

Expression of interest 1:

THE ROLE OF DENDRITES IN INFORMATION PROCESSING IN NEURONS – we invite **postdoctoral candidates** for a [Marie Skłodowska-Curie Individual Fellowship](#) to contact us by **30th July 2019**.

Type: Hosting

Location: Spain

Company/Institute: Institute for Cross-Disciplinary Physics and Complex Systems, University of the Balearic Islands- Spanish National Research Council

Contact person/ Scientist in charge: Dr. Claudio Mirasso claudio@ifisc.uib-csic.es

Brief description of the project:

This research project is carried out in collaboration with the Institute of Neurosciences (IN), San Juan de Alicante, Spain. As part of the [Marie Skłodowska-Curie actions](#) (MSCA), a prestigious funding scheme offered by the **European Commission** to finance postdoctoral research projects, we invite researchers/ postdoctoral candidates from any country of origin with no age limit to apply at the **Institute for Cross-Disciplinary Physics and Complex Systems, University of the Balearic Islands (Mallorca, Spain)- Spanish National Research Council** as **host institute**.

To gain insight into the mechanisms that our brain uses to perform complex mental operations, an interdisciplinary approach and the combination of mathematical models and experiments are desirable. From the modeling point of view, most of the studies carried out so far have considered neuronal models involving single-compartment neurons, i.e., neurons have been assumed as single point with a membrane potential that mostly described what occurs in the axon, neglecting any effect of dendrites, which represent the most elaborated part of a neuron. However, numerous types of neurons populate the brain, each with its own dendritic arbor with a characteristic morphology and electrical properties. These features influence many aspects of a neuron's function, including the number and type of presynaptic inputs and how these inputs are integrated to determine the neuron's firing properties. Although quite successful, single-compartment models are clearly insufficient when addressing the issue of information processing and communication. In this project we aim at working in a theoretical/numerical-experimental environment to gain insight into the aspects of information coding in the brain. We plan to extend commonly used single-compartment neuronal models to include the effects that dendrites have on information processing and transmission. In particular, active and passive dendrites with single or multiple branches will be considered as well as the effects that the combination of excitation and inhibition have on these dendrites.

Brief description of the Research Group

IFISC (Institute for Cross-Disciplinary Physics and Complex Systems) is a joint research institute of the **University of the Balearic Islands (UIB)** and the **Spanish National Research Council (CSIC)**. Its mission is to develop Cross-Disciplinary and Strategic Research in complex systems following the established scientific approach of physicists. As a recognition of its scientific leadership and impact, IFISC has been awarded the "**Unit of Excellence Maria de Maeztu**", a unique seal received by organizational structures with highly competitive strategic research programmes in the frontiers of knowledge and which are among the best in the world in their respective scientific areas. <https://ifisc.uib-csic.es>

Research lines within the Maria de Maeztu Unit of Excellence include:

1. INFORMATION PROCESSING IN BIOLOGICAL SYSTEMS (Information processing in biochemical networks, brain circuits and structures, and ecological networks; Genetic diversity in ecosystems and its response to environmental changes; Biodiversity patterns, especially in microbial communities; alternative ways to encode and store information).

2. BRAIN-INSPIRED ANALOG COMPUTING IN PHOTONIC AND ELECTRONIC SYSTEMS (Hardware implementations of reservoir computing and their applications in telecom and Datacom; Development of novel computing concepts, theoretical framework for scaling and modelling; Autonomous operation of recurrent networks).
3. QUANTUM INFORMATION: DECOHERENCE, DISSIPATION AND TRANSMISSION (Emergent quantum phenomena and information retrieval in extended and network systems; New functionalities based on nanoelectronic devices; Information processing using quantum materials).
4. INFORMATION PROCESSING IN SOCIO-TECHNICAL SYSTEMS (Evolution of social-system and processing of information: opinion, consensus, meme spreading, fake news, etc.; Studies of mobility of people and animals; Data-driven modelling and response of urban systems to external perturbations).

Brief description of the university

The **University of the Balearic Islands**, Palma de Mallorca is one of the country's leading universities in teaching, research, international cooperation and technological development and innovation. The UIB is a time-honored member of prominent international university networks, it has attracted countless students from abroad and successfully joined the European Space for Higher Education.

CSIC (Spanish National Research Council), part of the Spanish Ministry of Science, Innovation and Universities, is Spain's largest public research institution, and ranks third among Europe's largest research organizations. It carries out research in all fields of knowledge, throughout its 123 Institutes.

