Program/book of abstracts

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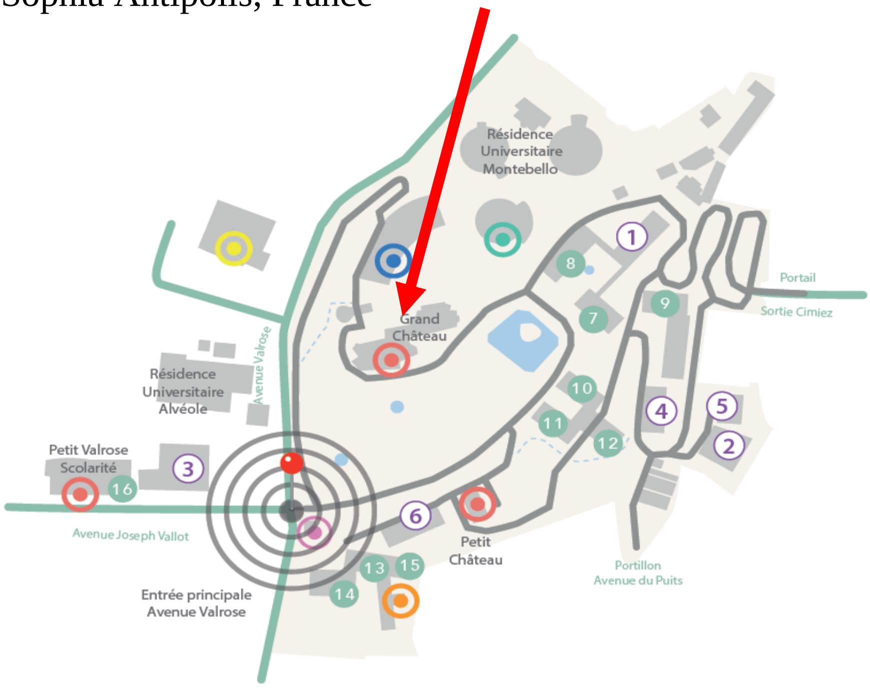
Venue

The conference will take place in the **Théâtre du Chateau**, Parc Valrose, Université de Nice-Sophia Antipolis, France



The gala dinner will take at the **Hotel Aston La Scala**, 12 avenue Félix Faure, 06000 Nice, Tram T1 from **Valrose Université** to **Opéra Vieille Ville**

Overall program

	Wednesday, December 5, 2018		Thursday, December 5, 2018	Friday, December 7, 2018	
8h45 - 9h			F. Bouchet (Théâtre du Château) *chairman D. Vincenzi*		
9h - 9h15				S. Rafai (Théâtre du Château) *chairman E. Lemaire*	
9h15 - 9h30					
9h30 - 9h45	Welcome				
9h45 - 10h			B. Dubrulle (Théâtre du Château) *chairman D. Vincenzi*		
10h - 10h15	P. Tabeling (Théâtre du Château) *chairman C. Raufaste*			Y. Forterre (Théâtre du Château) *chairman E. Lemaire*	
10h15 - 10h30					
10h30 - 10h45					
10h45 - 11h			Coffee Break (Salle à Manger)		
11h - 11h15	(Théâtre du Château) *chairman C. Raufaste* Nicolas Bruot Duc Quang Tran Franck Pigeonneau Olivier Liot Etienne Jambon-Puillet	(Salle du Belvédère) *chairman H. Politano* Thierry Passot Roumaissa Hassaini Hubert Baty Léonie Canet Yannick Ponti		Coffee Break (Salle à Manger)	
11h15 - 10h30			(Théâtre du Château) *chairman D. Vincenzi* Benjamin Favier Christophe Henry Umberto Giuriato Robin Vallée Sofia Allende Vincent Rossetto		
11h30 - 11h45				(Théâtre du Château) *chairman E. Lemaire* Thomas Bickel, Luis Gómez Nava Antoine Lagarde Hervé Henry	(Salle du Belvédère) *chairman B. Dubrulle* Adrien Guérin Jhaswantsing Purseed Bastien Polizzi Le Reun Thomas
11h45 - 12h					
12h - 12h15					
12h15 - 12h30					
12h30 - 12h40					
12h40-12h45	Buffet - Poster Session (Salle à Manger- Salon de Musique)				
12h45-12h50					
12h50 - 13h				Buffet and closing (Salle à Manger)	
13h - 13h15					
13h15 - 13h30			Buffet - Poster Session (Salle à Manger- Salon de Musique)		
13h30 - 13h45					
13h45 - 14h					
14h - 14h15	S. Kuksin *chairman J. Bec* (Théâtre du Château)				
14h15 - 14h30					
14h30 - 14h45			D. Quere (Théâtre du Château) *chairman X. Noblin*		
14h45 - 15h					
15h - 15h15	M. Brachet *chairman J. Bec* (Théâtre du Château)				
15h15 - 15h30					
15h30 - 15h45			(Théâtre du Château) *chairman X. Noblin* Youness Tourtit Anselmo Pereira Laurent Limat		
15h45 - 16h					
16h - 16h15	Coffee Break - Poster Session (Salle à Manger- Salon de Musique)				
16h15 - 16h30					
16h30 - 16h45			Coffee Break (Salle à Manger)		
16h45 - 17h					
17h - 17h15			(Théâtre du Château) *chairman X. Noblin* Harunori Yoshikawa Christophe Raufaste Mederic Argentina		
17h15 - 17h30					
17h30 - 17h45	(Théâtre du Château) *chairman J. Bec* Vishwanath Shukla Valentina Valori Stefano Musacchio	(Salle du Belvédère) *chairman F. Pigeonneau* Fernando Perruani Enzo D'Ambriosio Rudy Valette			
17h45 - 18h					
18h - 18h15			Departure for Gala Dinner		
18h15 - 18h30					
18h30 - 18h45					
18h45 - 19h					
19h-23h			Gala dinner - Poster Prices Hotel Aston La Scala, 12 Avenue Felix Faure, 06000 Nice Tram Opéra Vielle Ville		

Invited speakers

Wednesday 5th

10:00 am	**Patrick TABELING**	Particle deposition in microchannels
2:00 pm	**Sergei KUKSIN**	Rigorous results in space-periodic two-dimensional turbulence
3:00 pm	**Marc BRACHET**	Quantitative estimation of effective viscosity in quantum turbulence

Thursday 6th

8:45 am	**Freddy BOUCHET**	Rare events in turbulent flows
9:45 am	**Bérengère DUBRULLE**	Intermittency and singularities in experimental von Karman flow
2:30 pm	**David QUERE**	To be announced

Friday 7th

9:00 am	**Salima RAFAI**	Flowing active suspensions: plankton as a model active particle
10:00 am	**Yoël FORTERRE**	Grains in Fluids: impact, shear-thickening and active avalanches in plant cells

Wednesday, 5th, sessions

Théâtre session, morning

11:00 - 11:20	› Aggregation and phase transition of colloids induced by optical tweezers and thermophoresis - *Nicolas Bruot, CNRS, InPhyNi, Institute of Industrial Science, The University of Tokyo*
11:20 - 11:40	› Microfluidic study to investigate characteristics of collective and individual motions of swimming zoospores - *Quang D. Tran, Institut de Physique de Nice (INPHYNI)*
11:40 - 12:00	› Numerical simulation of dynamics of wetting dynamics using the Cahn-Hilliard/Stokes model - *Franck Pigeonneau, MINES ParisTech - CEMEF*
12:00 - 12:20	› Clogging of model pores: towards non-linear behaviours - *Olivier Liot, Institut de mécanique des fluides de Toulouse (IMFT)*
12:20 - 12:40	› The liquid helix: Inertial-capillary adhesion of liquid jets around cylinders - *Etienne Jambon-Puillet, Institute of Physics-University of Amsterdam (UvA-IoP)*

Belvédère session, morning

11:00 - 11:20	› Imbalanced kinetic Alfvén wave turbulence - *Thierry Passot, Observatoire de la Côte d'Azur*
11:20 - 11:40	› Gravity-capillary wave turbulence at the interface of two fluids - *Roumaissa Hassaini, Laboratoire des écoulements géophysiques et industriels*
11:40 - 12:00	› Turbulent magnetohydrodynamic reconnection in plasmoid-dominated regime - *Hubert Baty, Observatoire Astronomique, Université de Strasbourg*
12:00 - 12:20	› Time dependence of correlation functions in homogeneous and isotropic turbulence - *Léonie Canet, Laboratoire de physique et modélisation des milieux condensés*
12:20 - 12:40	› Magnetic fluid-structure Dynamo - *Yannick Ponty, UCA/OCA*

Théâtre session, afternoon

17:30 - 17:50	› Time reversible Navier-Stokes equation: Detailed statistical characterization - *Vishwanath Shukla, INPHYNI*
17:50 - 18:10	› Energy fluxes and scaling in Turbulent Rayleigh-Bénard: the weak analysis in a cubic cell - *Valentina Valori, CEA Paris Saclay*
18:10 - 18:30	› Rayleigh-Taylor turbulence with time-periodic acceleration - *Stefano Musacchio, LJAD*

Belvédère session, afternoon

17:30 - 17:50	› Classification of active systems: hydrodynamic equations, instabilities, and pattern formation - *Fernando Peruani, Université Nice Sophia Antipolis*
17:50 - 18:10	› Shear-induced viscous Resuspension in a Couette Flow - *Enzo Azzara D'Ambriosio, Institut de Physique de Nice*
18:10 - 18:30	› Buckling of viscoplastic Bingham fluid filaments under compression stresses - *Rudy Valette, CEMEF*

Aggregation and phase transition of colloids induced by optical tweezers and thermophoresis

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[3] Institute of Industrial Science, The University of Tokyo – Japan

Optical tweezers are an appropriate tool to manipulate colloidal systems. We present here a technique based on optical trapping and thermophoresis to create and manipulate large aggregates of colloidal particles.

