**PhD POSITION IN DYNAMICAL, GEOMETRIC AND NUMERICAL ASPECTS OF MULTI-AGENT CONTROL SYSTEMS FOR ROBOTICS APPLICATIONS AT THE ICMAT FOR THE INPhINIT PROGRAMME**

**Job Position title:** PhD in dynamical, geometric and numerical aspects of multi-agent control systems for robotics applications.

**Research project/ group description**

Dynamical systems are central in the study of evolutionary problems and they pervade all of the applied mathematics literature for both finite and infinite dimensional systems. Dynamical systems are typically classified into two categories: when the time is a continuous variable, and the dynamical system under study takes the form of a differential equation; and, when time is a discrete variable, and the dynamical system is a difference equation. Prof. David Martin de Diego and Dr. Leonardo Colombo are part of the research group GEONUMA (Geometric and Numerical Analysis of Dynamical Systems and Applications to Mathematical Physics). The group study fundamental problems through geometric and numerical analysis of dynamical systems combining both the continuous and discrete points of view.

The research interests of GEONUMA include geometric methods for dynamical systems, integrability in fluid dynamics, constitutive theories for materials, numerical simulations and geometric integration of mechanical systems, among others. This group is attested by the number of publications in high impact journals, the international funding obtained (ERC StG, H2020 Program, La Caixa Programme: Junior Leader and INPhINIT, Bilateral projects, National projects...) and the training of predoctoral students and postdoctoral researchers. The research group interests seek mutual enrichment in the fields of geometric mechanics, dynamical systems, control theory and optimization, geometric integration and mechanics of materials.

The research group has 4 graduate students, 2 postdoctoral fellows, 2 Master students, several associated undergraduate students, an Associated Professor from Universidad Politécnica de Madrid and three group leaders (Manuel de Leon, David Martin de Diego and Daniel Peralta Salas) working in several aspects of the above topics. We have regular seminars and groups meetings, several international visitors every year, and workshops, summer schools and conferences organized by the group each year. The members of the group also have different interests and collaborate with different international group leaders within the thematic of this Ph.D. position (University of Michigan, University of Groningen, EECS-KTH, Delft University, University of Oxford, University of California San Diego, etc.).

**Job position description**

The PhD candidate is expected to enroll a research training program with researcher leaders in the field, participate in the group activities (seminars, courses, conferences, summer schools, young researchers workshops, etc.), have regular meetings with her/his supervisor and the research group, and work in the proposed research topic. The position will be co-advised with Dr. Leonardo Colombo who is a Junior Leader Fellow from La Caixa Foundation and specialist in multi-agent systems.
Proposed Project's Title: Geometric integration for cooperative motion of multi-agent systems

The systems under study consist of simple robots with a desired collective behavior emerging from the interactions among individual robots and the environment. The usage of robots in a coordinated fashion is a reality in many tasks such as area exploration & surveillance. These tasks have practical applications in the society such as rescue missions in disaster areas or exploration missions. We are interested on investigate swarms of robots modeled by controlled Lagrangian, Hamiltonian and port-Hamiltonian systems. Within this research project, the goal is to build:

(i) A continuous-time decentralized methodology for motion planning of the agents to accomplish mission specifications given the dynamics of each robot and the geometry of the network defining its interactions.

(ii) From a realistic analysis perspective, the multi-agent systems under study are large-scale control systems and we will try to extract a smaller abstracted system with equivalent properties. Therefore, analyzing the dynamics and control properties of the abstracted system, gives us information about the properties on the original system. This last property is very important for control design.

(iii) Develop new geometric integrators for multi-agent systems with realistic specifications, for instance, incorporating barrier function characterizing the safe zones for the multi-agent systems and abstractions of the system for real-time computation of the trajectories of the agents.

The research will be enriched by the collaboration with others research groups in Europe and US as the Research group of Prof. Dimos Dimarogonas at EECS-KTH, Sweden, Prof. Ming Cao in University of Groningen, Prof. Manuel Mazo Jr. at Delf University and Prof. Anthony Bloch at University of Michigan. USA.

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David Martin’s website: [https://www.icmat.es/dmartin](https://www.icmat.es/dmartin)

**Other relevant websites:** GEONUMA’s website: [https://www.icmat.es/research/national-grants/GEONUMA/index.php](https://www.icmat.es/research/national-grants/GEONUMA/index.php)

Website of the ICMAT’s group on Differential Geometry and Geometric Mechanics: [https://www.icmat.es/research/groups/group5](https://www.icmat.es/research/groups/group5)

**Links to the INPhINIT 2020 Incoming Open Call:**

**Programme description:** [https://obrasociallacaixa.org/en/investigacion-y-becas/programa-de-becas-de-posgrado/inphinit/incoming](https://obrasociallacaixa.org/en/investigacion-y-becas/programa-de-becas-de-posgrado/inphinit/incoming)

**Application website:** [https://www.lacaixafellowships.org/index.aspx](https://www.lacaixafellowships.org/index.aspx)

**Programme rules here.**

**PhD position finder:** [https://hosts.lacaixafellowships.org/finder](https://hosts.lacaixafellowships.org/finder)