GT03

Geometric Structures in Manifolds

Estructuras Geométricas en Variedades Diferenciables

Organizers **Organizadores** **Antolatzaileak**

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Description **Descripción** **Deskribapena**

The main object of study of differential topology are differentiable manifolds. Their behavior is in many instances too flexible, so they are commonly endowed with a geometric structure which simplifies and enriches their study. Such structures can be of various types: Riemannian metrics, symplectic forms, contact distributions, complex structures, spin structures, foliations... All of them behave differently, but one can commonly observe relations between techniques from different areas.
Here we provide a link between geometers from different fields mainly focused on symplectic and contact geometry, as well as in their applications to different areas such as topology and dynamical systems.

El comportamiento de las variedades diferenciables puede resultar demasiado flexible en algunas ocasiones, por lo que se les suele agregar algún tipo de estructura geométrica que enriquezca y simplifique su estudio. Algunos ejemplos son: métricas riemannianas, formas simplécticas, distribuciones de contacto, estructuras complejas, estructuras de spin o foliaciones. Aunque cada una presenta diferentes comportamientos, en ocasiones pueden encontrarse relaciones entre las técnicas empleadas en cada área.
Con esta sesión tratamos de poner en contacto a geómetras de diferentes áreas, enfocándonos especialmente en las geometrías simpléctica y de contacto y en sus aplicaciones a la topología y a los sistemas dinámicos

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

57R17

(primary)

57R15; 37J39

(secondary)

Slots **Bloques** **Blokeak**

1.A (Aula 0.19S); 1.B (Aula 0.19S); 1.C (Aula 0.19S)

QR Code **Código QR** **QR Kodea**

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

L13 | 17:30-17:50 | 0.19S
Hodge structures on configuration spaces of orbits
Alejandro Calleja (UCM-ICMAT)

L13 | 18:00-18:20 | 0.19S
Complex and symplectic geometry in dimension 8
Luis Pizarro Golvano (Universidad de Zaragoza)

L13 | 18:30-18:50 | 0.19S
The cosymplectic Chern–Hamilton conjecture
Søren István Adorján Dyhr (Universitat Politècnica de Catalunya & Centre de Recerca Matemàtica)

L13 | 19:00-19:20 | 0.19S
On integrable contact systems and bi-Hamiltonian structures
Asier López-Gordón (Institute of Mathematics of the Polish Academy of Sciences)

M14 | 15:00-15:20 | 0.19S
Prelegendrian submanifolds in elliptic distribution
Wei Zhou (UCM-ICMAT)

M14 | 15:30-15:50 | 0.19S
Geometric formalism of Poisson-Poincaré reduction
Miguel A. Berbel (Universidad Pontificia Comillas)

M14 | 16:00-16:20 | 0.19S
Symplectic invariant connections
José Luis Carmona Jiménez (IMAR)

M14 | 16:30-16:50 | 0.19S
A Gentle Introduction to Generalized Riemannian Geometry
Jaime Pedregal Pastor (Utrecht University)

M14 | 17:30-17:50 | 0.19S
Floer Theory for the 3-Body Problem
Jagna Wiśniewska (Universitat Politecnica de Catalunya)

M14 | 18:00-18:20 | 0.19S
Morse Theory Applied to Topological Quantum Field Theories
Enrique Aycart Maldonado (Complutense University of Madrid)

M14 | 18:30-18:50 | 0.19S
A sketch of the Atiyah-Singer index theorem and its extensions
Josep Fontana McNally (Universitat Politècnica de Catalunya)

Monday 13 **Lunes 13** **Astelehena 13**
17:30-17:50 **17:30-17:50** **17:30-17:50**
[Room 0.19S] **[Aula 0.19S]** **[Gela 0.19S]**

Hodge structures on configuration spaces of orbits

Alejandro Calleja
(UCM-ICMAT)

Given an algebraic variety X with an action of an algebraic group G, we define the n-th configuration space of orbits as the set of n-tuples of points of X such that the orbits through G of these points are pairwise disjoint. In this talk we introduce these spaces and their applications to Knot Theory. We will also show how we can study the Hodge structure of these spaces by relating it to the one of X.

arXiv:2403.07765

Monday 13 **Lunes 13** **Astelehena 13**
18:00-18:20 **18:00-18:20** **18:00-18:20**
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Complex and symplectic geometry in dimension 8

Luis Pizarro Golvano
(Universidad de Zaragoza)

The objective of this talk is to ask some questions about complex non-Kähler geometry and symplectic geometry by working with some examples of homogeneous spaces that are built from a nilpotent Lie group. This type of homogeneous spaces are known as nilmanifolds and they are the key in order to build examples and counter examples in problems of geometric structures in manifolds. In addition, nilmanifolds allow you to study geometry using linear algebra and Lie Groups theory.

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The cosymplectic Chern–Hamilton conjecture

Søren István Adorján Dyhr
(Universitat Politècnica de Catalunya & Centre de Recerca Matemàtica)

We study a functional on compatible metrics on compact, 3-dimensional, cosymplectic manifolds. It generalizes the functional studied by Chern and Hamilton in 1984 for contact manifolds.
We classify which manifolds admit critical metrics by computing local forms and making explicit constructions: they are either co-Kähler or mapping tori of the 2-torus by maps conjugate to hyperbolic toral automorphisms. In the first case, the Reeb vector field is Killing, in the second it is Anosov.