The system is a mixture in organic solvents of refractive index- and density-matched PMMA colloids that do not interact directly with the laser of the optical tweezers, and titania particles that can be trapped. Trapped titania colloids are heated by the laser beam of the optical tweezers and create a very localized temperature gradient in the fluid. Surrounding PMMA colloids experience this gradient and are subject to thermophoresis that causes their aggregation around the titania particle. The strength and the range of the thermophoretic effect are sufficient to create aggregates of several thousands of particles in a few minutes.

With confocal imaging, we characterize the growth dynamics of such aggregates and show in particular that they can induce the crystallization of colloids around the titania particle. The advantage of this method compared to direct optical trapping [1] and direct heating of the fluid [2] is that spherically symmetric aggregates can be created in the bulk of a sample. We suggest that this system could be used to study the evaporation of a nuclei of a dense phase in a colloidal gas by turning off the laser.

A. A. Verhoeff, F. A. Lavergne, D. Bartolo, D. G. A. L. Aarts and R. P. A. Dullens, *Soft Matter* **11**, 3100-3104 (2015).

H.-R. Jiang, H. Wada, N. Yoshinaga and M. Sano, *Phys. Rev. Lett.* **102**, 208301 (2009).

Keywords: colloids, phase transitions, thermophoresis, optical tweezers

[1] Speaker

Microfluidic study to investigate characteristics of collective and individual motions of swimming zoospores

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[2] Institut Sophia Agrobiotech (ISA) – Université Côte d'Azur (UCA), Institut national de la recherche agronomique (INRA) : UMR1355, CNRS : UMR7254 – France

Zoospores are flagellate swimming microorganisms that initiate pathogens and destroy plants, causing big threats to agriculture and eco-systems. Understanding their swimming mechanism and their interactions against gradients and surrounding environments becomes important. Our study is a part of Project COMOZOO, which aims to investigate the COllective and individual MOtion of swimming ZOOspores. The project involves the collaboration between INPHYNI, ISA, LP2M, and LJAD. The physical part consists in developing a microfluidic system to investigate collective and individual motions of *Phytophthora parasitica* zoospores, a species that infects a broad range of host plants and represents most of the genus *Phythophthora*. Our system has the ability to generate a chemical gradient diffusing to a group of swimming zoospores and observe their swimming motions as well as the changes of the gradient at the same time. Our preliminary result shows that a group of *P. parasitica* react significantly against a gradient of potassium chloride. Low concentration of potassium helps reducing the speed of the zoospores and lure them away. High concentration of potassium (> 3mM) causes the zoospores to change the swimming pattern to circulating around and stop moving. Moreover, when observing a single zoospore swimming in water, we achieved to measure the characteristics of its beating flagella. The correlation between the zoospore velocity and its flagella motions can help us explain their reaction against the potassium gradient. The future work of this study will focus on the motions of an individual zoospore under potassium condition. We are also looking into the swimming behaviors of zoospores when showing collective dynamics or under constrained conditions with different obstacles.

Keywords: Microfluidics, zoospores

[2] Speaker

Numerical simulation of dynamics of wetting dynamics using the Cahn-Hilliard/Stokes model

Franck Pigeonneau [3]

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The dynamics of wetting of a liquid on a substrate is difficult to simulate in detail due to the triple line singurarity. It comes from that interfaces are considered sharp and fluids stick right on solid wall. To remove this singularity, the usual non-slip condition can be replaced by a slip condition or interfaces can be considered as diffuse.

To study the wetting dynamics, the second approach mentionned above has been chosen. The Cahn-Hilliard theory is used to described the phase field which can be considered as a volume fraction of each fluid. The interface thickness is controlled by the choice of the Cahn number, ratio of the diffuse interface thickness to the macroscopic scale (typically radius of drop, for instance). Since it is out of range to use the real interface thickness, interfaces are thikened. The important question which then rises is: Wath is the limit of interface thickess which can be used to be representatif of the macroscopic phycics?

A numerical solver coupling the Cahn-Hilliard/Stokes equations has been developed using a discontinuous Galerkin finite element method. First, the capillary rising is studied in a tube. We investigate in particular the scale of the velocity gradient close to the triple line. A boundary layer appears due to the diffusion of the chemical potential corresponding to the variational derivative of the free energie of the system. The scale of this boundary layer is driven by a Péclet number, ratio of the diffusion time scale of chemical potential diffusion to advection time scale. We show that the boundary layer scale as the inverse of the Péclet number at the power one fourth in agreement with the previous work of Briant and Yeomans [1].

The drop spreading on a solid substrate is also simulated. Starting from a non-equilibrium state, we study the dynamics of weeting by determining the dynamic contact angle as a function of the velocity of triple line which can be written as a capillary number. The numerical results are compared with the Cox's theory [2] in which we adapt the scale of the slip length required in the Cox's theory. We show that our parameter is in agreement which the boundary layer thickness over which the chemical potential diffuses.

From these preliminary works, we can conclude that the Cahn-Hilliard/Stokes model is useful to describe the wetting dynamics with a Cahn number arround 0.01. Moreover, the singularity at the triple line is removed and replace by a diffusion between the two phases which can be seen as a slip length controlled by a Péclet number.

Briant, A. J. & Yeomans, J. M. Lattice Boltzmann simulations of contact line motion. II. Binary fluids *Phys. Rev. E, American Physical Society*, **2004**, *69*, 031603.

Cox, R. G. The dynamics of the spreading of liquids on a solid surface. Part 1. Viscous flow. *J. Fluid Mech.*, **1986**, *168*, 169-194.

Keywords: wetting, drop, phase, field theory, Cahn, Hilliard model, finite element method

[3] Speaker

Clogging of model pores: towards non-linear behaviours

Olivier Liot [4] [1], Akash Singh [2], Patrice Bacchin [3], Paul Duru [4], Jeffrey Morris [5], Pierre Joseph [6]

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[2] Institut Lumière Matière [Villeurbanne] – Université Claude Bernard Lyon 1, CNRS : UMR5306 – France

[3] Laboratoire de Génie Chimique, Université de Toulouse, CNRS, INPT, UPS, Toulouse, France – CNRS : UMR5503, Université Paul Sabatier - Toulouse III, Institut National Polytechnique de Toulouse - INPT – France

[4] Institut de mécanique des fluides de Toulouse (IMFT) – Institut National Polytechnique de Toulouse - France

[5] The City College of New York – United States

[6] Laboratoire d'analyse et d'architecture des systèmes [Toulouse] (LAAS) – Institut National Polytechnique de Toulouse - INPT, Université Paul Sabatier (UPS) - Toulouse III, CNRS : UPR8001, Institut National des Sciences Appliquées [INSA] - Toulouse – 7 Av du colonel Roche 31077 TOULOUSE CEDEX 4, France

A colloidal suspension flowing through a pore network often results in fouling or clogging. This phenomenon of particle accumulation is involved in many industrial (oil recovery [6], filtration), biological (artery diseases [5], cell detection [**Erreur ! Source du renvoi introuvable.**, 4] or natural (water infiltration in soils [8]) processes. It is a complex process which involves surface, steric and hydrodynamic interactions. During the last decade, following an early study which described clogging of pores by smaller particles [7], a number of studies have focused on determining the pore-scale mechanisms involved in pore blockage [2]. The sub-micron dimensions are still unexplored in spite of strong specificities (Brownian motion, system size comparable to scales of interaction), and relevance (0.2 μm being a typical industrial pore size). In addition, prior to the advent of pore-scale investigations, which have been greatly facilitated by microfluidic technology, numerous studies were made at a more macroscopic membrane scale, where the usual focus was on the "filtration cake" (see e.g. [1,3]). Since a typical filtration membrane consists of a large number of closely-spaced pores, clog formation at one pore could affect its neighbours, and hence the macroscopic behaviour of the membrane. Considered in this way, there is a notable lack of information related to clog formation at the pore scale, with connection to the membrane scale by consideration of interactions between pores.

In this work, we address this gap of knowledge at an intermediate scale, by considering in detail the time evolution of the clog formation process at pore scale, in a short one-dimensional (1-D) array of pores with a Brownian suspension. The flow is driven by a fixed pressure difference. We present observations of interactions between the pores. We measure a clogging growth rate as a function of the number of already clogged pores. We observe an increase in the clogging growth rate as the number of fully blocked pores rises. It is the signature of interactions between pores during filtration process, named "cross-talk". We propose a model based on a local increase of colloid concentration close to clogged pores to explain the observations. As clogs are porous, solvent can still pass through, but particles advected by this fluid remain in suspension because of electrostatic repulsion from the clog. By diffusion, these particles go towards neighbour pores and locally increase the concentration and consequently the clog growth rate. This model is in fair agreement with experimental data.

[4] Speaker

This work is a first step to connect studies from single pore scale to macroscopic membrane. It was performed at LAAS-CNRS within the context of NEMESIS project from University of Toulouse. It will be continued at IMFT in order to fill the gap between pore-scale clogging and membrane fouling. This work aim at rising the complexity of studied porous media. Several perspectives of this work will be presented, especially involving other possible cross-talk mechanisms such as clogging with biofilms or with soft objects.

References:

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Dressaire, E. & Sauret, A. Clogging of microfluidic systems. Soft Matter, 13(1), 37{48 (2017).
Hong, S., Faibish, R. S., & Elimielech, M. Kinetics of Permeate Flux Decline in Cross ow Membrane Filtration of Colloidal Suspensions. Journal of Colloid and Interface Science, 196, 267{277 (1997).
Pang, L., Shen, S., Ma, C., Ma, T., Zhang, R., Tian, C., Zhao, L., Liu, W., & Wang, J. Deformability and size-based cancer cell separation using an integrated microfluidic device. The Analyst, 140(21), 7335{7346 (2015).
Rothberg, M. B. Coronary Artery Disease as Clogged Pipes: A Misconceptual Model. Circulation: Cardiovascular Quality and Outcomes, 6(1), 129{132 (2013).
Tavakkoli, M., Grimes, M. R., Liu, X., Garcia, C. K., Correa, S. C., Cox, Q. J., & Vargas, F. M. Indirect Method: A Novel Technique for Experimental Determination of Asphaltene Precipitation. Energy & Fuels, 29(5), 2890{2900(2015).
Wyss, H. M., Blair, D. L., Morris, J. F., Stone, H. A., & Weitz, D. A. Mechanism for clogging of microchannels. Physical Review E, 74(061402) (2006).
Zhang, W., Tang, X., Weisbrod, N., & Guan, Z. A review of colloid transport in fractured rocks. Journal of Mountain Science, 9(6), 770{787 (2012).