Research area

- Physics, Neuroscience, Mathematics

Applications (documents to be submitted)

- Motivation letter
- CV
- summary of project
- At least one reference letter

Deadline: 30th July 2019

Expression of interest 2:

Open Quantum Systems--> emergent phenomena in complex quantum systems; Quantum Machine Learning; Quantum Synchronization; Quantum Networks- we invite **postdoctoral candidates** for a [Marie Skłodowska-Curie Individual Fellowship](#) to contact us by **30th July 2019**

Type: Hosting

Location: Spain

Company/Institute: Institute for Cross-Disciplinary Physics and Complex Systems, University of the Balearic Islands- Spanish National Research Council

Contact person/ Scientist in charge: Dr. Roberta Zambrini, roberta@ifisc.uib-csic.es

Brief description of the project:

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The project can fall into the following research areas:

- Open Quantum Systems--> emergent phenomena in complex quantum systems;
- Quantum Machine Learning;
- Quantum Synchronization;
- Quantum Networks.

Brief description of the Research Group

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2. **BRAIN-INSPIRED ANALOG COMPUTING IN PHOTONIC AND ELECTRONIC SYSTEMS** (Hardware implementations of reservoir computing and their applications in telecom and Datacom; Development of novel computing concepts, theoretical framework for scaling and modelling; Autonomous operation of recurrent networks)
3. **QUANTUM INFORMATION: DECOHERENCE, DISSIPATION AND TRANSMISSION (Emergent quantum phenomena and information retrieval in extended and network systems; New functionalities based on nanoelectronic devices; Information processing using quantum materials)**
4. **INFORMATION PROCESSING IN SOCIO-TECHNICAL SYSTEMS** (Evolution of social-system and processing of information: opinion, consensus, meme spreading, fake news, etc.; Studies of mobility of people and animals; Data-driven modelling and response of urban systems to external perturbations).

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Research area

- Quantum Physics

Applications (documents to be submitted)

- Motivation letter
- CV
- summary of project
- At least one reference letter

Deadline: 30th July 2019

Expression of interest 3:

Power grid stability under demand stress and cascading failures - we invite **postdoctoral candidates** for a [Marie Skłodowska-Curie Individual Fellowship](#) to contact us by 30th July 2019

Type: Hosting

Location: Spain

Company/Institute: Institute for Cross-Disciplinary Physics and Complex Systems, University of the Balearic Islands- Spanish National Research Council

Contact person/ Scientist in charge: Prof. Pere Colet, pere@ifisc.uib-csic.es

Brief description of the project:

As part of the [Marie Skłodowska-Curie actions](#) (MSCA), a prestigious funding scheme offered by the **European Commission** to finance postdoctoral research projects, we invite researchers/postdoctoral candidates from any country of origin with no age limit, skilled in **mathematical modeling, computing, data collection and analysis** to apply at the **Institute for Cross-Disciplinary Physics and Complex Systems, University of the Balearic Islands in Mallorca-Spanish National Research Council, Spain** as host institute.

The power grid is, arguably, the largest socio-technical system in the world. Stable operation requires the synchronization of the power plants and a precise balance between generation and consumption. The balance is not easy to achieve due to the random character of (part of) the load and the increasing use of renewable sources which are subject to uncontrollable factors, such as wind or sunlight. Large demand changes, such as those occurring at touristic areas in high season further stress the system. We aim at using big data from ICT sources to determine the spatio-temporal distribution of population in order to infer the energy demand in different areas. With this input we will study the stability and resilience of prototypical grids as well as of specific power grids in touristic regions such as the Balearic Islands, including the effect of stochastic demand. We also aim to analyze the effect on the stability resulting from a growing amount of local generation (prosumers), the progressive transition to renewable power plants (wind and photovoltaic) and the incorporation of demand side management methods.

Brief description of the Research Group

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Research areas

- [Physics, Computer Science, Engineering, Applied Mathematics](#)

Applications (documents to be submitted)

- Motivation letter
- CV
- summary of project
- At least one reference letter

Deadline: 30th July 2019

Expression of interest 4

Socio-technical systems (big data, mobility and social interactions, the multilevel structure of urban systems)- we invite **postdoctoral candidates** for a [Marie Skłodowska-Curie Individual Fellowship](#) to contact us by **30th July 2019**

Type: Hosting

Location: Spain

Company/Institute: Institute for Cross-Disciplinary Physics and Complex Systems, University of the Balearic Islands- Spanish National Research Council

Contact person/ Scientist in charge: José Javier Ramasco, jramasco@ifisc.uib-csic.es

Brief description of the project:

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Related topics of research: **socio-technical systems (big data, mobility and social interactions, the multilevel structure of urban systems)**.

