gazteak RSME 2025

AM07

Partial Differential Equations IV: Fluid Dynamics and Related Areas

Ecuaciones en Derivadas Parciales IV: Dinámica de Fluidos y Áreas Relacionadas

Organizers **Organizadores** **Antolatzaileak**

Antonio Hidalgo Torné
(MPI MiS Leipzig)

Luis Martínez Zoroa
(University of Basel)

Francisco Mengual Bretón
(MPI MiS Leipzig)

Elena Salguero Quirós
(MPI MiS Leipzig)

Description **Descripción** **Deskribapena**

Fluid dynamics is an essential discipline in mathematics with significant applications in the natural sciences. In this session, young researchers will present their latest results in the theoretical study of partial differential equation models arising from fluid dynamics and related areas.
Theoretical issues such as the existence and uniqueness of solutions, stability, formation of singularities, bifurcations, and asymptotic behavior in various fluid models and related problems will be explored. The session will address some of the most recent challenges in the analysis of PDEs in fluid dynamics and will promote collaboration and the exchange of ideas among young mathematicians.

La dinámica de fluidos es una disciplina esencial en matemáticas con aplicaciones significativas en las ciencias naturales. En esta sesión, jóvenes investigadores presentarán sus últimos resultados en el estudio teórico de modelos de ecuaciones en derivadas parciales que surgen de la dinámica de fluidos y áreas relacionadas.
Se explorarán cuestiones teóricas como la existencia y unicidad de soluciones, estabilidad, formación de singularidades, bifurcaciones y comportamiento asintótico en varios modelos de fluidos y problemas relacionados. La sesión abordará algunos de los desafíos

más recientes en el análisis de EDPs en dinámica de fluidos y promoverá la colaboración y el intercambio de ideas entre jóvenes matemáticos.

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

76-XX
(primary)

35-XX; 70-XX; 37-XX
(secondary)

Slots **Bloques** **Blokeak**

1.A (Aula 0.12); 1.B (Aula 0.12); 1.C (Aula 0.12)

QR Code **Código QR** **QR Kodea**

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

L13 | 17:30-17:50 | 0.12
Smooth self-similar singularity formation in fluids
Gonzalo Cao-Labora (NYU Courant)

L13 | 18:00-18:20 | 0.12
On Gavrilov-Mikado flows
Francisco Javier Torres de Lizaur (Universidad de Sevilla)

L13 | 18:30-18:50 | 0.12
On the dynamics of magma
Rafael Granero-Belinchón (Universidad de Cantabria)

L13 | 19:00-19:20 | 0.12
Global existence for certain IV evolution equations arising in Physics
Martina Magliocca (Universidad de Sevilla)

M14 | 15:00-15:20 | 0.12
Mixing and ideal dynamo with randomized ABC flows
Víctor Navarro-Fernández (Imperial College London)

M14 | 15:30-15:50 | 0.12
Traveling waves near shear flows for 2D Euler
Daniel Lear (Universidad de Cantabria)

M14 | 16:00-16:20 | 0.12
Unstable vortices and nonuniqueness for 2D Euler and SQG
Marcos Solera Diana (Universitat de València)

M14 | 16:30-16:50 | 0.12
Pre-Lie and Novikov algebras for (stochastic) (partial) differential equations
Pablo Linares Ballesteros (Universidad Autónoma de Madrid)

M14 | 17:30-17:50 | 0.12
Monitoring fluid migration from Lipschitz resistivities
María Ángeles García Ferrero (ICMAT)

M14 | 18:00-18:20 | 0.12
Regularity of isometric embeddings
Ángel D. Martínez (CUNEF Universidad)

M14 | 18:30-18:50 | 0.12
Smooth nonradial stationary Euler flows on the plane with compact support
Antonio J. Fernández (Universidad Autónoma de Madrid)

M14 | 19:00-19:20 | 0.12
Global existence and asymptotic behavior for diffusive Hamilton-Jacobi equations with Neumann boundary conditions
Joaquín Domínguez de Tena (ICMAT)

Monday 13
17:30-17:50
[Room 0.12]

Lunes 13
17:30-17:50
[Aula 0.12]

Astelehena 13
17:30-17:50
[Gela 0.12]

Smooth self-similar singularity formation in fluids

Gonzalo Cao-Labora
(NYU Courant)

We will talk about smooth singularity formation for the compressible Euler equations, with applications to compressible Navier-Stokes and to the supercritical defocusing NLS equation. This is based on a discrete countable family of smooth self-similar profiles that blow-up in finite time, which are unstable but stable in some finite codimension space. We will explain how to obtain those profiles and the tools to show their stability properties.

