Welcome to the

Spanish-French Workshop on Analysis of PDEs from Fluid Mechanics

All the talks will take place in *el Aula Naranja* and will have a duration of 40 min (questions/remarks included).

Here are the titles and abstracts of the talks :

Timetable of the Workshop

hours/days	Monday 19 september	Tuesday 20 september	Wednesday 21 september
10h00-10h40		**C. Cheverry**	**J. Soler**
10h40-11h20		**F. Gancedo**	**P-G Lemarié-Rieusset**
11h20-11h40		*Break*	*Break*
11h40-12h20		**R. Danchin**	**N. Grubic**
12h20-13h00		**J. Mateu**	**D. Peralta**
13h00-15h00	*Registration & Lunch*	*Lunch*	*Lunch*
15h00-15h40	**A. Castro**	**D. Bresch**	
15h40-16h20	**D. Lannes**	**R. Granero**	
16h20-16h40	*Break*	*Break*	
16h40-17h20	**O. Lazar**	**L. Vega**	
17h20-18h00	**T. Hmidi**	**D. Faraco**	
21h00		*Dinner*	

The lunch will take place at Plaza Mayor (10 min walking from the ICMAT).

Abstract of the talks

D. Bresch (Univ Savoie Mont-Blanc)

Title : Diffusion versus dispersion

Abstract : In this talk, I will show on some examples how dispersion and diffusion terms may discuss together when they act in a compressible framework.

A. Castro (Univ Autonoma de Madrid & ICMAT)

Title : Global smooth solutions for the inviscid SQG equation

Abstract : In this talk we will present the construction of some global smooth solutions for the Surface Quasi-Geostrophic equation. These solution consist of a rotation with constant angular vorticity. We will present the main ingredients of the proof which includes a computer assisted part. This is a joint work with J. Gómez-Serrano, and D. Córdoba.

C. Cheverry (Univ Rennes 1)

Title : Anomalous transport.

Abstract : I will present a deterministic description of the turbulence in magnetized plasmas, and its consequences on magnetohydrodynamics.

R. Danchin (Univ Paris-Est Créteil)

Title : Optimal time-decay estimates for the compressible Navier-Stokes equations in the critical regularity framework

Abstract : The global existence issue for the isentropic compressible Navier-Stokes equations in the critical regularity framework has been addressed in [1] more than fifteen years ago. However, whether (optimal) time-decay rates could be shown in general critical spaces and any dimension $d \geq 2$ has remained an open question. In this joint work with J. Xu [4], we give a positive answer to that issue not only in the L^2 critical framework of [1] but also in the more general L^p critical framework of [2, 3, 5]. More precisely, we show that under a mild additional decay assumption that is satisfied if the low frequencies of the initial data are in e.g. $L^{p/2}(\mathbb{R}^d)$, the L^p norm (the slightly stronger $\dot{B}^0_{p,1}$ norm in fact) of the critical global solutions decays like $t^{-d(\frac{1}{p}-\frac{1}{4})}$ for $t \to +\infty$, exactly as firstly observed by A. Matsumura and T. Nishida in [6] in the case $p = 2$ and $d = 3$, for solutions with high Sobolev regularity.

Our method relies on refined time weighted inequalities in the Fourier space, and is likely to be effective for other hyperbolic/parabolic systems that are

encountered in fluid mechanics or mathematical physics.

Références

[1] R. Danchin : Global existence in critical spaces for compressible Navier-Stokes equations, *Inventiones Mathematicae*, **141**(3), 579–614 (2000).

[2] F. Charve and R. Danchin : A global existence result for the compressible Navier-Stokes equations in the critical L^p framework, *Arch. for Rat. Mech. and Analysis*, **198**(1), 233–271 (2010).

[3] Q. Chen, C. Miao and Z. Zhang : Global well-posedness for the compressible Navier-Stokes equations with the highly oscillating initial velocity, *Comm. Pure App. Math.*, **63**(9), 1173–1224 (2010).

[4] R. Danchin and J. Xu : Optimal time-decay estimates for the compressible Navier-Stokes equations in the critical L^p framework, arXiv :1605.00893.

[5] B. Haspot : Existence of global strong solutions in critical spaces for barotropic viscous fluids, *Archive for Rational Mechanics and Analysis*, **202**(2), 427–460 (2011).

[6] A. Matsumura and T.Nishida : The initial value problem for the equation of motion of compressible viscous and heat-conductive fluids, *Proc. Jpn. Acad. Ser-A*, **55**, 337–342 (1979).

[7] M. Okita : Optimal decay rate for strong solutions in critical spaces to the compressible Navier-Stokes equations, *Journal of Differential Equations*, **257**, 3850–3867 (2014).

D. Faraco (Univ Autonoma de Madrid & ICMAT)

Title : Mixing solutions in the Muskat Problem

Abstract : We will discuss how the method of convex integration can be used to obtaining weak solutions to the Muskat Problem in the fully unstable regime. This is a joint work with Angel Castro and Diego Córdoba.

F. Gancedo (Univ de Sevilla)

Title : Recents results for SQG sharp front and the Muskat problem

Abstract : In this talk we study two scenarios in contour dynamics. The Muskat problem, where the dynamics of two fluids of different nature in porous media are modeled. And front of temperature driven by the Surface Quasi-geostrophic equation (SQG). The dynamics for both free boundary problems are not well understood. A main issue for these problems is finite time singularity formation versus global in time results. For Muskat we show a blow-up criteria for solution to became singular in a stable case. For SQG a uniqueness results for the free boundary modulo reparameterization is given.

