MA03

Nonlinear Dynamics and Applications

Dinámica No Lineal y Aplicaciones

Organizers **Organizadores** **Antolatzaileak**

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Description **Descripción** **Deskribapena**

One of the branches of mathematics grounded in the modeling natural processes is dynamical systems, through the study of differential equations. Furthermore, to more realistically characterize certain evolutions of the phenomena we aim to model, it is logical to lean towards models that describe a nonlinear dynamic.
The following session consists of researchers who aim to work with nonlinear models, which can be applied to study natural processes such as the movement of celestial bodies, the spread of pandemics or the evolution of species populations.

Una de las ramas de las matemáticas que se basa en la modelización de los procesos naturales es la de los sistemas dinámicos, mediante el estudio de las ecuaciones diferenciales. Además, para caracterizar de forma más realista ciertas evoluciones de dichos fenómenos es lógico inclinarse por modelos que describan una dinámica no lineal.
La siguiente sesión está formada por investigadores que trabajan con modelos no lineales que pueden aplicarse al estudio de procesos naturales como el movimiento de los cuerpos celestes, la propagación de pandemias o la evolución de las poblaciones de especies.

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

37J46

(primary)

37N05; 37D05; 37J20

(secondary)

Slots **Bloques** **Blokeak**

2.A (Aula 0.20S); 2.B (Aula 0.20S)

QR Code **Código QR** **QR Kodea**

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

J16 | 11:00-11:20 | 0.20S
Mean Motion Resonance in Saturn's Moons
Óscar Rodríguez (Universitat Politècnica de Catalunya)

J16 | 11:30-11:50 | 0.20S
Bifurcation and resonance analysis in a Celestial Mechanics model
Begoña Nicolás (Universidade de Santiago de Compostela)

J16 | 12:00-12:20 | 0.20S
Billiards with Keplerian potential: refractive and reflective case
Irene De Blasi (University of Turin)

J16 | 12:30-12:50 | 0.20S
Invariant tori in Hamiltonian systems
Álvaro Fernández-Mora (Universitat de Barcelona)

J16 | 16:30-16:50 | 0.20S
Unfolding dynamics from a coupling of two FitzHugh-Nagumo systems
Diego Noriega Rodríguez (Universidad de Oviedo)

J16 | 17:00-17:20 | 0.20S
An overview of connecting trajectories in the Earth-Moon Spatial Restricted Three-Body Problem
Miquel Barcelona (Universitat Autònoma de Barcelona)

J16 | 17:30-17:50 | 0.20S
Advances in the study of the Hide-Skeldon-Acheson system
Érika Diz Pita (Universidade de Santiago de Compostela)

J16 | 18:00-18:20 | 0.20S
Periodic solutions to superlinear indefinite planar systems: A topological degree approach
Juan Carlos Sampedro Pascual (Universidad Politécnica de Madrid)

Thursday 16	**Jueves 16**	**Osteguna 16**
11:00-11:20	**11:00-11:20**	**11:00-11:20**
[Room 0.20S]	**[Aula 0.20S]**	**[Gela 0.20S]**

Mean Motion Resonance in Saturn's Moons

Óscar Rodríguez
(Universitat Politècnica de Catalunya)

The interaction between Hyperion and Titan illustrates a 3:4 mean motion resonance. Titan, Saturn's largest moon, exerts significant gravitational influence, while Hyperion is smaller and orbits farther out. This system is well-suited for modeling via the Restricted Three-Body Problem (RTBP). We will discuss how to integrate JPL data into our model to compute periodic and quasi-periodic orbits, using Poincaré sections to analyze invariant tori and their stability.

Thursday 16	**Jueves 16**	**Osteguna 16**
11:30-11:50	**11:30-11:50**	**11:30-11:50**
[Room 0.20S]	**[Aula 0.20S]**	**[Gela 0.20S]**

Bifurcation and resonance analysis in a Celestial Mechanics model

Begoña Nicolás
(Universidade de Santiago de Compostela)

In this work we analyse a Hamiltonian system of two and a half degrees of freedom corresponding to a Restricted Three-Body Problem (RTBP) under a time-periodic perturbation that depends on two parameters. Hence, the dynamical equivalents of the Lagrangian points in this model go through different bifurcations and resonances as the parameters vary. Their analysis will help us to understand the conditions needed for the presence of stability regions in the vicinity of the triangular points.

Joint work with Joan Gimeno, Àngel Jorba and Marc Jorba-Cuscó.

