gazteak RSME 2025

MA05

Partial Differential Equations V:
Fluid Dynamics and Control Theory
Ecuaciones en Derivadas Parciales V:
Dinámica de Fluidos y Teoria de Control

Organizers **Organizadores** **Antolatzaileak**

Jon Asier Bárcena Petisco
(UPV/EHU)

Arnab Roy
(BCAM)

Irene Marín Gayte
(Universidad Loyola)

Description **Descripción** **Deskribapena**

The purpose of this parallel session is to examine recent trends in the mathematical analysis and control of fluid dynamics. Developing efficient control systems and comprehending the complex behavior of fluids are essential for process optimization and problem-solving in real-world scenarios. A wide range of subjects will be covered at the parallel session, such as novel control strategies, modeling of complex fluid flows, numerical approaches to fluid dynamics problems, and theoretical advances in PDE analysis.

El objetivo de esta sesión paralela es examinar las tendencias recientes en el análisis matemático y el control de la dinámica de fluidos. El desarrollo de sistemas de control eficaces y la comprensión del complejo comportamiento de los fluidos son esenciales para la optimización de procesos y la resolución de problemas en escenarios del mundo real. En la sesión paralela se tratará una amplia gama de temas, como estrategias de control novedosas, modelización de flujos de fluidos complejos, enfoques numéricos de los problemas de dinámica de fluidos y avances teóricos en el análisis de EDP.

MSC Codes **Códigos MSC** **MSC Kodeak**

35Q35; 93C15; 93C20

(primary)

Slots **Bloques** **Blokeak**

2.A (Aula 0.27); 2.B (Aula 0.27); 2.C (Aula 0.27)

QR Code **Código QR** **QR Kodea**

Session Schedule **Horario de la Sesión** **Saioaren Ordutegia**

J16 | 11:00-11:20 | 0.27
The effect of a large cloud of rigid particles on the motion of an incompressible fluid
Arnab Roy (BCAM)

J16 | 11:30-11:50 | 0.27
Dirichlet boundary control problem for lake eutrophication
Éloïse Comte (French National Research Institute for Agriculture, Food and Environment)

J16 | 12:00-12:20 | 0.27
Existence of undercompressive travelling waves of a non-local generalised Korteweg-de Vries-Burgers equation
Xuban Diez Izagirre (UPV/EHU)

J16 | 12:30-12:50 | 0.27
Modeling the Aortic Valve: A Fluid-Structure Interaction Approach Using Navier-Stokes Equations
Irene Marín-Gayte (Universidad Loyola Andalucía)

J16 | 16:30-16:50 | 0.27
A priori estimates for the 2D one-phase Muskat problem with contact points
Edoardo Bocchi (Politecnico di Milano)

J16 | 17:00-17:20 | 0.27
Time-periodic solutions for fluids and elastic structures
Claudiu Mindrila (BCAM)

J16 | 17:30-17:50 | 0.27
Polymeric fluid-structure interaction
Romeo Mensah (TU Clausthal)

V17 | 9:00-9:20 | 0.27
Finite-difference least square method for solving Hamilton-Jacobi equations using neural networks
Carlos Esteve Yagüe (Universidad de Alicante)

V17 | 9:30-9:50 | 0.27
Rermarks on matching measures with ML architectures
Domènec Ruiz-Balet (Imperial College London)

V17 | 10:00-10:20 | 0.27
Kinetic modeling of social crowds with infectious disease contagion
Damián A. Knopoff (Universidad de Deusto)

Thursday 16	**Jueves 16**	**Osteguna 16**
11:00-11:20	**11:00-11:20**	**11:00-11:20**
[Room 0.27]	**[Aula 0.27]**	**[Gela 0.27]**

The effect of a large cloud of rigid particles on the motion of an incompressible fluid

Arnab Roy
(BCAM)

In this talk, we examine multiple bodies moving within a fluid and explore the collective impact of their motion on the fluid dynamics as the bodies simultaneously decrease in size.

Thursday 16	**Jueves 16**	**Osteguna 16**
11:30-11:50	**11:30-11:50**	**11:30-11:50**
[Room 0.27]	**[Aula 0.27]**	**[Gela 0.27]**

Dirichlet boundary control problem for lake eutrophication

Éloïse Comte
(French National Research Institute for Agriculture, Food and Environment)

We propose an optimal control problem for the lake eutrophication modeling the dynamics of phosphorus stock and cyanobacteria concentration with coupled non-linear PDE. Our control is only defined on the lake shore leading to a Dirichlet boundary control problem which is generally treated by using a lifting of the control from the boundary into the whole domain. We discuss the originality of the model, detail the shifting of the control and prove the existence of a global solution.

Joint work with Catherine Choquet.

Thursday 16	**Jueves 16**	**Osteguna 16**
12:00-12:20	**12:00-12:20**	**12:00-12:20**
[Room 0.27]	**[Aula 0.27]**	**[Gela 0.27]**

Existence of undercompressive travelling waves of a non-local generalised Korteweg-de Vries-Burgers equation

Xuban Diez Izagirre
(UPV/EHU)

Hyperbolic conservation laws are ill-posed in general and a common way to derive uniqueness of weak solutions are the so called regularisations. In this talk we study a non-local diffusive and dispersive regularisations of a hyperbolic conservation law given by a fractional derivative. We will analyse the travelling wave solutions in relation with shock formation and show the existence of undercompressive waves that in the limit of vanishing diffusion and dispersion lead to non-classical shocks.