Joint work with Tristan Buckmaster, Javier Gómez-Serrano, Jia Shi, and Gigliola Staffilani.

arXiv:2208.09445
arXiv:2310.05325
arXiv:2410.04532

Monday 13
18:00-18:20
[Room 0.12]

Lunes 13
18:00-18:20
[Aula 0.12]

Astelehena 13
18:00-18:20
[Gela 0.12]

On Gavrilov-Mikado flows

Francisco Javier Torres de Lizaur
(Universidad de Sevilla)

Gavrilov-Mikado flows are a special class of divergence-free fields on the 3-torus that give rise to quasiperiodic solutions to the 3D Euler equations. We will review their construction and present some applications as well as open problems.

Monday 13
18:30-18:50
[Room 0.12]

Lunes 13
18:30-18:50
[Aula 0.12]

Astelehena 13
18:30-18:50
[Gela 0.12]

On the dynamics of magma

Rafael Granero-Belinchón
(Universidad de Cantabria)

In this talk we will review some recent results on the transport of deep mantle material. Such situation can be described as a buoyancy driven, cylindrical free interface between two immiscible, Stokes fluids with high viscosity contrast. In particular, we will derive a new asymptotic model for this situation and describe some of the properties of the solutions.

Monday 13
19:00-19:20
[Room 0.12]

Lunes 13
19:00-19:20
[Aula 0.12]

Astelehena 13
19:00-19:20
[Gela 0.12]

Global existence for certain IV evolution equations arising in Physics

Martina Magliocca
(Universidad de Sevilla)

We will focus on global existence and regularity results with Wiener data for certain fourth order problems. We will mainly discuss the cases of a porous-medium type equation (modeling the evolution of a thin-film liquid height spreading on a solid surface), and the one of an equation involving the hessian of the solution (modeling epitaxial growth).

Joint work with Rafael Granero-Belinchón.

Tuesday 14	**Martes 14**	**Asteartea 14**
15:00-15:20	**15:00-15:20**	**15:00-15:20**
[Room 0.12]	**[Aula 0.12]**	**[Gela 0.12]**

Mixing and ideal dynamo with randomized ABC flows

Víctor Navarro-Fernández
(Imperial College London)

In this work we consider the Lagrangian properties of a random version of the ABC flows in a three-dimensional periodic box. We prove that the flow map possesses a positive top Lyapunov exponent, and its associated Markov chains are geometrically ergodic. For a passive scalar, it follows that such a velocity is a space-time smooth exponentially mixing field, uniformly in the diffusivity coefficient. For a passive vector, it provides an example of a universal ideal kinematic dynamo.

Joint work with M. Coti Zelati.

arXiv:2407.18028

Tuesday 14	**Martes 14**	**Asteartea 14**
15:30-15:50	**15:30-15:50**	**15:30-15:50**
[Room 0.12]	**[Aula 0.12]**	**[Gela 0.12]**

Traveling waves near shear flows for 2D Euler

Daniel Lear
(Universidad de Cantabria)

In this talk we will consider the existence of traveling waves arbitrarily close to shear flows for the incompressible 2D Euler equations. In particular we will present some results concerning the existence of such solutions near Couete, Taylor-Couete and Poiseuille flows. In the first part of the talk we will introduce the problem and review some well-known results on this subject. In the second, we will outline some of the ideas underlying the construction of our traveling waves.

Tuesday 14	**Martes 14**	**Asteartea 14**
16:00-16:20	**16:00-16:20**	**16:00-16:20**
[Room 0.12]	**[Aula 0.12]**	**[Gela 0.12]**

Unstable vortices and nonuniqueness for 2D Euler and SQG

Marcos Solera Diana
(Universitat de València)

We present an alternative proof of Vishik's nonuniqueness theorem for the forced 2D Euler equation in the vorticity class $L^1 \cap L^p$, where $2 < p < \infty$. Our main contribution is the construction of a smooth, compactly supported unstable vortex. Notably, we extend this approach to the Surface Quasi-Geostrophic (SQG) equation, addressing new challenges that arise at each step and require refined techniques.