Thursday 16	**Jueves 16**	**Osteguna 16**
12:00-12:20	**12:00-12:20**	**12:00-12:20**
[Room 0.20S]	**[Aula 0.20S]**	**[Gela 0.20S]**

Billiards with Keplerian potential: refractive and reflective case

Irene De Blasi
(University of Turin)

A new type of billiard system, of interest for Celestial Mechanics, is taken into consideration: here, a closed refraction interface separates two regions in which different potentials (harmonic and Keplerian) act. This model, which can be studied both in two and three dimensions, presents strong analogies with the more studied Kepler billiard, where a Keplerian inner potential is associated with a reflecting wall.

Joint work with Vivina Barutello, and Susanna Terracini.

arXiv:2105.02108
arXiv:2108.11159
arXiv:2212.01150
arXiv:2312.01312

Thursday 16	**Jueves 16**	**Osteguna 16**
12:30-12:50	**12:30-12:50**	**12:30-12:50**
[Room 0.20S]	**[Aula 0.20S]**	**[Gela 0.20S]**

Invariant tori in Hamiltonian systems

Álvaro Fernández-Mora
(Universitat de Barcelona)

We are concerned with the existence and computation of invariant tori in Hamiltonian systems. In particular, under the parameterization method, we focus on KAM schemes for invariant tori and their invariant manifolds. Such schemes can be both used for numerical implementations and to obtain the necessary theorems for existence. We will cover both aspects in this synergy between computation and rigor.

Joint work with Alex Haro, Rafael de la LLave, and Josep-María Mondelo.

arXiv:2212.00412

Thursday 16	**Jueves 16**	**Osteguna 16**
16:30-16:50	**16:30-16:50**	**16:30-16:50**
[Room 0.20S]	**[Aula 0.20S]**	**[Gela 0.20S]**

Unfolding dynamics from a coupling of two FitzHugh-Nagumo systems

Diego Noriega Rodríguez
(Universidad de Oviedo)

The FitzHugh-Nagumo oscillator is a well-known 2-dimensional system displaying a Hopf bifurcation. We explore the dynamics unfolded from the linear coupling of two identical FitzHugh-Nagumo systems on both of its variables; among others, we expect to observe a Hopf-Hopf bifurcation on the global system. We will look for non-resonance and find all possible cases in the system, paying special attention to one of them whose phase portrait theoretically contains 3-toroidal repelling orbits.

Joint work with Fátima Drubi Vega, and Santiago Ibáñez Mesa.

Thursday 16	**Jueves 16**	**Osteguna 16**
17:00-17:20	**17:00-17:20**	**17:00-17:20**
[Room 0.20S]	**[Aula 0.20S]**	**[Gela 0.20S]**

An overview of connecting trajectories in the Earth-Moon Spatial Restricted Three-Body Problem

Miquel Barcelona
(Universitat Autònoma de Barcelona)

Heteroclinic and homoclinic connections in the spatial circular restricted three-body problem play a key role in astrodynamics by providing zero-propellant transfers. This work presents results on the numerical computation of these connections between the libration points L_1 and L_2 in the Earth-Moon system, including their geometrical structure and potential applications in mission design.

Joint work with Alex Haro and Josep-Maria Mondelo.

arXiv:2301.08526

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17:30-17:50 **17:30-17:50** **17:30-17:50**
[Room 0.20S] **[Aula 0.20S]** **[Gela 0.20S]**

Advances in the study of the Hide-Skeldon-Acheson system

Érika Diz Pita
(Universidade de Santiago de Compostela)

This presentation focuses on the Hide, Skeldon and Acheson dynamical system, which models a self-excited dynamo. We provide by first time its invariant algebraic surfaces, first integrals and Darboux invariants. To show the importance and usefulness of these results, we will illustrate how they allow us to study the global dynamics with some examples, one with a first integral and another with a Darboux invariant.

Joint work with Jaume Libra, M. Victoria Otero-Espinar and Claudia Valls.

Thursday 16 **Jueves 16** **Osteguna 16**
18:00-18:20 **18:00-18:20** **18:00-18:20**
[Room 0.20S] **[Aula 0.20S]** **[Gela 0.20S]**

Periodic solutions to superlinear indefinite planar systems: A topological degree approach

Juan Carlos Sampedro Pascual
(Universidad Politécnica de Madrid)

In this talk, we deal with a general type of superlinear indefinite planar differential systems. Based on the coincidence degree theory, we prove the existence of positive T-periodic solutions. Our results generalise and unify previous contributions about Butler's problem on positive periodic solutions for second-order differential equations (involving linear or ϕ-Laplacian-type differential operators).

Joint work with Guglielmo Feltrin and Fabio Lanolin.

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