Joint work with Ángel González-Prieto, Eva Miranda, and Daniel Peralta-Salas.

Monday 13 **Lunes 13** **Astelehena 13**
19:00-19:20 **19:00-19:20** **19:00-19:20**
[Room 0.19S] **[Aula 0.19S]** **[Gela 0.19S]**

On integrable contact systems and bi-Hamiltonian structures

Asier López-Gordón
(Institute of Mathematics of the Polish Academy of Sciences)

We have recently proven a Liouville-Arnol'd theorem for contact Hamiltonian systems. In this setting, one has a (2n+1)-dimensional contact manifold with n+1 functions in involution w.r.t. the Jacobi bracket, and the invariant submanifolds are n-codimensional and coisotropic. In a work in progress, we utilize Jacobi-Nijenhuis structures and extend the theory of bi-Hamiltonian systems to obtain those functions in involution in a contact manifold.

Joint work with Leonardo Colombo, Manuel de León, María Emma Eyrea Irazú, and Manuel Lainz.

arXiv:2302.12061

Tuesday 14 | **Martes 14** | **Asteartea 14**
15:00-15:20 | **15:00-15:20** | **15:00-15:20**
[Room 0.19S] | **[Aula 0.19S]** | **[Gela 0.19S]**

Prelegendrian submanifolds in elliptic distribution

Wei Zhou
(UCM-ICMAT)

The maximally non-involutive $(4, 6)$-distribution has two classes: elliptic and hyperbolic. The latter was shown to exhibit an h-principle by Javier Martínez and Álvaro del Pino. For the elliptic case, there is a natural association with a contact 7-manifold, an S^1-fibration. In this talk, we introduce the counterpart to Legendrian submanifolds in elliptic distributions and discuss the potential existence of non-isotopic PreLegendrian submanifolds in $\mathbb{R}^6$.

Joint work with Álvaro del Pino.

Tuesday 14 | **Martes 14** | **Asteartea 14**
15:30-15:50 | **15:30-15:50** | **15:30-15:50**
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Geometric formalism of Poisson-Poincaré reduction

Miguel A. Berbel
(Universidad Pontificia Comillas)

This talk presents the covariant bracket formulation of first-order Hamiltonian field theories, introducing specific polisymplectic and multisymplectic structures on the configuration bundle. When the physical system has a symmetry, a G-principal connection can be used to reduce these geometric structures and simplify its description. We focus on the Poisson-Poincaré reduction and related canonical structures that may play a crucial role in this reduction process.

Tuesday 14
16:00-16:20
[Room 0.19S]

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[Gela 0.19S]

Symplectic invariant connections

José Luis Carmona Jiménez
(IMAR)

Homogeneous spaces are differentiable manifolds with a transitive action of a Lie group. The Ambrose-Singer Theorem characterizes Riemannian homogeneous spaces through an invariant tensor that satisfies covariant equations and is central to the Tricerri-Vanhecke program, which focuses on Riemannian homogeneous manifolds. However, it is limited to metric cases.
We present a generalization of the Ambrose-Singer Theorem for non-metric instances and apply this to symplectic homogeneous manifolds.

Joint work with Marco Castrillón López.

arXiv:2001.06254

Tuesday 14
16:30-16:50
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[Aula 0.19S]

Asteartea 14
16:30-16:50
[Gela 0.19S]

A Gentle Introduction to Generalized Riemannian Geometry

Jaime Pedregal Pastor
(Utrecht University)

Generalized geometry has proven to be a powerful unifying framework for different geometries such as complex, symplectic, Poisson and the like. The theory of generalized metrics has led to further links to other geometries, e.g. bihermitian geometry, which are also of interest in supersymmetric sigma models in string theory. In this talk we will give a gentle introduction to generalized geometry, focusing in particular on the Riemannian aspect of the theory.

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Floer Theory for the 3-Body Problem

Jagna Wiśniewska
(Universitat Politecnica de Catalunya)

In my talk I will explain how to use tools from symplectic geometry and Hamiltonian dynamics to tackle the following problem: Can we send a rocket between any two points in the gravitational field of the Moon and the Earth, using the engines only at the beginning and at the end of the journey?

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Morse Theory Applied to Topological Quantum Field Theories

Enrique Aycart Maldonado
(Complutense University of Madrid)

Topological Quantum Field Theories (TQFTs) are powerful algebro-geometric tools that provide us with a new way of computing topological and algebraic invariants of closed manifolds. In particular, cobordism categories play a fundamental role in the formulation of TQFTs, providing a geometric framework that connects category theory, topology and theoretical physics. We will focus on the application of Morse theory to the study of the two-dimensional case and the associated bicategory of bordisms.

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A sketch of the Atiyah-Singer index theorem and its extensions

Josep Fontana McNally
(Universitat Politècnica de Catalunya)

The Atiyah-Singer index theorem brings together ideas from analysis, geometry, and topology, and generalizes many important results such as the Gauss-Bonnet and Riemann-Roch theorems. In this talk, we present the key objects in the statement, sketch one of the different proofs that have been given, and describe an extension to manifolds with boundary. We discuss how this last extension is the starting point of b-geometry, a framework to work with singular differential forms.