Keywords: Filtration, clogging, model pores, pore interactions

The liquid helix: Inertial-capillary adhesion of liquid jets around cylinders

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[2] Physics of Fluids Group, University of Twente – Netherlands

[3] Institute of Physics-University of Amsterdam (UvA-IoP) – Faculty of Science Science Park 904 1098 XH Amsterdam, Netherlands

From everyday experience, we all know that a solid edge can deflect a liquid flowing over it significantly, up to the point where the liquid completely sticks to the solid. Although important in pouring, printing and extrusion processes, there is no predictive model of this so-called "teapot effect". Here by grazing vertical cylinders with inclined capillary liquid jets, we use the teapot effect to attach the jet to the solid and form a helical rivulet: the liquid helix. We quantitatively predict the shape of the helix by modeling how rivulets relax toward their final velocity and the critical velocity for the helix formation follows from a parameter-free inertial-capillary adhesion model.

Keywords: jet, adhesion, rivulet, capillarity, inertia

[5] Speaker

Imbalanced kinetic Alfvén wave turbulence

Thierry Passot [6], Pierre-Louis Sulem

Observatoire de la Côte d'Azur – CNRS : UMR7293, Université Côte d'Azur – France

A Hamilitonian two-field reduced gyrofluid model for kinetic Alfvén waves (Passot et al., 2018) taking into account ion finite Larmor radius corrections, parallel magnetic field fluctuations and electron inertia, is used to study turbulent cascades, from the MHD to the sub-ion scales, in particular in the case of imbalance between waves propagating along or opposite to the direction of the ambient magnetic field. Applying the weak turbulence formalism (in the absence of electron inertia) leads to equations for the spectral density of the two conserved quantities, total energy and generalized cross-helicity, which provide a uniform description matching between the kinetic equations based on RMHD at large scales (Nazarenko, 2011) and on eMHD (Galtier and Bhattacharjee, 2003) (in the quasi-transverse limit) at small scales. In the limit of ultra-local interactions, Leith-type nonlinear diffusion equations are derived, and phenomenologically adapted to the strong turbulence regime by appropriately modifying the transfer time. Stationary solutions of the diffusion models are discussed. It is in particular shown that, in the strong regime, turbulence is balanced at small scales, even if is strongly imbalanced at large scales.

T. Passot, P.L. Sulem & E. Tassi 2018, Phys. Plasmas 25, 042107.

Nazareko 2011, "Wave turbulence", Lecture Notes in Physics vol. 825

S. Galtier and A. Bhattacharjee 2003, Phys. Plasmas 10, 3065.

Keywords: MHD, EMHD, weak turbulence, nonlinear diffusion equations

[6] Speaker

Gravity-capillary wave turbulence at the interface of two fluids

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The Weak Turbulence Theory (WTT) has been developed since the 60's in order to describe the non-linear interactions between a large number of waves of different scales. The WTT predicts the evolution of energy spectra and has been applied to a wide range of domains such as non-linear optics, thin plates and waves at the surface of a fluid. In the latter case experiments at the human scale involve gravity-capillary waves, in order to study essentially capillary waves, for which WTT provides an exact solution, we propose a set up that will highly reduce the gravity range to make the capillary range more accessible to measurements.

We study experimentally weak capillary wave turbulence at the interface of two in-miscible fluids in a closed vessel. By using pure water and silicone oil of close densities the gravity term in the dispersion relation is highly reduced leading to the observation of essentially capillary waves. Decreasing viscosities corresponding to decreasing densities for the silicone oil have been tried out going from 10 cSt to 1cSt resulting for gravity-capillary crossovers from 0.8 Hz to 3.3 Hz.

Measurements fully resolved in time and space have been carried out using the Fourier transform profilometry. Fourier analysis of the vertical velocity of the water/oil interface permits us to observe the spatio-temporal spectrum of capillary waves. We report an important impact of the viscous dissipation on the energy cascade and the angular energy distribution. Indeed the space-time spectra of the interfacial waves show a more efficient energy cascade as the viscosity of the silicone fluid decreases and a highly improved angular energy distribution even though the forcing is unidirectional.

The slope of the velocity spectrum measured is in disagreement with the theoretical one as it has been also observed in our group for the water air interface. We suspect that the clear \$f^{-3}\$ scaling observed by Falcon et al. is related to a rather strong regime described by Przadka et al. rather than a truly weakly non linear regime.

Moreover a Doppler shift in the space-time spectrum of the waves propagating in the x-direction, which is the direction of the forcing, arising from a streaming away from the wave maker has been noticed.

Keywords: wave, turbulence, viscosity, dissipation

[7] Speaker

Turbulent magnetohydrodynamic reconnection in plasmoid-dominated regime

Hubert Baty [8]

Observatoire Astronomique, Université de Strasbourg – Observatoire Astronomique, Université de Strasbourg – France

Magnetic reconnection is believed to be the underlying mechanism that powers explosive events in many magnetically dominated plasmas, such as solar flares and sawtooth crashes in laboratory thermonuclear fusion experiments. Despite many years of research, the fast time scales observed during such events remain an unsolved problem.

In recent years, significant progress has been made in the magnetohydrodynamic (MHD) description of the reconnection layer in the high Lundquist number regime. In particular, dynamical current sheets driving the magnetic reconnection process are shown to be strongly affected by the formation of magnetic islands at smaller length scales (called plasmoids). A turbulent MHD reconnection regime can thus set in, giving rise to a tremendous increase of the reconnection rate that is weakly dependent on the Lundquist number.

Despite the success of the previous scenario, they are some important controversial issues, that will be presented. Moreover, a comprehensive theory of the interplay between magnetic reconnection and MHD turbulence is lacking for this plasmoid-mediated regime. A new code based on a reduced incompressible MHD model and written in current-vorticity variables is actually under development in order to tackle this problem. The disparate length scales are described with an adaptive finite element method using Freefem++ software. Preliminary results will be presented.

Keywords: MagnetoHydrodynamics, Turbulence, Astrophysics, Numerical Methods

[8] Speaker

Time dependence of correlation functions in homogeneous and isotropic turbulence

Léonie Canet [9][1], Malo Tarpin [2], Nicolas Wschebor [3]

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Turbulence is an ubiquitous phenomenon in fluid flows. Yet, calculating its statistical properties, and in particular what is generically called intermittency effects, remains an open issue. We will focus on isotropic and homogeneous fully developed turbulence in three-dimensional incompressible flows. While much effort has been devoted to characterizing equal-time properties of the turbulent state, less is known about its time behavior. I will present some analytical results on the time dependence of generic n-point correlation functions in the stationary turbulent state. These results are obtained starting from the Navier-Stokes equation, and using a field-theoretical approach (based on Functional and Non-Perturbative Renormalisation Group techniques). They are asymptotically exact in the limit of large wave-numbers. I will compare our predictions with available results from numerical simulations and experiments.

M. Tarpin, L. Canet, N. Wschebor, Phys. Fluids 30 (2018)

L. Canet, V. Rossetto, N. Wschebor, G. Balarac, PRE 95 (2017)

L. Canet, B. Delamotte, N. Wschebor, PRE 91 (2015), PRE 93 (2016)

Keywords: homogeneous and isotropic turbulence, Navier Stokes equation, correlation functions, field theoretical approach

[9] Speaker

Magnetic fluid-structure Dynamo

Yannick Ponty [10] [1], Nicolas Plihon [2], Holger Homann [3], Rainer Grauer [4]

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[2] ENS Lyon – École Normale Supérieure - Lyon, Univ Lyon, ENS de Lyon, Univ Lyon 1, CNRS, Laboratoire de Physique, F-69342 Lyon, France – France

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The experimental observation of the dynamo instability has been a long quest requiring careful ow optimization, which has only be achieved in the Riga, Karlsruhe and von Karman sodium (VKS) experiments. While the behavior of the two former experiments could be explained from computations using simplified flows, this is not the case for the VKS experiment - in which a strongly turbulent liquid sodium flow is driven by the counter-rotation of impellers fitted with blades, in a cylindrical vessel. Two major puzzles in the understanding of the dynamo mechanism are still unanswered: (i) the dynamo instability was only observed in the presence of impellers having high magnetic permeability and (ii) the time-averaged dynamo magnetic field in the saturated regime has an axial dipolar structure , while an equatorial dynamo dipole is expected from computations.

We present results from consistent dynamo simulations, where the electrically conducting and incompressible flow inside a cylinder vessel is forced by moving impellers numerically implemented by a penalization method. The numerical scheme models also the jumps of magnetic permeability for the solid impellers, resembling various configurations tested experimentally in the von-Karman Sodium experiment.

The most striking experimental observations are reproduced in our set of simulations. In particular, we report on the existence of a time averaged axisymmetric dynamo mode, self-consistently generated when the magnetic permeability of the impellers exceeds a threshold. We describe a possible scenario involving both the turbulent flow in the vicinity of the impellers and the high magnetic permeability of the impellers [1]. Non linear behaviors, including oscillation and reversals will be also presented.