R. Granero-Belinchón (Univ Claude Bernard, Lyon 1)

Title : Fluid-Solid & Fluid-Fluid interactions : The Muskat problem and the Rayleigh-Taylor instability

Abstract : In this talk we will present some new results regarding the evolution of interfaces in incompressible fluids. In particular, we will discuss some new well-posedness results for the Muskat problem for discontinuous permeabilities. We will also introduce two new one-dimensional models for the classical Rayleigh-Taylor instability.

N. Grubic (ICMAT)

Title : On the existence of stationary splash singularities for the Euler equations.

Abstract : We discuss the existence of stationary incompressible fluids with splash singularities. Specifically, we discuss sta- tionary solutions to the Euler equations with two fluids whose interfaces are arbitrarily close to a splash. This is joint work with D. Córdoba and A. Enciso.

T. Hmidi (Univ Rennes 1)

Title : Structure of the bifurcation diagram near the degenerate eigenvalues

Abstract : We shall discuss for the incompressible Euler equations the structure of the bifurcation diagram for the rotating doubly connected patches close to the degenerate case. We will show in particular that the branches with the same symmetry and close enough to each other merge forming small loop. The content of the talk is from joint works with Joan Mateu and Coralie Renault.

D. Lannes (Univ Bordeaux 1)

Title : On the dynamics of floating structures

Abstract : The goal of this talk is to derive some equations describing the interaction of a floating solid structure and the surface of a perfect fluid. This is a double free boundary problem since in addition to the water waves problem (determining the free boundary of the fluid region), one has to find the evolution of the contact line between the solid and the surface of the water. The so-called floating body problem has been studied so far as a three-dimensional problem. Our first goal is to reduce it to a two-dimensional problem that takes the form of a coupled compressible-incompressible system. We will also show that the hydrodynamic forces acting on the solid can be partly put under the form of an added mass-inertia matrix, which turns out to be affected by the dispersive terms of the equations.

O. Lazar (ICMAT)

Title : On the stable Muskat problem.

Abstract : The Muskat problem models the dynamics of an interface between two incompressible fluids in porous media having the properties to be immiscible and with different characteristics. We shall present some global existence results in critical Sobolev spaces which allow solutions to have slope bigger than 1 under a symmetry condition on the data. The proof is based on the use of a new formulation of the problem that allows us to use oscillatory integral theorems and commutator estimates to deal with the most singular terms and are crucials to get nice *a priori estimates*. This a joint work with D. Córdoba.

P.G. Lemarié-Rieusset (Univ d'Évry Val d'Essonne)

Title : On the Caffarelli-Kohn-Nirenberg regularity criterion without control on the pressure.

Abstract : We discuss a slight extension of the notion of suitable solutions, while removing control on the pressure. As an application, we state a variant of the Caffarelli-Kohn-Nirenberg regularity criterion and a kind of stability theorem for suitable solutions in the case of loss of control on the pressure.

J. Mateu (Univ Autonoma de Barcelona)

Title : Corotating and counter-rotating vortex pairs for active scalar equations.

Abstract : In this talk we discuss the existence of corotating and counter-rotating pairs of simply connected patches for Euler equations and the generalized $\alpha-$quasi geostrophic equation with $\alpha \in (0,1)$. From some numerical experiments implemented for Euler equations it is conjectured the existence of a curve of steady vortex pairs passing through the point vortex pairs. Recently we have proved some results that confirm the numerical experiments and extend these results for the generalized $\alpha-$quasi geostrophic equation with $\alpha \in (0,1)$. It is a joint work with Taoufik Hmidi.

D. Peralta (ICMAT)

Title : Vortex reconnection in the three-dimensional Navier-Stokes equations.

Abstract : An important property of the 3D Euler equations is that the topology of the vortex structures of the fluid does not change in time as long as the solutions do not develop any singularities. To put it differently, the set of (say) vortex tubes and vortex lines of the fluid at time t is diffeomorphic to that of the initial vorticity, provided that the solution remains smooth up to this time. Of course, numerical simulations and experiments with real fluids have shown that the situation is completely different in the case of viscous fluids. In this

talk we will show how vortex tubes and vortex lines, of arbitrarily complex topologies, are created and destroyed in smooth solutions to the 3D Navier-Stokes equations. This is joint work with Alberto Enciso and Renato Luca.

J. Soler (Univ de Granada)

Title : Euler-type equations and commutators in singular and hyperbolic limits of kinetic Cucker-Smale models.

Abstract : This talk is concerned with the derivation of a hyperbolic scaling for the kinetic Cucker-Smale system via a hydrodynamic singular limit. The resulting limit is a compressible Euler-type or aggregation equation with a singular commutator. We analyze the existence of measure solutions to this equation, as well as some of its qualitative properties

---

L. Vega (BCAM)

Title : Remarks about the self similar solutions of the binormal flow.

Abstract : I will review some of the properties of the self-similar solutions of the binormal flow that turn out to be relevant to understand the dynamics under this flow of a regular polygon. A new result about the transfer of energy will be also given.