Social interactions as well as the relation between people and the environment are registered in real time with unprecedented detail. This raises questions on the limits of privacy but also provides information, for instance, on transport demand and on land use in urban systems that before could be only obtained with painstaking survey processes. In previous works, it has been shown that cities are characterized by the presence of centers of activity that mediate the mobility patterns. It is important to go beyond and categorize such centers, the relations between them in terms of mobility and activity correlations, and to explore how the center hierarchy (in case of existence) is proper of the different urban areas or a generic feature.

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Research areas

- Physics, Computer Science, Applied Math

Applications (documents to be submitted)

- Motivation letter
- CV

- summary of project
 - At least one reference letter
- Deadline: 30th July 2019**

Expression of interest 5

Complex phenomena in nonlinear photonic systems: experimental implementation, characterization and modelling. Cognitive computing implementations and reservoir computing using photonic systems - we invite **postdoctoral candidates** for a [Marie Skłodowska-Curie Individual Fellowship](#) to contact us by **30th July 2019**

Type: Hosting

Location: Spain

Company/Institute: Institute for Cross-Disciplinary Physics and Complex Systems, University of the Balearic Islands- Spanish National Research Council

Contact person/ Scientist in charge: Ingo Fischer, ingo@ifisc.uib-csic.es

Brief description of the project:

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Related topics of this Research Group: **Complex phenomena in nonlinear photonic systems: experimental implementation, characterization, modelling and application. Cognitive computing implementations and reservoir computing using photonic systems.**

We have been pioneering applications to exploit the complex behavior of nonlinear photonics systems for information technologies. These applications include neuro-inspired information processing, cognitive computing, random bit sequence generation and encrypted communication. Our studies are based on a variety of photonic systems, with an emphasis on semiconductor laser systems. Current experimental systems include delayed-feedback systems, delay-coupled systems, laser networks, as well as spatially extended systems. Our main aim is to bridge the fundamental understanding of these systems with their utilization for novel functionalities.

We are currently witnessing a revolution in novel computing concepts and implementations, and photonics offers an attractive potential. Electronic computers, based on the concept of the von-Neumann machine, are facing some technological challenges. They are not optimized to tackle certain tasks, including speech and dynamic pattern recognition. Also the power consumption of von-Neumann machines for artificial intelligence call for alternative concepts and hardware.

Among these new concepts, brain-inspired information processing and cognitive computing are gaining attention offering fascinating opportunities. In recent years, we have been developing learning-based brain-inspired information processing concepts using lasers. With a minimal design approach and using standard telecommunication components, we have been implementing recurrent network-based concepts like reservoir computing and feedforward-based concepts like extreme learning machines. Our photonic architectures can tackle computationally hard tasks, including speech recognition and nonlinear prediction with high processing speed, exhibiting excellent performance and energy efficiency.

We aim at extending these photonic information processing concepts. The targeted extensions include using multiple hidden layer architectures to process multiscale data and to combine

temporal and spatial multiplexing. Based on these extended architectures, we will address real-world tasks in communication networks, ultimately allowing for an integration of communication and computation.

Brief description of the Research Group

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Research areas

- Physics

Applications (documents to be submitted)

- Motivation letter
- CV
- summary of project
- At least one reference letter

Deadline: 30th July 2019

Expression of interest 6

Quantum correlation and interaction effects in mesoscopic conductors driven out of equilibrium- we invite **postdoctoral candidates** for a [Marie Skłodowska-Curie Individual Fellowship](#) to contact us by **30th July 2019**

Type: Hosting

Location: Spain

Company/Institute: Institute for Cross-Disciplinary Physics and Complex Systems, University of the Balearic Islands- Spanish National Research Council

Contact person/ Scientist in charge: David Sánchez, david.sanchez@uib.es

Brief description of the project:

As part of the [Marie Skłodowska-Curie actions](#) (MSCA), a prestigious funding scheme offered by the **European Commission** to finance postdoctoral research projects, we invite researchers/ postdoctoral candidates from any country of origin with no age limit to apply at the **Institute for Cross-Disciplinary Physics and Complex Systems, University of the Balearic Islands- Spanish National Research Council, Mallorca, Spain** as **host institute**.