Dynamo Enhancement and Mode Selection Triggered by High Magnetic Permeability

S. Kreuzahler, **Y. Ponty**, N. Plihon, H. Homann, and R. Grauer

Phys. Rev. Lett. 119, 234501 – Published 6 December 2017 (Cover page of the 6/12/2017)

Keywords: Magnetohydrodynamic, Turbulence, Numerical mathod, High Performance Computing

[10] Speaker

Time reversible Navier-Stokes equation: Detailed statistical characterization

Vishwanath Shukla [11] [1], Bérengère Dubrulle, Sergey Nazarenko, Giorgio Krstulovic [2], Simon Thalabard [3]

[1] INPHYNI – Université Côte d'Azur (UCA) – France

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[3] University of Massachusetts – United States

We present an exhaustive study of the statistical features of a three-dimensional reversible Navier- Stokes system, whereby the standard viscosity is replaced by a fluctuating thermostat, that compensates dynamically for fluctuations in the total energy. Three different statistical regimes are identified, depending on the value of non-dimensional parameter R_r. We identify a region whereby low-order statistics of the reversible system are qualitatively similar to those observed in direct numerical simulations of Navier-Stokes turbulence, hereby supporting the "equivalence conjecture" formulated in Ref. Phys. Lett. A, 223(1-2):91–95, 1996. With the insights from a toy model of turbulence (Leith model), we argue that the critical value or Rr should be independent of the resolution.

Keywords: Turbulence, irreversibility, thermalization, direct numerical simulations, nonequilibrium ensembles

[11] Speaker

Energy fluxes and scaling in Turbulent Rayleigh-Bénard: the weak analysis in a cubic cell

Valentina Valori [12] [1], Alessio Innocenti , Bérengère Dubrulle [1], Sergio Chibbaro [2]

[1] CEA Paris Saclay – Commissariat à l'énergie atomique et aux énergies alternatives – France

[3] Università di Pisa – Italy

[2] Institut Jean Le Rond dÁlembert – Sorbonne Université, Centre National de la Recherche Scientifique : UMR7190 – France

Energy fluxes and their scalings were studied in an aspect ratio one cubical Rayleigh-Bénard cell, in which a horizontal fluid layer is heated from below. Two different Rayleigh numbers were considered, Ra = 10^7 and Ra = 10^8, with Prandtl number equal to 1.
Direct Numerical Simulations (DNS) were performed using the open-source code Basilisk (see http://www.basilisk.fr/). DNS data were analyzed using a local fluctuating form of the K{a}rḿ{a}n-Howarth-Monin (KHM) equation, in the Boussinesq approximation [1], for a wide range of scales, from sub-Kolmogorov values, to the inertial range.

Statistics of energy fluxes were computed by averaging over time and space on six horizontal slices, at mid height of the cell. Results showed the presence of Bolgiano scaling [2] for a small interval of scales in the inertial range.

Davide Faranda, Valerio Lembo, Manasa Iyer, Denis Kuzzay, Sergio Chibbaro, Francois Daviaud, and Bérengère Dubrulle, Computation and characterization of local sub-filter-scale energy transfers in atmospheric flows. Journal of the Atmospheric Sciences, 2018.

Bolgiano, R. 1959. Turbulent spectra in a stably stratified atmosphere. J. Geophys. Res. 64 (12). 2226-2229.

Keywords: Rayleigh, Bénard convection, turbulence, energy fluxes, Bolgiano length, Bolgiano scaling, sub, Kolmogorov scales

[12] Speaker

Rayleigh-Taylor turbulence with time-periodic acceleration

Stefano Musacchio [13]

INSMI (CNRS) – Université Côte d'Azur (UCA) – France

The dynamics of Rayleigh-Taylor turbulence convection in presence of an alternating, time periodic acceleration is studied by means of extensive direct numerical simulations of the Boussinesq equations.

Within this framework, we discover a new mechanism of relaminarization of turbulence: The alternating acceleration, which initially produces a growing turbulent mixing layer, at longer times suppresses turbulent fluctuation and drives the system toward an asymptotic stationary configuration.

Dimensional arguments and linear stability theory are used to predicts the width of the mixing layer in the asymptotic state

as a function of the period of the acceleration.

Our results provide an example of simple control and suppression of turbulent convection with potential applications in different fields.

Keywords: Turbulence, Rayleigh, Taylor

[13] Speaker

Classification of active systems: hydrodynamic equations, instabilities, and pattern formation

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From the remarkably large number of microscopic active models that have been studied, only a limited number of distinct, large-scale, self-organized patterns have been identified. Here, we will classify active systems according to their hydrodynamic equations and instabilities and identify three main large-scale structures that emerge: polar structures, nematic structures, and aggregates where local (orientational) order is absent. At the microscopic level, we will identify two main distinct classes of active systems: those where interactions depend on the relative velocity of the active particles, and those where interactions depend primarily on the relative position.

Keywords: Active Matter, hydrodynamic equations, non, equilibrium statistical physics

[14] Speaker

Shear-induced viscous Resuspension in a Couette Flow

Enzo D'ambrosio Azzara [15], Frédéric Blanc, Elisabeth Lemaire

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The shear-induced resuspension of solid particles involves an upward flux of solid particles which balances the sedimentation due to gravity. Several theoretical models characterize this phenomenon of migration but there is a lack of experimental measurements to verify if these models are corrects. The first model has been developed by Acrivos, Morris and Fan in 1993 and links the resuspension to shear-induced particule diffusion. A characteristic quantity is extracted from this model: The Shields number that balances the responsible force of the resuspension with the weight of the particles on the lowest layer, which sustains the entire suspension. A second model is the Suspension Balance Model, developed by Morris and Boulay in 1999. It links the resuspension to particle stress. More precisely, according to this model, the migration is proportional to the divergence of particle stress tensor whose components depend on both the shear rate and particle fraction. In the case of the resuspension in the steady state, the gradient of this stress can be deduced knowing the gradient of concentration. The point of my experiment is to measure directly the concentration along the height to verify if these models are corrects. A laser sheet (r,z) lights a Couette cell where a suspension is sheared. This suspension is made transparent by an accurate refractive index between the solid and liquid phase. With an appropriate image processing, the experimental profiles of concentration for various Shields number are compared to the theoretical predictions deduced from SBM and diffusion model.

Keywords: resuspension, concentrated suspension, particle stress, migration, concentration

[15] Speaker

Buckling of viscoplastic Bingham fluid filaments under compression stresses

Anselmo Pereira, Romain Castellani, Mehdi Khalloufi , Elie Hachem, Rudy Valette [16]

Centre de Mise en Forme des Matériaux (CEMEF) – CNRS : UMR7635, MINES ParisTech - École nationale supérieure des mines de Paris – Rue Claude Daunesse CS 10207 06904 Sophia Antipolis cedex, France

Fluid buckling instabilities represent a major source of irregularities for several industrial and natural processes such as container filling, glass plate fabrication and folding of geological structures. Despite some recent and significant works

regarding such instabilities in Newtonian fluids, the buckling of non-Newtonian materials remains scarcely explored in the literature.

In the present work, we analyse through scaling laws, experiments and direct numerical simulations the buckling of filaments of a viscoplastic Bingham fluid compressed at constant velocity by two parallel plates.

Under low gravity conditions (Laplace pressure being larger thab the hydrostatic pressure), three regimes are observed for slender filaments: a first one driven by the capillary force and during which there is no deflection and a folding regime that is dominated by the compressive viscous force and for which the inertia is negligible, as found by Le Merrer, Quéré and Clanet [PRL 109, 064502 (2012)]; and a twist/coil regime appearing at larger Reynolds number, triggered by a sequence of high to low wavelength instabilities. Introducing a yield stress induces localization that restricts the buckled flow dimensions by restricting the dissipated energy. Our main results are then summarized in a four-dimensional phase diagram whose axes are a slenderness parameter, capillary number, Reynolds number and Bingham number.

Keywords: buckling, compression, viscoplastic fluid, Bingham plastic, direct numerical simulation

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[16] Speaker

Thursday, 6th

Théâtre session, morning

11:15 - 11:35	› Curvature statistics of flexible fibres in turbulence - *Benjamin Favier, Institut de Recherche sur les Phénomènes Hors Equilibre*
11:35 - 11:55	› Particles in wall-bounded turbulent flows: interactions between particles and with surfaces - *Christophe Henry, Team TOSCA, INRIA*
11:55 - 12:15	› Trapping of active particles by quantum vortices and Kelvin waves generation - *Umberto Giuriato, Laboratoire Lagrange*
12:15 - 12:35	› Turbophoresis of small heavy particles in homogeneous isotropic turbulence - *Robin Vallée, Lagrange, CEMEF*
12:35 - 12:55	› Stretching and Buckling of Small Elastic Fibers in Turbulence - *sofia allende, Université Côte d'Azur*
12:55 - 13:15	› Numerical analysis of the dissipative regime in wind turbulence - *Vincent Rossetto, Laboratoire de physique et modélisation des milieux condensés*

Théâtre session, afternoon

15:30 - 15:50	› Liquid Bridge between a Cone and a Plane: Effect of the Apex Angle on the Liquid Transfer - *Youness Tourtit, Microfluidics lab (Université de Liège), Transfers, Interfaces and Processes (Université Libre de Bruxelles)*
15:50 - 16:10	› Water entry of yield-stress droplets - *Anselmo Pereira, Centre de Mise en Forme des Matériaux*
16:10 - 16:30	› Statics and dynamics of wetting on a soft substrate - *Laurent Limat, Matière et Systèmes Complexes (MSC)*
17:00 - 17:20	› Spiral liquid curtains falling from a downward-facing free surface - *Harunori Yoshikawa, Institut de Physique de Nice*
17:20 - 17:40	› The superpropulsion effect with droplets and soft elastic projectiles - *Christophe Raufaste, Université Côte d'Azur, CNRS, Institut de Physique de Nice, 06100 Nice, France*
17:40 - 18:00	› Study of the thrust–drag balance with a swimming robotic fish - *Mederic Argentina, Institut de Physique de Nice*

Curvature statistics of flexible fibres in turbulence

Amélie Gay, Benjamin Favier [17], Gautier Verhille

Institut de Recherche sur les Phénomènes Hors Equilibre – Ecole Centrale de Marseille, Aix Marseille Université, CNRS : UMR7342 – France

The transport of deformable objects by a turbulent flow is common in environmental sciences (for the dynamics of plankton in the ocean for example) and in the industry (for papermaking or textile industries). Most studies concerned with the Lagrangian properties of turbulence are however focusing on small rigid objects, neglecting the potential impact of elasticity.