Joint work with Á. Castro, D. Faraco, and F. Mengual.

arXiv:2404.15995

Tuesday 14	**Martes 14**	**Asteartea 14**
16:30-16:50	**16:30-16:50**	**16:30-16:50**
[Room 0.12]	**[Aula 0.12]**	**[Gela 0.12]**

Pre-Lie and Novikov algebras for (stochastic) (partial) differential equations

Pablo Linares Ballesteros
(Universidad Autónoma de Madrid)

Since the works of Cayley, combinatorial structures based on trees have been applied in the description of solutions to differential equations: first for their numerical approximations (Butcher, Hairer, Wanner, etc), later in the theories of rough paths (Gubinelli) and regularity structures Hairer). A different bookkeeping based on multi-indices was introduced in works of Otto and collaborators. We will compare these two approaches and describe their algebraic structures and applications.

Joint work with Y. Bruned, F. Otro and M. Tempelmayr.

arXiv:2307.06769
arXiv:2307.03036

Tuesday 14 | **Martes 14** | **Asteartea 14**
17:30-17:50 | **17:30-17:50** | **17:30-17:50**
[Room 0.12] | **[Aula 0.12]** | **[Gela 0.12]**

Monitoring fluid migration from Lipschitz resistivities

María Ángeles García Ferrero
(ICMAT)

Electrical resistivity tomography is a geophysical technique for determining the resistivity of the interior of a structure from electrical measurements on its surface, which can be used to track the movement of fluids in the subsurface during gas drilling.
Greatly studied by mathematicians, reconstruction solutions were provided for C^2 resistivities in the 80's. In this talk, we will address the reconstruction in the case that the resistivities are only Lipschitz continuous.

Joint work with Pedro Caro and Keith M. Rogers.

Tuesday 14 | **Martes 14** | **Asteartea 14**
18:00-18:20 | **18:00-18:20** | **18:00-18:20**
[Room 0.12] | **[Aula 0.12]** | **[Gela 0.12]**

Regularity of isometric embeddings

Ángel D. Martínez
(CUNEF Universidad)

A celebrated result of Nash provides the existence of isometric embeddings with C^1 regularity in codimension two (Kuiper provided a variant to reach codimension one). Another celebrated result of Nash constructs smooth embeddings in high codimension. The precise relation of regularity and codimension is an intriguing open question. In this talk we will discuss a result that for codimension $n(n+1)/2$ claims $C^{1,1}$ regularity of (local) isometric embeddings (improving Kallen's 1978 codimension).

arXiv:2409.00440

Tuesday 14	**Martes 14**	**Asteartea 14**
18:30-18:50	**18:30-18:50**	**18:30-18:50**
[Room 0.12]	**[Aula 0.12]**	**[Gela 0.12]**

Smooth nonradial stationary Euler flows on the plane with compact support

Antonio J. Fernández
(Universidad Autónoma de Madrid)

In this talk we will show how to construct nonradial classical solutions to the 2d incompressible Euler equations. More precisely, for any positive integer k, we will see how to construct compactly supported stationary Euler flows of class $C^k(\mathbb{R}^2)$ which are not locally radial.

Joint work with Alberto Enciso and David Ruiz.

Tuesday 14	**Martes 14**	**Asteartea 14**
19:00-19:20	**19:00-19:20**	**19:00-19:20**
[Room 0.12]	**[Aula 0.12]**	**[Gela 0.12]**

Global existence and asymptotic behavior for diffusive Hamilton-Jacobi equations with Neumann boundary conditions

Joaquín Domínguez de Tena
(ICMAT)

We will present recent results on the diffusive Hamilton-Jacobi equation $u_t - \Delta u = |\nabla u|^p$, an important model in stochastic control. This equation has been extensively studied in the whole space or bounded domains with Dirichlet conditions, where gradient blow-up can occur in finite time. However, it has been less studied with Neumann conditions. We focus on the global existence and asymptotic behaviour for the Neumann problem with Lipschitz data, improving some previous results.

Joint work with Philippe Souplet.

arXiv:2409.07338