Related topics of this Research Group: **Quantum correlation and interaction effects in mesoscopic conductors driven out of equilibrium.**

We elaborate theoretical models to understand quantum correlation and interaction effects in mesoscopic conductors driven out of equilibrium by means of external perturbations (electric fields, temperature gradients) and in the presence of novel and exotic materials, as topological systems, graphene or superconductors. Our main focus is on nonlinear and time-dependent transport of heat, charge and spin in nanoelectronic devices. Although we are a theory group, we have collaborations with experimental groups worldwide (Würzburg, ETH Zürich, Lund, Stanford).

Brief description of the Research Group

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Brief description of the university

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Research areas

- Physics

Applications (documents to be submitted)

- Motivation letter
- CV
- summary of project
- At least one reference letter

Deadline: 30th July 2019

Expression of interest 7:

Modeling and understanding the dynamics of social systems - we invite **postdoctoral candidates** for a [Marie Skłodowska-Curie Individual Fellowship](#) to contact us by 30th July 2019

Type: Hosting

Location: Spain

Company/Institute: Institute for Cross-Disciplinary Physics and Complex Systems, University of the Balearic Islands-Spanish National Research Council

Contact person/ Scientist in charge: Prof. Raúl Toral, raul@ifisc.uib-csic.es

Brief description of the project:

As part of the [Marie Skłodowska-Curie actions](#) (MSCA), a prestigious funding scheme offered by the **European Commission** to finance postdoctoral research projects, we invite researchers/postdoctoral candidates from any country of origin with no age limit, skilled in **mathematical modeling, computing, data collection and analysis** to apply at the **Institute for Cross-Disciplinary Physics and Complex Systems, University of the Balearic Islands- Spanish National Research Council, Mallorca, Spain** as **host institute**.

The research to be carried out can fall into any of the following lines:

1. Aging in models of social processes
2. Game theory and evolution dynamics
3. Coevolution of network topology and dynamics
4. Search algorithms and rare events
5. The role of delay in social dynamics

Brief description of the Research Group

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Research areas

- [Physics](#), [Computer Science](#), [Applied Mathematics](#)

Applications (documents to be submitted)

- Motivation letter
- CV
- summary of project
- At least one reference letter

Deadline: 30th July

Expression of interest 8:

CONNECTIVITY AND THREE-DIMENSIONAL DYNAMICS IN OCEAN TRANSPORT. IMPLICATIONS FOR MARINE ECOSYSTEMS.

We invite **postdoctoral candidates** for a [Marie Skłodowska-Curie Individual Fellowship](#) to contact us by **30th July 2019**

Type: Hosting

Location: Spain

Company/Institute: Institute for Cross-Disciplinary Physics and Complex Systems, University of the Balearic Islands-Spanish National Research Council

Contact person/ Scientist in charge: [Emilio Hernández-García, emilio@ifisc.uib-csic.es](mailto:emilio@ifisc.uib-csic.es)

Brief description of the project:

As part of the [Marie Skłodowska-Curie actions](#) (MSCA), a prestigious funding scheme offered by the **European Commission** to finance postdoctoral research projects, we invite researchers/postdoctoral candidates from any country of origin with no age limit to apply at **IFISC, the Institute for Cross-Disciplinary Physics and Complex Systems (University of the Balearic Islands-Spanish National Research Council) in Mallorca, Spain** as **host institute**.

We have been pioneering innovative approaches to the study of Lagrangian transport in the oceans, using methodologies from the mathematical theories of dynamical systems and complex networks, and combining them with reanalysis, satellite, and in situ data of the state of the sea and of biological populations living there. We aim to expand further these approaches, and to improve the understanding of couplings between physical dynamics and biological processes in the marine environment. To this end we are open to host candidates with a background suitable to study of the impact of the oceanic motions, in particular vertical velocities, on transported marine biogeochemical substances. We plan to characterize the three-dimensional skeleton of transport in different areas of the seas and analyze how it influences the transport of carried substances ranging from abiotic (temperature, salinity), marine particulate organic matter (detritus, marine snow, phytoplankton, non-swimming zooplankton) to higher trophic levels in the marine web (mammals). Specific problems that are of our interest are: sedimentation of biogenic particles, the cross-shore transport of temperature and salinity by coastal filaments, the role of subduction movements in open-water fronts, or the impact on the movement of some marine mammals (elephant seals). Connectivity between marine populations is also a subject of interest in this context. Our main focus will be in the western Mediterranean Sea but also analyze other areas where data is available: Iberian Peninsula upwelling region, Benguela upwelling zone and Southern Ocean around the Kerguelen Islands. In all of them, we also want to develop theoretical approximations for the transport of non-passive substances driven by a flow, which may be of importance for the transport of large particles and organisms or a more accurate description of plastic dispersion.