In this study, the deformations of long flexible fibres in homogeneous isotropic turbulence are experimentally and numerically investigated. Experimentally, we track the three-dimensional conformation of slender silicon objects in a von Kármán flow. Numerically, we solve a 1D elastica equation for inextensible fibers advected by an analytic chaotic flow with prescribed statistical properties.

By comparing our results to the predictions of worm-like chain polymers in an ideal solvent, we are able to identify the role of the spatial and temporal correlations of the turbulent forcing. In particular, we show that these correlations are responsible for an apparent straightening of long fibres which become statistically less distorted by turbulence as their length increases. We explain this surprising effect, ultimately related to the inextensibility of the object and to the spatial correlations of the turbulence, by deriving simple statistical models which also allow us to predict the probability density function of the curvature along the fiber.

Keywords: Turbulence, Elasticity, Fluid/Solid interaction

[17] Speaker

Particles in wall-bounded turbulent flows: interactions between particles and with surfaces

Christophe Henry [18] [1], Robin Vallée [2,3], Jérémie Bec [3]

[1] Team TOSCA – CRISAM - Inria Sophia Antipolis - Méditerranée – France

[2] CEMEF – MINES ParisTech, Center for Material Forming (CEMEF), CNRS – France

[3] Lagrange – Université Côte d'Azur, CNRS, OCA, Bd de l'Observatoire, Nice, France – France

This research activity aims at deepening our understanding of the transport of particles in wall-bounded turbulent flows, their interaction with surfaces (deposition) and their interactions within the fluid (agglomeration). Suspensions of particles are present in a wide range of fields, ranging from industrial applications (fouling of pumps by micro-organisms or fouling of combustion engines by soot particles) to environmental issues (dynamics of pollutants in the atmosphere or droplet formation in clouds) with implications even in our every-day life (accumulation of lime-scale in pipes). This accumulation results from the coupling between the transport of suspended particles by the fluid and the adhesion between particles and surfaces. One of the key challenges related to this research is that it involves different fields (including fluid dynamics, interface chemistry and material sciences) which span a wide range of time- and spatial-scales.

Recent studies have shown that the combined effects of particles inertia and of inelastic shocks among them or with a surface leads to intricate outcomes. For instance, Belan et al (2014, Phys. Rev. Lett. 112, 234502) have shown that inelastic collapse can occur in random flows or non-linear fluid flows mimicking the behaviour in viscous boundary layers. This inelastic collapse is due to the fact that particles colliding inelastically on a surface can undergo an infinite number of collisions in a finite time. Direct numerical simulations in homogeneous isotropic turbulent flows have shown that particles can undergo sticky elastic collisions and form clusters under the sole influence of their dissipative viscous drag (Bec et al 2013, Phys. Rev. E 87, 063013). In wall-bounded flows, recent DNS studies have shown that finite-sized particles tend to localize in the near-wall region (Sardina et al 2012, J Fluid Mech, 699, 50-78).

Within this scope, the specific aim of this research is to address the role of particle-surface interactions in their near-wall concentration in turbulent flows. For that purpose, numerical experiments are performed using Direct Numerical Simulations (DNS) of wall-bounded turbulent flows along with particle tracking. In particular, we characterize whether or not a noisy behavior in the particles dynamics is absolutely necessary for observing a collapse to the surface. The effect of inelastic collisions between particles or with a surface on their concentration near the surface is also addressed. It can indeed have noticeable consequences on the question of particle accretion on a larger particle (for droplet formations in cloud) as well as in particle deposition on surfaces (for particle fouling in pipes). Finally, numerical results are also analysed to develop new macroscopic models for the dynamics of particles in turbulent flows.

Keywords: two phase flows, wall bounded turbulence, particle suspensions

[18] Speaker

Trapping of active particles by quantum vortices and Kelvin waves generation

Umberto Giuriato [19]

Laboratoire Lagrange – Observatoire de la Cote d'Azur, Observatoire de la Cote d'Azur – France

The attractive interaction between particles and quantized vortices at zero temperature is studied numerically and theoretically in the framework of the three-dimensional Gross-Pitaevskii (GP) model. Particles are described as localized potentials depleting the superfluid and follow a newtonian dynamics. A reduced central-force model that only depends on the classical degrees of freedom of the particle is derived analytically from the GP hamiltonian. Such model is found to be consistent with the GP simulations, predicting the observed scaling of energies with the particle position as well motion curves and trajectories of the particle itself. The model is then generalized to include small deformations of the vortex filament, giving a mutual long range interaction between the particle and the vortex line. This interaction can qualitatively reproduce the observed generation of a smoothed cusp on the vortex line during the particle approach and the generation of Kelvin waves induced by a linear resonant mechanism.

Keywords: Quantum vortices, superfluids, particles

[19] Speaker

Turbophoresis of small heavy particles in homogeneous isotropic turbulence

Robin Vallée [20]

[1] CEMEF – MINES ParisTech, Center for Material Forming (CEMEF), CNRS – France

[2] Lagrange – Université Côte d'Azur, CNRS, OCA, Bd de l'Observatoire, Nice, France – France

Suspended particles are widely encountered in industry or in nature where droplets, dust, sediments or other kinds of impurities are transported by a turbulent fluid. When those particles have inertia, they detach from the flow and form uneven distribution leading to clustering or preferential concentration. Small particles have the tendency to drift out from excited turbulent regions since faster particles fly longer distances before equilibration. That fundamental phenomenon, called turbophoresis, is widely encountered in nature, in clouds for example, and used in industry. It is mainly observed in inhomogeneous turbulent flow where particles concentrate in low energy regions. We show here that this phenomenon can also be observed in homogeneous turbulent flows and we illustrate and quantify the importance of instantaneous inhomogeneities. Many applications require modeling the fluctuations of the particle density for scales within the inertial range. We perform direct numerical simulations with suspension of Lagrangian, heavy, point-like particles to study this problem and the density distribution dependence on the particle inertia and on the Reynolds number of the flow. We show that voids in the distribution are important because outside them the particles are uniformly distributed. The size of such voids strongly depends on the Stokes number of the particles and to quantify this dependence we construct the voids by using the Delaunay triangulation of the set of particles. We obtain that the volumes of voids follow a non trivial distribution characterized by a power law $p(v) \propto v^{-\alpha}$, where the exponent α depends on the Stokes number. This behavior can be explained by a space and time-dependent diffusion model related to the ejection of particles from vortical regions and a preferential sampling of the Laplacian of pressure. To corroborate these arguments, we also study dynamical properties. The coarse-grained acceleration of the particles is for instance shown to strongly depend on the Laplacian of pressure. These results are put together to show that turbophoresis can explain inhomogeneities in the inertial-range distribution of heavy particles suspended in homogeneous isotropic turbulence. Such considerations have consequences on modeling particles in large-eddy simulations.

Keywords: Turbulence, turbophoresis, inertial particles

[20] Speaker

Stretching and Buckling of Small Elastic Fibers in Turbulence

Sofia Allende [21] [1], Christophe Henry [2], Jérémie Bec [3]

[1] Université Côte d'Azur – Université Côte d'Azur (UCA) – France

[2] Observatoire de la Côte d'Azur – Observatoire de la Cote d'Azur – France

[3] Observatoire de la Cote d'Azur, CNRS, OCA, Laboratoire J.-L. Lagrange, Nice, France – CNRS : UMR7293 – France

The motion of small, non-spherical, elongated particles suspended in a fluid flow concern several branches of science and various industrial applications. Fibers in paper industry, as well as plankton colonies in the ocean, are well described by non-diffusive macroscopic particles subject to two forces: bending elasticity and viscous drag with the flow. In developed turbulence, the Lagrangian dynamics is chaotic. The drag thus tends to stretch the fibers, acting in the same direction as bending elasticity. Deformable, elongated particles are thus most of the time as straight as rods. Still, due to turbulent fluctuations, this simple rod dynamics can be destabilized in an intermittent manner. This occurs when the fiber experiences a strong-enough local compression, leading to its buckling. We present here the main results of a recent article (Allende et al., Phys. Rev. Lett. 121, 154501, 2018), in which the fiber is modelled using the slender-body theory and transported by a three-dimensional, homogeneous isotropic turbulent flow. Buckling is observed to happen when the instantaneous shear rate along the fiber is compressive and strong enough. For small flexibilities, this occurs very rarely, with a probability related to the far-tail of the distribution of turbulent velocity gradients. This implies that buckling events are similar to an activation process, where the fiber flexibility acts as temperature in chemical reactions. It is moreover known that such large excursions of turbulent velocity gradients are not isolated events, but form intermittent bursts with durations over inertial time scales. This is responsible for long-range Lagrangian correlations of the turbulent shear that we could resolve thanks to large-size numerical simulations. We find that such an intermittent behavior has a strong influence on the time correlation between successive bucklings and is responsible for memory effects.

