instabilities, fingers emerge from the initially featureless interface that creep down the channel and, further, exhibit selection rules that beg to be explained. This has led to a mathematical reformulation of the viscous fingering problem as the more general free-boundary problem, revealing a rich structure that profoundly interconnects various branches of mathematical physics.

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Presenter : Mr. WIDLOSKI, John (University of Texas)

Track classification :

Contribution type : Oral

Abstract ID : 9

Faraday instability in a deformable domain

In 1831, Faraday discovered that when subjected to vertical oscillation the free surface of a liquid is unstable to surface waves. The Faraday instability has been widely explored in confined geometry. What happens if Faraday waves develop in a deformable domain? If a drop of a liquid of weak viscosity is deposited on a bath of another liquid, more viscous and denser, we can induce Faraday waves in the drop an not in the bath. As a result the drop deforms under the pressure exerted by the waves, assuming different stationary and dynamically evolving shapes.

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Presenter : Mr. PUCCI, Giuseppe (Université de Paris 7 Denis Diderot)

Track classification :

Contribution type : Oral

Abstract ID : 15

Supramolecular Photochemistry for turbulence

Clustering of particles in turbulence is of key relevance to diverse phenomena, one of which is the formation of rain drops in atmospheric clouds. The dynamics of these inertial particles displays a resonance phenomenon: when the relaxation time of the particle becomes of the order of the turnover time of the smallest eddies, the particle dispersion will demix spontaneously. In order to see this process, we must resolve the droplet concentration on the smallest length scales in turbulence. This will be done using a relatively new technique, phosphorescence tagging.
Droplets in a turbulent cloud are excited with a UV laser and their subsequent luminescence is recorded with an ICCD camera, sampling at different delay times. Long-lived luminescence arises due to doping the droplets by phosphorescent supramolecular complexes, viz. a lanthanide ion (Eu^{3+} or Tb^{3+}) with several aromatic ligands, that exhibit luminescence lifetimes in the millisecond regime.

summary :
Poster

Primary authors : Ms. LAMBERTS, Thanja (Radboud University Nijmegen)

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Presenter : Ms. LAMBERTS, Thanja (Radboud University Nijmegen)

Track classification :

Contribution type : Poster

Abstract ID : 16

Models of turbulence. Applications to the case of particulate mixing induced by the flow of traffic in urban areas

I will talk about the study of Traffic Produced Turbulence (TPT) and of mixing of particulate matter in atmospheric boundary layer induced by flow of vehicles in urban areas.
A brief review of the main theoretical and numerical models to be applied in this study will be presented. In particular, the possibility of writing a stochastic model of TPT, through a 3D stochastic Navier – Stokes equation with particular stochastic forcing terms, will be discussed.
By means of the study of Markov processes properties associated to the equations, or by means of the study of the renormalization group of an associated field theory, it's possible to study TPT structure.
To describe non passive interacting particles advected and diffused in the turbulent velocity field it's necessary to introduce a stochastic differential equation for the stochastic process of particle advection and diffusion, whose associated equation for the generator of the process is a modification of the Fokker – Plank equation for the conservation of a passive scalar.
Another approach to study the problem is to numerically solve the equations of turbulence and conservation of interacting scalars with moving boundaries, in a LES or in a variational multiscale model of turbulence, via an adaptive mesh refinement strategy or an immersed interface method to simulate the flow of vehicles as moving boundaries in the model.

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Track classification :

Contribution type : Poster

Abstract ID : 19

Targeting Complete Chaotic Mixing in an Electro-osmotic Mixer

Abstract: Two-dimensional electro-osmotic flow with strong spatial and weak temporal variations of the zeta potential is investigated theoretically for the purpose of enhancing mixing in a microchannel. The flow is a superposition of a primary component and a perturbation: The primary flow, generated by the spatially periodic zeta potential, consists of recirculating rolls, while the perturbation is created by a small time periodic variation of the zeta potential distribution. In this work, we propose a method that allows us to identify the values of the parameters which produce complete mixing. This method is based on tracking the linear stability of the central periodic orbit corresponding to the recirculating rolls (i.e., the primary flow). Poincaré maps, Lyapunov exponents and a box counting measure are computed to corroborate our results.

Primary authors : Mr. CHABREYRIE, Rodolphe ()

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Presenter : Mr. CHABREYRIE, Rodolphe ()

Track classification :

Contribution type : Poster

Abstract ID : 26

The effect of finite container size on granular jet formation

When an ob ject is dropped into a bed of fine, loosely packed sand, a surprisingly energetic jet shoots out of the bed. In this work we study experimentally the e□ect that boundaries have on the granular jet formation. We did this by (i) decreasing the depth of the sand bed and (ii) reducing the container diameter to only a few ball diameters. These confinements change the behavior of the ball inside the bed, the void collapse, and the resulting jet height and shape.

