

DOCTORAL INPhINIT FELLOWSHIPS PROGRAMME – INCOMING - CALL 2022

**PHD POSITION IN “APPLIED MATHEMATICS:
MATHEMATICS OF QUANTUM INFORMATION THEORY” AT THE
ICMAT FOR THE INPhINIT PROGRAMME**

Job Position title: PhD in Applied Mathematics: Mathematics of Quantum Information Theory

Research project/ group description

ICMAT RESEARCH GROUP C: APPLIED MATHEMATICS

This research group works with mathematical foundations and models needed to deal with new societal challenges, with a focus on Data Science, Machine Learning and Quantum Technologies.

The main research lines may be grouped into the following general directions:

- **Mathematics of Quantum Information Theory:** Quantum technologies are one of the most promising technologies for the near future. They exploit quantum effects to develop new techniques in cryptography, metrology, material science, pharmacology, etc., which have the potential to go far beyond the current state of the art. Some of the mathematical problems are related to condense matter and many body systems, quantum control, foundational aspects of quantum mechanics and the theory of operator algebras.
- **Machine Learning and Data Science:** Machine learning and Data Science are disciplines at the core of many current significant societal developments. Embedded in the disciplines of Statistics, Probability, Optimization and Algebra, with strong support from Computer Science developments, this line focuses on providing efficient Bayesian approaches to the treatment of large scale inference and prediction problems and methods through adversarial risk analysis and adversarial machine learning. Moreover, it also emphasizes dealing with complex applied problems mainly in the areas of security and cybersecurity, with the aid of its DataLab.
- **Mathematical Modelling and Simulation:** This covers a wide spectrum ranging from the multidisciplinary mathematical approach to the problems, with emphasis in numerical computation, to the promotion of applications in engineering, biology, physics and earth sciences. Research include topics such as microfluidics modelling and technological applications, geophysical fluid dynamics, etc.

The group is formed by the following faculty members:

M.A. Fontelos, A. Ibort, F. Lledó, C. Palazuelos, D. Pérez, C. Rascón, D. Ríos, I. Villanueva.

Job position description

Quantum Information and Computation is positioning as one of the most promising emergent technologies. Since it is a rather new theory, its associated mathematical toolbox is still very much under construction. In this project, the PhD candidate will consider the central problem of understanding multipartite entanglement in some of its many facets, such as quantum non-locality, topological quantum systems or many body quantum control.



The PhD candidate will work on the most promising associated mathematical theories (operator spaces and algebras, tensor networks, Lie groups, ...) to show how they allow to produce important steps forward in some of the key applications of multipartite entanglement: quantum cryptography, quantum computing (including quantum inspired classical algorithms), quantum memories, quantum complexity theory or machine learning (both classical and quantum).

The PhD candidate will be appointed a supervisor among the faculty members of the Group, with whom regular meetings will be held. He/she will be expected to participate in the group activities including seminars and conferences, interacting with visitors and international colleagues. ICMAT will also provide counselling to help the PhD candidate develop a successful research career.

Research Group Contact: D. Pérez (dperezga@ucm.es) and F. Lledó (fernando.lledo@icmat.es) **Research Group website:**

ICMAT RESEARCH GROUP C: APPLIED MATHEMATICS: <https://www.icmat.es/researchers/groups/group-c/>

Links to the INPhINIT 2022 Incoming Open Call:

Programme description: <https://fundacionlacaixa.org/en/educacion-becas/becas-la-caixa/doctorado-inphinit/descripcion-del-programa>

Application website: <https://candidate.lacaixafellowships.org/login>

Programme rules [here](#).

PhD position finder: <https://hosts.lacaixafellowships.org/finder>