Keywords: Elongated particles, turbulent flow, deformable particles

[21] Speaker

Numerical analysis of the dissipative regime in wind turbulence

Vincent Rossetto [22], Léonie Canet

[1] Laboratoire de physique et modélisation des milieux condensés – Centre National de la Recherche Scientifique : UMR5493, Université Grenoble Alpes – France

We study the data obtained in Modane's ONERA wind tunnel as part of the ESWIRP project in 2014 [Bourgoin et al.,CEAS Aeor. J. 2018] with the goal to confront the energy spectrum to the recent theoretical prediction obtained from the Non-Perturbative Renormalization Group [Canet et al., Phys. Rev. E 2017]. Beyond the inertial regime well described by Kolmogorov, we analyse the dissipative regime at small scales such that viscous effects manifest themselves and the eddies' energy is dissipated into heat. The theory expects a behaviour characterized by a stretched exponential (the spectrum analytical form contains a factor exp[-A k^{2/3}]). We present the results of our investigation of the dissipative regime and we show that the dissipative regime in Modane wind tunnel displays a compatible behaviour with the theory.

Keywords: turbulence theory, dissipative regime, data analysis

[22] Speaker

Liquid Bridge between a Cone and a Plane: Effect of the Apex Angle on the Liquid Transfer

Youness Tourtit [23], Tristan Gilet [2], Pierre Lambert [1]

[1] Transfers, Interfaces and Processes (Université Libre de Bruxelles) – Belgium

[2] Microfluidics lab (Université de Liège) – Belgium

The transfer of liquid between two solid surfaces through the stretching of a liquid bridge was extensively studied for its importance in many industrial applications. This paper presents a novel insight on the axially symmetric rupture of a liquid bridge between a cone and a plane, and the volume distribution after break up. We use truncated cones and conical cavities for our experiments. We find out that, the aperture angle of the cone influences the meniscus shape and therefore the liquid transfer ratio. For small aperture angle, liquid bridge prefers to slip off from the cone and a poor transfer is observed. However for larger aperture angle, a significant amount of liquid is transferred to the cone. In the case of conical cavities, the liquid is transferred to the cone cavity and a maximum of liquid transfer ratio is observed for an aperture angle of 220∘. The distance between the cone and the plane at which the liquid bridge ruptures is also discussed.

Keywords: liquid bridge, break, up, apex angle, liquid transfer

[23] Speaker

Water entry of yield-stress droplets

Anselmo Pereira [24] [1], Rudy Valette [1], Elie Hachem [1], Maziyar Jalaal [2], Dave Kemper [2], Detlef Lohse [2]

[1] Centre de Mise en Forme des Matériaux – MINES ParisTech, PSL Research University – France

[2] Physics of Fluids group, Faculty of Science and Technology, MESA+ Institute and J.M. Burgers Centre for Fluid Dynamics, University of Twente – Netherlands

We study through experiments and direct numerical simulations the water entry of yield-stress droplets. Following the impact on water free surfaces, these Non-Newtonian fluids undergo at least three stages: a spreading one (1), related to the impact acceleration, driven by the viscous dissipation and during which the droplet reaches its maximum deformation; a droplet-water interaction stage (2) along which the viscoplastic material tends to recover its initial morphology before being finally dominated by the yield-stress (3), which prevents further deformations. Different final shapes are observed. Their link with the fluid rheology is discussed in the light of scaling laws, kinematic and energy exchange analyses.

Keywords: water entry, yield, stress fluid, experiment, direct numerical simulation.

[24] Speaker

Statics and dynamics of wetting on a soft substrate

Laurent Limat [25] [1], Matthieu Roché [1], Julien Dervaux [1], Ioan Ionescu [2], François Lequeux [3], Menghua Zhao [1], Robin Masurel [1], Tetsu Narita

[1] Matière et Systèmes Complexes (MSC) – Laboratoire MSC, UMR 7057 CNRS, Université Paris Diderot – France

[2] Laboratoire de Science des Procédés et des Matériaux – LSPM : UPR3407, CNRS, Université Paris 13 et Institut Galilée – France

[3] Science et Ingénierie de la Matière Molle – SIMM : UMR7615, ESPCI, Paris – France

We have investigated the statics and dynamics of wetting on highly deformable substrates, by analytical calculations, numerical simulations and experiments performed on gels. Surprisingly, we found that the well known Neumann triangle is not always satisfied, especialy in two limits: (1) contact line moving on a very thin layer of an elastic solid, (2) static contact line in the limit of large, finite deformations. We provide new, analytical laws, relevant for both cases. The fist one is extremely interesting for applications to coating, with even the possibility to guide drops moving on a patterned substrate with substrate thickness gradients. The second case opens a suprising analogy between the ”ridge” formed on a soft solid at the contact line, and defects in crystals, the departure to Neumann equilibrium being ruled by an analog of the well known Peach-Kohler force.

References:

(1) Geometrical control of dissipation during the spreading of liquids on soft solids, M. Zhao, J. Dervaux, T. Narita, F. Lequeux, L. Limat, and M. Roché.. Proceedings of the National Academy of Sciences, 115 (8), pp.1748-1753 (2018).

(2) Reply to Karpitschka et al.: The Neumann force balance does not hold in dynamical elastowetting, M Zhao, J Dervaux, T Narita, F Lequeux, L Limat, M Roché, Proceedings of the National Academy of Sciences 115 (31), E7234-E7235 (2018)

(3) Corners in soft solids behave as defects in crystals, R Masurel, M Roché, L Limat, I Ionescu, J Dervaux, arXiv preprint arXiv:1806.07701 (2018)

Keywords: Wetting, Elastowetting, Contact line dynamics, Drops and Capillarity

[25] Speaker

Spiral liquid curtains falling from a downward-facing free surface

Harunori Yoshikawa [26] [1], Christian Mathis [2]

[1] Institut de Physique de Nice – Centre National de la Recherche Scientifique : UMR7010, Université Côte d'Azur (UCA) – France

[2] Laboratoire Jean Alexandre Dieudonné – Centre National de la Recherche Scientifique : UMR7351, Université Côte d'Azur (UCA) – France

We investigate spiral patterns observed at the free surface of a horizontal thin liquid film. The surface is downward facing and destabilized by the Rayleigh-Taylor (RT) instability. The liquid discharge resulting from the instability occurs in different modes: in drops, in columns, and in curtains, depending on the rate of liquid fed to the film (Pirat et al., Phys.Rev. Lett., 92, 104501, 2004). In the curtain modes, falling liquid can exhibit spiral patterns with their arms leading the direction of rotation. Characterizing the formation of spiral curtains by an experiment and comparing the results with a phenomenologically developed theoretical model, we show that the patterns result from the synchronized development of the RT instability with the motion of curtains.

Keywords: Pattern formation, Rayleigh Taylor instability

[26] Speaker

The superpropulsion effect with droplets and soft elastic projectiles

Christophe Raufaste [27] [1], Gabriela Ramos Chagas [2], Thierry Darmanin [2], Cyrille Claudet [1], Frédéric Guittard [2], Franck Celestini [1]

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[2] Université Côte d'Azur, NICE Lab, IMREDD, 61-63 avenue Simone Veil, 06200 Nice, France – Université Côte d'Azur (UCA) – France

Liquid droplets exhibit solid-like properties and large deformations owing to the effect of surface tension. Due to these elastic-like features, the ejection of a droplet with a catapult is not as obvious as we could initially imagine. While rigid projectiles exhibit a regular acceleration phase, the propulsion of droplets, or soft elastic projectiles in general, requires to solve the whole elastodynamics problem to account for the balance between inertia and capillarity/elasticity.

Experiments are performed with both droplets and hydrogels, which are propelled with a catapult. Data show that the ejection velocity depends on both the projectile deformation and the catapult acceleration dynamics. With a matching given by a specific value of the projectile/catapult characteristic times ratio, a 250% kinetic energy gain is obtained as compared to the propulsion of a rigid projectile. A model based on solving the wave equation for the mechanical deformation gives a very good agreement.

We will discuss several applications: actuation of droplets, sorting of objects according to their elastic properties, impedance-matching for a better ejection of rigid projectiles

Reference:

Superpropulsion of droplets and soft elastic solids,

C. Raufaste, G. Ramos Chagas, T. Darmanin, C. Claudet, F. Guittard, F. Celestini, Phys. Rev. Lett. 119, 108001 (2017).

Keywords: drop, capillarity, catapult, ejection, superpropulsion, wave, resonance

[27] Speaker

Study of the thrust–drag balance with a swimming robotic fish

Mederic Argentina [28] [1], Christophe Raufaste [1], Florence Gibouin [2], Yann Bouret [1]

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[2] Institut Pprime (PPRIME) – CNRS : UPR3346, Université de Poitiers, ENSMA – France

A robotic fish is used to test the validity of a simplification made in the context of fish locomotion. With this artificial aquatic swimmer, we verify that the momentum equation results from a simple balance between a thrust and a drag that can be treated independently in the small amplitude regime. The thrust produced by the flexible robot is proportional to A^2 f^2, where A and f are the respective tail- beat amplitude and oscillation frequency, irrespective of whether or not f coincides with the resonant frequency of the fish. The drag is proportional to U^2, where Uis the swimming velocity. These three physical quantities set the value of the Strouhal number in this regime. For larger amplitudes, we found that the drag coefficient is not constant but increases quadratically with the fin amplitude. As a consequence, the achieved locomotion velocity decreases, or the Strouhal number increases, as a function of the fin amplitude

Keywords: locomotion, swimming, robotic

[28] Speaker

Friday, 7th, sessions

Théâtre session, morning

11:30 - 11:50	› Erosion patterns created by a thin free-surface flow of water over a soluble rock - Adrien Guérin, MSC, Paris Diderot
11:50 - 12:10	› Rayleigh-Bénard convection interacting with a melting boundary - Jhaswantsing Purseed, IRPHE, Aix-Marseille Université
12:10 - 12:30	› Effect of the growing conditions on the productivity of micro-algae phototrophic biofilm - Bastien Polizzi, Institut Camille Jordan [Villeurbanne]
12:30 - 12:50	› Transition from inertial wave turbulence to geostrophic turbulence in rotating fluids - an experimental study - Le Reun Thomas, Institut de Recherche sur les Phénomènes Hors Equilibre

Belvédère session, morning

11:00 - 11:20	› Imbalanced kinetic Alfvén wave turbulence - *Thierry Passot, Observatoire de la Côte d'Azur*
11:20 - 11:40	› Gravity-capillary wave turbulence at the interface of two fluids - *Roumaissa Hassaini, Laboratoire des écoulements géophysiques et industriels*
11:40 - 12:00	› Turbulent magnetohydrodynamic reconnection in plasmoid-dominated regime - *Hubert Baty, Observatoire Astronomique, Université de Strasbourg*
12:00 - 12:20	› Time dependence of correlation functions in homogeneous and isotropic turbulence - *Léonie Canet, Laboratoire de physique et modélisation des milieux condensés*
12:20 - 12:40	› Magnetic fluid-structure Dynamo - *Yannick Ponty, UCA/OCA*

Light-driven actuation of interfacial swimmers

Thomas Bickel [29]

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Light is a convenient way to remotely control the locomotion of small particles. In this presentation, I will show that light-induced Marangoni flows can produce powerful propulsion forces in order to actuate interfacial swimmers. Two experimental realizations are described and theoretically discussed.