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IFISC's research lines:

Transport and Information in Quantum Systems: quantum transport for charge (nanoelectronics), spin (spintronics), energy (thermoelectrics) and information (quantum correlations), with a particular focus on nanostructures. Moreover, we investigate decoherence effects in complex environments, explore quantum probing, and emergent phenomena such as synchronization, with a focus on quantum correlations and thermodynamics and their impact on information processing.

Nonlinear Photonics: We study nonlinear and spatio-temporal emission properties of semiconductor lasers, implement optical complex networks based on lasers, advance characterization techniques, and demonstrate the utility of optical complexity for information technologies including encryption and ultra-fast neuro-inspired photonic information processing.

Nonlinear dynamics in fluids: we develop techniques useful to characterize transport in fluids, quantify stretching, mixing, and connectivity between parts of a fluid. We apply them to geophysical settings, mostly in the ocean. We develop tools to identify barriers to the transport of oxygen and nutrients, evaluate the ecological implications of larval transport, or track the origins of water vapor masses transported by atmospheric winds.

Biocomplexity: the ecological level where we consider modes of organisms' mobility and their interplay with food search, disease propagation, spatial patterning, and also with the basic ecological interactions such as competition, predation, or mutualism; understanding brain function, at scales that range from individual neurons to the whole brain. At the neuronal level, we concentrate on aspects of synchronization between interacting neuronal populations and study how information flows. With the help of statistical measures, we analyze experimental data and compare the results with neuronal models.

Dynamics and Collective Phenomena in Social and Socio-technical Systems: we develop new concepts, tools and models aiming at identifying generic mechanisms underlying collective phenomena in these systems. We do this in the framework of Computational Social Sciences with the use of Game Theory, Statistical Physics, Agent Based Models, Complex Networks Theory, and Big Data analysis. We study phenomena such as opinion formation, cooperation, cultural conflicts, language competition and social learning. Moreover, we focus on ICT data-driven research on socio-technical systems, addressing problems of human mobility, transportation, tourism, city science, epidemics, and energy consumption.

Brief description of the university

The **University of the Balearic Islands**, Palma de Mallorca is one of the country's leading universities in teaching, research, international cooperation and technological development and innovation. The UIB is a time-honored member of prominent international university networks, it has attracted countless students from abroad and successfully joined the European Space for Higher Education.

CSIC (Spanish National Research Council), part of the Spanish Ministry of Science, Innovation and Universities, is Spain's largest public research institution, and ranks third among Europe's largest research organizations. It carries out research in all fields of knowledge, throughout its 123 Institutes.

Research areas

- Physical Oceanography, Applied Math, Physics

Applications (documents to be submitted)

- Motivation letter
- CV
- Summary of project
- At least one reference letter

Deadline: 30th July

Expression of interest 9:

Modelling the progression of Alzheimer disease as an epidemic. We invite **postdoctoral candidates** for a [Marie Skłodowska-Curie Individual Fellowship](#) to contact us by **30th July 2019**

Type: Hosting

Location: Spain

Company/Institute: Institute for Cross-Disciplinary Physics and Complex Systems, University of the Balearic Islands-Spanish National Research Council

Contact person/ Scientist in charge: Dr. Manuel Matias, manuel.matias@ifisc.uib-csic.es

Brief description of the project:

As part of the [Marie Skłodowska-Curie actions](#) (MSCA), a prestigious funding scheme offered by the **European Commission** to finance postdoctoral research projects, we invite researchers/postdoctoral candidates from any country of origin with no age limit to apply at **IFISC, the Institute for Cross-Disciplinary Physics and Complex Systems (University of the Balearic Islands-Spanish National Research Council) in Mallorca, Spain** as **host institute**.

Many neurodegenerative diseases (including Alzheimer) share a common trait: the accumulation of characteristic proteins into insoluble aggregates in vulnerable neurons. Recent evidence indicates that the progression of these neurodegenerative diseases is driven by a prion-like, template-directed misfolding, seeded aggregation and cell-cell transmission of characteristic disease-related proteins. Evidence also strongly suggests that the anatomical connections made by neurons determine whether they are vulnerable to degeneration in these disorders. At IFISC we have a theory group working on epidemic spreading (collaboration with Drs. J.J Ramasco and S. Meloni) and collaborate with a group in a Medical School and Hospital in Bilbao, with access to clinical data.

Brief description of the Research Group

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