XXII Winter Meeting on Geometry, Mechanics and Control (Zoom meeting)

Registration

PROGRAM

February 18

16:00-17:00	Alberto Ibort
17:00-17:30	Víctor Jiménez
17:30-18:00	Coffee break
18:00-18:30	Jordi Gaset
18:30-19:00	César Romaniega

February 19

16:00-16:30	Alexandre Anahory
16:30-17:00	Iván Gutiérrez
17:00-17:30	Coffee break
17:30-18:00	M. Lainz

ABSTRACTS

A. Ibort (Universidad Carlos III de Madrid & Instituto de Ciencias Matemáticas): Is Classical Mechanics classical? (50 minutes)

Abstract: The description of a dynamical system as elaborated by Lagrange or Hamilton, and their modern dressing under the name of Geometrical Mechanics, constitute the epitome of "classical physics", in contraposition with the always misterious and imposing quantum one. The modern descrition of quantum systems provided by the groupoidal interpretation of Schwinger's quantum mechanics tells us a different story. There is a classical counterpart to any quantum system, true, but it is not the rich dynamical behaviour provided by Lagrangian and Hamiltonian mechanics, but rather the static description provided by Thermodynamics. On the other hand, the familiar dynamical descriptions, with their associated geometries, arise as natural approximations to the quantum full description, allowing to interpret the geometrical structures of Classical Mechanics as vestigial quantum remnants.

A. Anahory (Intituto de Ciencias Matemáticas): Kinetic nonholonomic trajectories are Riemannian geodesics! (25 minutes)

Abstract: Nonholonomic mechanics describes the motion of systems subjected to velocity (nonintegrable) constraints. One of its most remarkable properties is that the derivation of the nonholonomic equations is not variational in nature. However, in a recent pre-print, we proved that for kinetic nonholonomic systems, the solutions starting from a fixed point are true geodesics for a family of Riemannian metrics on the image submanifold of the nonholonomic exponential map. This implies a surprising result: the kinetic nonholonomic trajectories with fixed starting point are, for sufficiently small times, length minimizing.

Jordi Gaset (Universitat Autònoma de Barcelona): Utiyama's Theorem and its Generalizations (25 minutes)

Abstract: In his original paper on invariant interactions, Utiyama proved a result (now known as Utiyama's theorem) that classified gauge invariant function on the bundle of connections. This is one of the cornerstone ideas of Yang-Mills theories. The result has been generalized and geometrized over the decades, but there are still open questions. In this talk I will present the major milestones in the evolution of Utiyama's theorem. I will show the difficulties of the higher-order case for non-abelian groups, and our attemps (together with Marco Castrillón) of solving it. Finally, I will highlight open problems and possible applications that arise from these ideas.

Iván Gutiérrez Sagredo (Universidad de Burgos): Hamiltonian structure of compartmental epidemiologial models (25 minutes)

Abstract: In this talk, I will present a recent result that shows that any epidemiological compartmental model with constant population is shown to be a generalized Hamiltonian dynamical system in which the total population plays the role of the Hamiltonian function. Moreover, some particular cases within this large class of models will be shown to be bi-Hamiltonian. New interacting compartmental models among different populations, which are endowed with a Hamiltonian structure, will be introduced. The Poisson structures underlying the Hamiltonian description of all these dynamical systems will be explicitly presented, and their associated Casimir functions will be shown to provide an efficient tool in order to find exact analytical solutions for epidemiological models.

Victor Jiménez (Universidad de Alcalá): Groupoids in continuum mechanics: from remodeling to aging (25 minutes)

Abstract: For any body-time manifold $\R\times B$, it can be defined some canonical groupoids, called *material groupoids*, encoding all the material properties of the evolution material. In paticular, we use these groupoids to characterize *aging* and *remodeling* of materials. Smooth distributions, the *material distributions*, are constructed to deal with the case in which the material groupoids are not Lie groupoids. This new tool gives us a unified framework to deal with the evolution of general non-uniform materials.

M. Lainz Valcázar (Instituto de Ciencias Matemáticas): Contact geometry and thermodynamic systems: the evolution vector fields (25 minutes)

Abstract: On a contact manifold (M, η), given a Hamiltonian function H one can naturally define the Hamiltonian vector field X_H. The evolution vector field $E_H = X_H + H R$, where R is the Reeb vector field can also be constructed from the Hamiltonian function and the contact structure alone. This vector field coincides with the Hamiltonian vector field on the zero set of the Hamiltonian, but differs from it on the rest of M. The evolution vector field is always tangent to the kernel of the contact form. The thermodynamic interpretation of this fact is that its integral curves fulfill the first law of thermodynamics. In addition, with a simple assumption on the Hamiltonian, the second law of thermodynamics is fulfilled.

On this talk, we will explain the geometric and dynamical properties of this vector field and its applications to the description of isolatedt hermodynamic systems. If time permits, we will also show how to generalize this construction to composed systems. In this context, contact geometry does not model correctly the dynamics, and we need to use different geometric structures.

[1] Simoes Alexandre Anahory, de León Manuel, Valcázar Manuel Lainz and de Diego David Martín. 2020, *Contact geometry for simple thermodynamical systems with friction*. Proc. R. Soc. A. 476:20200244. http://doi.org/10.1098/rspa.2020.0244

[2] A. A. Simoes, D. M. de Diego, M. L. Valcázar, and M. de León, *The geometry of some thermodynamic systems*, arXiv:2012.07404 [math-ph], Dec. 2020, Accessed: Jan. 12, 2021. [Online]. Available: http://arxiv.org/abs/2012. 07404.

César Romaniega (Universidad de Valladolid): Influence of geometry on the Casimir pressure for cavity configurations (25 minutes)

Abstract: The Casimir effect, as one of the major macroscopic manifestations of quantum field theory, plays a fundamental role in micrometer and nanometer scale physics. The experimental accessibility, together with the possibility of technological applications, requires a comprehensive knowledge of this phenomena. Although this is the case for simple configurations, we lack general theorems regarding the strong dependence of the force on geometry and boundaries. For instance, whether the force between two arbitrary bodies is attractive or repulsive has only been determined for a mirror symmetric arrangement of objects.

In this talk, I will consider the interaction pressure acting on the surface of a dielectric sphere enclosed within a magnetodielectric cavity. The sign of this quantity can be determined regardless of the geometry of the cavity for systems at thermal equilibrium, extending the Dzyaloshinskii-Lifshitz-Pitaevskii result for homogeneous slabs. As in previous theorems regarding Casimir-Lifshitz forces, the result is based on the scattering formalism. In this case the proof follows from the variable phase approach of electromagnetic scattering. Finally, I will present configurations in which both the interaction and the self-energy contribution to the pressure tend to expand the sphere.