First, I discuss the transport of a (millimeter-sized) liquid marble floating at the water-air interface. The water solution contains photosensitive surfactants, which upon UV irradiation generate a surface-tension gradient. Strikingly, it is observed that, below a critical liquid thickness, the particle moves in the direction opposite to the Marangoni flow. We demonstrate that this anti-Marangoni motion is driven by the deformation of the liquid surface, which gravity-propels the non-wetting marble against the surface flow.

Then I describe the motion of micron-sized particles heated up by a laser. The resulting thermocapillary flow drives the motion of the particles at speeds as large as 100 micron/second. Our study reveals that the structure of the flow is more complex than expected. Indeed, we observe pairs of contra-rotative vortices that are the signature of a hydrodynamic instability. A plausible scenario for this instability is presented.

Keywords: *Microswimmers, Marangoni flow*

[29] Speaker

Multiple Behaviors and Active Matter

Luis Gómez Nava [30] [1], Emiliano Perez Ipiña [1], Fernando Peruani [2]

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We introduce a theoretical framework to understand collections of active particles that operate with a finite number of discrete internal states that control the external behavior of these entities. These theoretical concepts are conceived to understand the large number of existing multiagent biological systems where the individuals display distinct behavioral phases that alternate with each other. By construction, the premise of our theoretical model is that an external observer has access only to the external behavior of the individuals, but not to their internal state. It is only after careful examination of the behavioral dynamics that the existence of these internal states becomes evident. This analysis is key to be able to associate the experimentally observed behaviors of individuals with one or many internal states of the model. This association between states and behaviors should be done accordingly to the observations and the phenomenology displayed by the biological system that is being the subject of study. The possible scenarios that can be observed using our theoretical model are determined by the design of the internal mechanism of the individuals (number of internal states, transition rates, etc) and will be of markovian nature by construction. We provide experimental evidence of two biological systems at different scales that suggest that our model is suitable to be used to describe real-life systems showing individual or collective intermittent behaviors and displacements. This here-introduced new framework of active particles with internal states is still in development and we are convinced that it can potentially open new branches of research at the interface between physics, biology and mathematics.

Keywords: *Active matter, intermittent behaviors, internal states, biological systems, Markov processes, collective phenomena, synchronized systems.*

[30] Speaker

Formation of dense granular rafts

Antoine Lagarde [31] [1], Suzie Protière [1], Christophe Josserand [2]

[1] Institut Jean Le Rond dÁlembert – Sorbonne Université, Centre National de la Recherche Scientifique : UMR7190 – France

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When an object is placed at the surface of a liquid, its weight deforms the interface. For two identical spherical objects, such a deformation creates an attractive force, leading to the aggregation of the two-body system. This effect can be used to generate self-assembled system with complex structures for numerous applications, including for instance microelectronics or robotics. It can also be observed in countless everyday life, such as the aggregation of breakfast cereals in a bowl of milk or bubbles in a glass of champagne. Some natural systems have managed to take advantage of these capillary forces, like fire ants for example that can collectively float on water by aggregating into a raft.

Here, we experimentally study the aggregation of dense millimeter-sized beads placed at an oil-water interface, which form an axisymmetric monolayer called a granular raft. The interfacial deformation created by such a two-dimensional object exceeds by at least an order of magnitude the deformation of an single bead. This leads to unusually high capillary forces, with a very strong dependency with the size of the raft. Similarly, because the raft grows in size as more particles are added, the viscous drag caused by the motion of the raft also increases with the number of beads.

By studying the relative motion of two granular rafts of different sizes, and comparing with numerical simulations of the interfacial deformation generated by a raft, we deduce the capillary attraction leading to the observed velocity profiles. The behavior of two granular rafts can then serve as a basis to understand a n-body system, constituted of an arbitrary number of granular rafts.

Keywords: *Granular rafts, aggregation, capillarity*

[31] Speaker

On self similarity and coarsening rate of a convecting bicontinuous phase separating mixture: effect of the viscosity contrast

Hervé Henry [32] [1], Gyorgy Tegze [2]

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[2] Wigner Research Center for Physics [Budapest] – Hungary

We present a computational study of the hydrodynamic coarsening in 3D of a critical mixture using the Cahn-Hilliard/Navier-Stokes model. The topology of the resulting intricate bicontinuous microstructure is analyzed through the principal curvatures to prove self-similar morphological evolution.We find that the self similarity exists for both systems: isoviscous and with variable viscosity. The two system have distinct topological character that can be quantified throughh quantities such as the averrage mean and gaussian curvature between the phases. Moreover an effective viscosity that accurately predicts coarsening rate is proposed.

When considering off critical mixtures where volume fraction of both phases differ significantly from 0.5, we find that the effects of the viscosity contrast between the phases can be much more pronounced and translates into either visible changes in the self similar structure or the loss of self-similarity.

Keywords: *Coarsenning, Phase Separation*

[32] Speaker

Erosion patterns created by a thin free-surface flow of water over a soluble rock

Adrien Guérin [33] , Julien Derr, Sylvain Courrech Du Pont [1], Michael Berhanu [2]

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Erosion by dissolution is a decisive process shaping small-scale landscape morphology [1]. On the surface of soluble rocks like gypsum, salt (halite) or limestone, characteristic patterns known as Rillenkarren can be observed. These patterns occur when the dissolving surface is inclined and subjected to a thin run-off flow. The rock surface then erodes into nearly parallel channels (rills) directed along the main slope and regularly spaced. Although these patterns are commonly observed, the conditions of their occurrence remain incompletely understood to our knowledge [2]. Here, we study in a laboratory experiment the dissolution patterns appearing on inclined blocks of salt submitted to a thin free-surface flow.

Blocks of salt of rectangular shape (10 X 20 cm and 3 cm in thickness) are tilted at a controlled angle. A constant-head reservoir supplies water at the top of the slope. Water flows down by gravity in a thin film of water uniformly spread over the salt block (typical depth 100-500 μm). The top surface of this film is a free surface, and the flow naturally adapts its velocity and the depth of the film to the two control parameters of the experiment (the flow-rate and the slope).

Each experiment is performed with constant flow-rate and slope. First, the dissolution rate averaged over the whole surface of the rock increases with the square root of the flow-rate. We explain this scaling law with a simple model of solute transport. Second, approximately 1mm-wide parallel rills spontaneously develop on the initially flat surface of the rock, at the time scale of a minute. The typical wavelength and pattern amplitudes are extracted from 3D reconstruction of eroded blocks using a laser scanner. Interactions between the rock surface and the flow induce a heterogeneous velocity field, which in turn induces heterogeneous solute concentration and dissolution rate.

P. Meakin and B. Jamtveit, {*Geological pattern formation by growth and dissolution in aqueous systems}, Proc. R. Soc. A 466 659-694 (2010)*

M. Perne and Franci Gabrovšek, {The problem of rillenkarren development: a modelling perspective}, in Karst Rock Features, Carsologica 9 (2009)

Keywords: *Erosion, dissolution, free, surface flow, instability*

[33] Speaker

Rayleigh-Bénard convection interacting with a melting boundary

Jhaswantsing Purseed [34] , Laurent Duchemin [1], Benjamin Favier [2]

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[2] Institut de Recherche sur les Phénomènes Hors Equilibre – Ecole Centrale de Marseille, Aix Marseille Université, CNRS : UMR7342 – France

We study the evolution of a melting front between the solid and liquid phases of a pure incompressible material where fluid motion is driven by unstable temperature gradients. In a plane layer geometry, this can be seen as classical Rayleigh-B enard convection, where the upper solid boundary is allowed to melt due to the heat flux brought by the fluid underneath. This free-boundary problem is studied numerically in two dimensions using a phase-field approach, which we dynamically couple with the Navier–Stokes equations under the Boussinesq approximation. We focus on the case where the solid is initially nearly isothermal, so that the evolution of the topography is related to the inhomogeneous heat flux from thermal convection, and does not depend on the conduction problem in the solid. From a very thin stable layer of fluid, convection cells appear as the depth (and therefore the Rayleigh number) of the layer increases. In the supercritical regime, the continuous melting of the solid leads to dynamical transitions between different convective cell sizes and topography amplitudes. The Nusselt number can be larger than its reference value for a flat upper boundary due to the feedback of the topography on the flow, which can stabilize large-scale laminar convective cells.