Joint work with F. Achleitner and C. M. Cuesta.

Thursday 16	**Jueves 16**	**Osteguna 16**
12:30-12:50	**12:30-12:50**	**12:30-12:50**
[Room 0.27]	**[Aula 0.27]**	**[Gela 0.27]**

Modeling the Aortic Valve: A Fluid-Structure Interaction Approach Using Navier-Stokes Equations

Irene Marín-Gayte
(Universidad Loyola Andalucía)

In this talk, we will present a mathematical model based on the Navier-Stokes equations applied to simulating blood flow through the aortic valve. We will focus on the fluid-structure interaction (FSI) between the blood and valve leaflets, essential for capturing valve dynamics. Numerical simulations will demonstrate the model's real-world application, providing insights into mechanisms contributing to aortic valve calcification.

Joint work with Inmaculada Gayte Delgado.

Thursday 16	**Jueves 16**	**Osteguna 16**
16:30-16:50	**16:30-16:50**	**16:30-16:50**
[Room 0.27]	**[Aula 0.27]**	**[Gela 0.27]**

A priori estimates for the 2D one-phase Muskat problem with contact points

Edoardo Bocchi
(Politecnico di Milano)

We address the dynamics of a viscous and incompressible free surface fluid in a Hele-Shaw cell or, equivalently, in a 2D bounded region of a porous medium with vertical lateral walls. In order to close a scheme of a priori estimates, following the approach of Guo and Tice for the Stokes problem, we bootstrap from energy-dissipation control of the time derivatives to higher spatial regularity via elliptic estimates. Despite the presence of corners, we avoid weights and restrictions on the angles.

Joint work with Ángel Castro and Francisco Gancedo.

Thursday 16	**Jueves 16**	**Osteguna 16**
17:00-17:20	**17:00-17:20**	**17:00-17:20**
[Room 0.27]	**[Aula 0.27]**	**[Gela 0.27]**

Time-periodic solutions for fluids and elastic structures

Claudiu Mindrila
(BCAM)

We present some existence results for time-periodic weak solutions of systems modelling the interaction of viscous incompressible fluids with elastic structures.

Thursday 16 | **Jueves 16** | **Osteguna 16**
17:30-17:50 | **17:30-17:50** | **17:30-17:50**
[Room 0.27] | **[Aula 0.27]** | **[Gela 0.27]**

Polymeric fluid-structure interaction

Romeo Mensah
(TU Clausthal)

We analyse the finitely extensible nonlinear elastic (FENE) dumbbell model of Warner-type for an incompressible polymer fluid (described by the Navier-Stokes-Fokker-Planck equations) interacting with a flexible elastic shell. The latter occupies the flexible boundary of the polymer fluid domain and is modeled by a beam equation coupled through kinematic boundary conditions and the balance of forces. We give a description of the model and discuss the construction of solutions.

Friday 17 | **Viernes 17** | **Ostirala 17**
9:00-9:20 | **9:00-9:20** | **9:00-9:20**
[Room 0.27] | **[Aula 0.27]** | **[Gela 0.27]**

Finite-difference least square method for solving Hamilton-Jacobi equations using neural networks

Carlos Esteve Yagüe
(Universidad de Alicante)

I consider the numerical approximation of Hamilton-Jacobi equations by means of a neural network. I will discuss the choice of the loss functional, which should satisfy that any critical point approximates the viscosity solution. I will consider functionals involving a numerical Hamiltonian of Lax-Friedrichs type. Using the numerical diffusion built in the numerical Hamiltonian, we can prove that any critical point solves the associated finite-difference problem and approximates the solution.

Joint work with Richard Tsai and Alex Massucco.

arXiv:2406.10758

Friday 17	**Viernes 17**	**Ostirala 17**
9:30-9:50	**9:30-9:50**	**9:30-9:50**
[Room 0.27]	**[Aula 0.27]**	**[Gela 0.27]**

Rermarks on matching measures with ML architectures

Domènec Ruiz-Balet
(Imperial College London)

In this talk we will speak about matching measures with deep learning architectures a problem that can be casted as a type of control problem for linear and nonlinear continuity equations.

Friday 17	**Viernes 17**	**Ostirala 17**
10:00-10:20	**10:00-10:20**	**10:00-10:20**
[Room 0.27]	**[Aula 0.27]**	**[Gela 0.27]**

Kinetic modeling of social crowds with infectious disease contagion

Damián A. Knopoff
(Universidad de Deusto)

In this presentation, I will introduce a kinetic model that couples social behavior in crowds with contagion dynamics. The approach is based on thekinetic theory of active particles where the activity represents the psychological state of pedestrians and the state related to adisease (e.g., infected). The activity evolves as the crowd moves and leaves from a closed room. Some case studies are proposed to show the role of activity and how awareness and stress influence the movement and shaping.

Joint work with Juan P. Agnelli, Claudio Armas, Bruno Buffa and Germán Torres.