Primary authors : Mr. JOUBAUD, Sylvain (University of Twente)

Co-authors :

Presenter :

Track classification :

Contribution type : Poster

Abstract ID : 29

Droplet Microfluidics for Cell Sorting

Droplets in microfluidic devices provide a wonderful set of tools for studying large populations of cells and permutations of reactions. With droplet production and screening rates in the kHz range, populations of 106 - 107 can be studied with relative ease. Analysis of populations this large is not feasible using conventional instruments unless a sizable investment is made into parallel handling of samples. We aim to harness the rapid screening power and parallelization potential of droplet microfluidics to interrogate and sort large populations of diverse cells, selecting those that produce particular antibodies of interest. We are progressing toward screening and sorting populations of mouse hybridoma cells, with the ultimate goal of growing and sorting a population of human immune cells. A hybridoma is an immortalized B-cell whose sole function is the production of a particular antibody. The work presented here details the chain of modular microfluidic devices we use to encapsulate, incubate, and interrogate mouse hybridoma cells, as well as the sorting results we have obtained thus far.

Primary authors : Mr. AUBRECHT, Donald (Harvard University, USA)

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Presenter : Mr. AUBRECHT, Donald (Harvard University, USA)

Track classification :

Contribution type : Poster

Abstract ID : 30

Flow and mass transport in random cylinder arrays: a model for aquatic plant canopies

With wetlands constituting about 6% of earth's land surface, aquatic vegetation plays a significant role in the transport of dissolved and particulate material in the environment, such as nutrients, pollutants, and sediment. In this talk, we consider the lateral dispersion of passive solute in arrays of randomly-distributed cylinders, a model for emergent aquatic plants. Previous models predict that lateral dispersion increases monotonically with cylinder density at all Reynolds numbers. I will present laboratory measurements which show that,
in contrast, lateral dispersion at high Reynolds number exhibits three distinct regimes. In particular, the measurements reveal an intermediate regime in which dispersion decreases with increasing cylinder density. I will present a scale model for turbulent diffusion in which we assume that only turbulent eddies with integral length scale greater than the cylinder diameter contribute significantly to net lateral dispersion. The observed dependence of asymptotic dispersion on cylinder density is accurately described by a linear superposition
of this turbulent diffusion model and existing models for dispersion due to the spatially-heterogeneous velocity field that arises from the presence of the cylinders. The cylinder density-dependence of lateral dispersion may have important implications for organisms that use chemical signals to locate their prey or mate, and for the design of artificial wetlands, which are used to treat domestic, agricultural, and industrial wastewater.

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Track classification :

Contribution type : Poster

Abstract ID : 40

Quasi-3D aerodynamic code for analyzing dynamic flap and sensor response

A fast and efficient quasi-3D aerodynamic code will be developed to analyze the local aerodynamic behaviour of an airfoil section of a wind turbine with a moving trailing edge flap and associated sensor response. The code will use the know concept of unsteady viscous-inviscid interaction via transpiration velocity. The inviscid calculations will be done by an unsteady potential flow solver; meanwhile the viscous flow will be calculated using the quasi 3-D integral boundary layer equations. Simulations will be carried out for flow around an airfoil with a moving trailing edge of a static or rotating blade. These calculations will provide guidelines for designing and evaluating the Adaptative
Trailing Edge Flap (ATEF) system on a wind turbine.

Primary authors : Mr. RAMOS GARCíA, Néstor (DTU Mechanical Engineering)

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Track classification :

Contribution type : Poster

Abstract ID : 41

Structure of steady drain vortex in a viscous fluid

When fluid is flowing out of a reservoir, it may develop a vortex as we all know from the bathtub. In this work, numerical simulations have been performed to investigate 1. the conditions of such a vortex to occur and 2. the structure of such a vortex. We consider a steady, laminar drain vortex in an incompressible fluid at fairly low Reynolds numbers (range 1-10). The flow around the drain pipe is assumed axisymmetric.

A simple model is used to compare with the simulations.

Primary authors : Mr. BøHLING, Lasse (DTU Physics)

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Track classification :

Contribution type : Poster

Abstract ID : 42

Morphological Transitions in Rapidly Expanding Compressible Foams

We present preliminary results on the deformation of a two-dimensional compressible foam subject to expansion into a low ambient pressure. We observe phenomena consistent with a morphological transition, which appears in the form of a transition in the Bubble Size Distribution (BSD) from unimodal to bimodal.

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Presenter :

Track classification :

Contribution type : Poster