Keywords: *Bénard convection, solidification/melting et topographic effects.*

[34] Speaker

Effect of the growing conditions on the productivity of micro-algae phototrophic biofilm

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[3] Equipe BIOCORE – L'Institut National de Recherche en Informatique et e n Automatique (INRIA) – 2004 route des lucioles - BP 93 06902 Sophia-Antipolis, France

[2] Laboratoire d'océanographie de Villefranche (LOV) – INSU, CNRS : UMR7093, Université Pierre et Marie Curie (UPMC) - Paris VI, Université Pierre et Marie Curie [UPMC] - Paris VI – Observatoire Océanologique Station zoologique 181, chemin du lazaret BP 28 06230 VILLEFRANCHE SUR MER Cedex, France

[4] Institut Denis Poisson – Université de Tours : UMR7013, Centre National de la Recherche Scientifique : UMR7013, Université d'Orléans : UMR7013 – France

[5] Laboratoire de Génie des Procédés et Matériaux - EA 4038 – CentraleSupélec – France

This talk will be devoted to the presentation of a mathematical model specifically designed to optimise quantifies the effects of growing conditions on the productivity of phototrophic micro-algae biofilms. In this model, a special attention has been paid to the description of biochemical mechanisms involved in the biofilm growth. Among other the photosynthesis, the extracellular matrix excretion, and mortality are considered. All the mechanisms are precisely described using kinetic laws that take into account saturation and inhibition effects induced by the different components. In particular, to obtain a detailed description of the micro-algae growth, we consider separately the lipids and the functional part of micro-algae (proteins, RNA, ...), the latter playing a leading role in photosynthesis. We also consider components dissolved in the liquid phase such as CO2. The model is based on mixture theory which allows describing in time and space complex systems of heterogeneous fluids at the mesoscale. Precisely, each component is described on the one hand by a mass conservation law, which takes into account biological features, and on the other hand by conservation of momentum, which describes the physical properties of the component. In order to estimate the solution, a semi-implicit numerical method in time has been elaborated and implemented. Numerical simulations showing that the model is able to estimate accurately the biofilm productivity will be presented. Finally, the harvest is also considered and it's on productivity will be described. This work is done in collaboration with M. Ribot, F. Lopes and O. Bernard.

Keywords: *Biofilm growth, Photosynthetic micro, algae biofilm, Front propagation, Fluid dynamics model, Numerical simulations, Mixture theory*

[35] Speaker

Transition from inertial wave turbulence to geostrophic turbulence in rotating fluids - an experimental study

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[2] Institut de Recherche sur les Phénomènes Hors Equilibre (IRPHE) – Ecole Centrale de Marseille, Aix Marseille Université, CNRS : UMR7342 – Technopole de Chateau-Gombert - 49 rue Joliot Curie - BP 146 - 13384 MARSEILLE cedex 13, France

[3] IRPHE, Marseille, France – CNRS, Aix-Marseille University, Centrale Marseille – France

A broad array of geophysical and astrophysical flows, be it in planetary cores, the Earth's ocean and atmosphere, or stellar interiors, are turbulent and strongly affected by rotation. These flows are very different from homogenous and isotropic turbulence owing to the presence of structures influenced by the Coriolis force and evolving on very different time scales. On one hand, the restoring effect of the Coriolis force leads to the existence of inertial waves that oscillate at frequencies smaller than or equal to twice the rotation rate. On the other hand, vortices aligned with the rotation axis and persisting over much longer time scales are also ubiquitously observed in rotating turbulence; they are associated to a balance between the pressure and Coriolis forces and are often called "geostrophic vortices". In the vast majority of rotating turbulence experiments and simulations, in which flows are excited by random fields, alternative jets or pairs of vortices, geostrophic eddies are dominant compared to inertial waves, the latter being advected and deformed by these persistent flows.

We propose to re-evaluate this standard observation via examining the turbulent saturation of parametric instabilities in rotating fluids, a problem of great interest for planetary and stellar interiors. Gravitational attraction exerted by other astrophysical bodies on a planet or a star produces a tidal deformation of its shape and causes periodic alterations of its rotation rate called librations. The combination of these two effects excites the resonance of two inertial waves at a precise frequency that eventually breaks down into turbulence. To reach this turbulent state, the forcing is very different compared to more classical works on rotating turbulence. First, energy is transfered to the flow only via a couple of inertial waves; besides, in the geophysical regimes we consider, both the forcing amplitude and dissipation are weak (i.e. both the Rossby and the Ekman numbers are small).

The experimental set-up we use to study the turbulent saturation of this inertial wave instability is designed to mimic tidal forcings in astrophysical bodies. An ellipsoidal container is mounted on a rotating table with a secondary motor forcing harmonic perturbations of the mean rotation rate. We characterise the turbulent saturation flow with particle image velocimetry (PIV). With temporal analysis of the velocity fields, we show that at the lowest forcing amplitudes, the resonant waves excite daughter waves with different frequencies via non-linear resonant interactions. Conversely, at large forcing amplitudes, the resonant waves force a more classical geostrophic turbulence where the flow is dominated by strong vortices.

Our study suggests that, in the regimes of low forcing amplitude and dissipation, it is possible to excite an inertial wave turbulence, i.e. a flow with many waves that are non-linearly, resonantly, interacting. It is the first time a transition between a wave-dominated and a geostrophic-dominated regime is observed experimentally. This result has strong implications for instance on tidal dissipation and dynamo action in planets and stars. In particular, generation of a magnetic field by a set of inertial waves has seldom been considered and remains to be studied in detail.

Keywords: *Geophysical fluid dynamics, rotating turbulence, inertial waves, parametric instability*

[36] Speaker

Posters

Vortex scattering by impurities in a Bose–Einstein condensate
Adam Griffin, George Stagg, Nick Proukakis, Carlo F. Barenghi

Condensation in Quasi-Geostrophic and Drift Wave Turbulence
Jonathan Skipp, Sergey Nazarenko

Turbulence in complex geometry: when simulations (numerics) meet experiments (laboratory)
Hugues Faller

Modelling of the flow behaviour of elastomer composites at the walls of an internal mixer
Prashanth Thirunavukkarasu, Edith Peuvrel-Disdier, Rudy Valette, Bruno Vergnes

Atmospheric transport shapes fungal strategies for survive
Daniele Lagomarsino Oneto, Andrea Mazzino, Agnese Seminara

Particle organization at air-water interface in Faraday waves
Héctor Alarcón

Numerical Investigation of Complex Phosphate Slurry Transport Models by Finite Volume Methods
Souhail Maazioui, Fayssal Benkhaldoun, Driss Ouazar

Preferential sampling of elastic chains in turbulent flows
Jason R Picardo, Dario Vincenzi, Nairita Pal, Samriddhi Sankar Ray

Modeling and simulation of non-buoyant suspension flows with thermal coupling
Ayoub Badia, Yves D'Angelo, Laurent Lobry, François Peters

Mechanics of filamentous growth in soft materials
Nicolas Bruot, Nino Kukhaleishvili, Charles Puerner, D Thompson, Agnese Seminara, Martina Bassilana, Robert Arkowitz, Xavier Noblin

Adaptive stopping criterion for iterative linear solvers in an anisotropic stabilized AFEM framework
Gabriel Manzinali, Elie Hachem

Analysis of the flow blockage of concentrated suspensions of solid particles
Olga Volkova, Alain Ciffreo, Yan Grasselli, Georges Bossis

Accurate Adaptive Eulerian Framework for Liquid-gas-solid Interactions
Chahrazade bahbah, Elie Hachem

Bacterial biofilm response to gradients in their physical environment
Martina Iapichino, Cyrille Claudet, Agnese Seminara

The capillary bridge setup for the study of superhydrophobic surfaces
Céline Cohen, Yann Bouret, Xavier Noblin

Ferrofluid in the Leidenfrost state
Christophe D'Angelo, christophe raufaste, Pavel Khuzir, franck celestini

Evidence of Intermittency à la Leray in hydrodynamical turbulence
Thierry Lehner

Hamiltonian reduced fluid models for non-dissipative plasmas
Emanuele Tassi

List of participants

- Agassant Jean-François
- Alarcón Héctor
- Allende Sofia
- Argentina Mederic
- Attuel Guillaume
- Badia Ayoub
- Bahbah Chahrazade
- Baty Hubert
- Bec Jérémie
- Bickel Thomas
- Bossis Georges
- Bouchet Freddy
- Brachet Marc
- Brissot Charles
- Bruot Nicolas
- Canet Léonie
- Castellani Romain
- Clamond Didier
- Cohen Céline
- D’ambrosio Azzara Enzo
- D’angelo Christophe
- Dangelo Yves
- Debue Paul
- Faller Hugues
- Favier Benjamin
- Forterre Yoel
- Fraysse Nathalie
- Frisch Thomas
- Gilbert Duncan
- Giuriato Umberto
- Gómez Nava Luis

- Gouzien Élie
- Griffin Adam
- Guérin Adrien
- Hassaini Roumaissa
- Henry Hervé
- Henry Christophe
- Hertel Tobias
- Homann Holger
- Iapichino Martina
- Iazzolino Antonio
- Jambon-Puillet Etienne
- Krstulovic Giorgio
- Kuksin Sergei
- Kuzhir Pavel
- Lagarde Antoine
- Lagomarsino Oneto Daniele
- Le Reun Thomas
- Lehner Thierry
- Lemaire Elisabeth
- Limat Laurent
- Liot Olivier
- Maazioui Souhail
- Manzinali Gabriel
- Musacchio Stefano
- Nazarenko Sergey
- Nguyen Florian
- Noblin Xavier
- Noullez Alain
- Passot Thierry
- Patrick Tabeling
- Pereira Anselmo
- Peruani Fernando
- Peters François
- Peuvrel-Disdier Edith

- Pigeonneau Franck
- Podvin Berengere
- Politano Hélène
- Polizzi Bastien
- Ponty Yannick
- Purseed Jhaswantsing
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- Rafaï Salima
- Raufaste Christophe
- Rigolli Nicola
- Rossetto Vincent
- SÁnchez RodrÍguez Jesús
- Sardo Lucas
- Seminara Agnese
- Shukla Vishwanath
- Simonnet Eric
- Skipp Jonathan
- Sulem Pierre-Louis
- Tassi Emanuele
- Thirunavukkarasu Prashanth
- Tourtit Youness
- Tran Duc Quang
- Valette Rudy
- Vallee Robin
- Valori Valentina
- Vincenzi Dario
- Yoshikawa Harunori