

ANNUAL REPORT

2021



EXCELENCIA
MARÍA
DE MAEZTU



Institute for Cross-Disciplinary Physics and Complex Systems



Universitat
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PRESENTATION
AND
RESEARCH
LINES

IFISC Institute de Física
Interdisciplinar
y Sistemas complejos

Universitat
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CSIC

*CONNECTING SCIENCE
UNDERSTANDING COMPLEXITY

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The diagram illustrates the IFISC research structure, organized into five main research lines (00 to 05) and various sub-fields:

- 00 COMPLEX SYSTEMS**: Multidimensional dynamics, High performance computers and big data, Input and fluctuation.
- 01 QUANTUM COMPLEXITY**: Quantum transport and nanophysics, Statistical and nonlinear optics.
- 02 NONLINEAR PHOTONICS**: Complex networks, Information processing.
- 03 FLUID DYNAMICS**: Complex laser dynamics, Geophysical fluids, Transport and mixing.
- 04 SOCIOCOMPLEXITY**: Structure and collective phenomena in biology, Socio-technical systems, big data.
- 05 SOCIAL SYSTEMS**: Microbial systems, Computational social science.

EXPLORING EMERGENT PHENOMENA
IN THE PHYSICAL, TECHNICAL, BIOLOGICAL
AND SOCIAL WORLD

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IFISC



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**) created in 2007 building upon the former Cross-Disciplinary Physics Department of the Mediterranean Institute for Advanced Studies (**IMEDEA**) dating from 1995. Its mission is to develop *Cross-Disciplinary* and *Strategic Research* in Complex Systems following the established scientific approach of physicists.

By *Cross-Disciplinary Research* we mean the transfer of knowledge, concepts and methods to create bridges among traditional disciplines. By *Strategic Research* we mean focusing on advanced studies in emerging strategic fields with a strong potential impact, avoiding the “basic-applied” polarization.

IFISC’s working environment is a complex system in itself seeking coherence and integration from diversity, interaction, scientific dialogue, transversal structures, bridge building and self-organization. Research is therefore organized in terms of research lines, rather than research groups.

1.1 IFISC RESEARCH LINES

Emerging from a back-bone transversal research line of exploratory nature on Complex Systems, Statistical and Nonlinear Physics, there are 5 research lines of transfer of knowledge in the interface with other disciplines (Quantum Technologies, Information and Communication Technologies, Earth Sciences, Life Sciences and Social Sciences):



Complex systems. Nonlinear and statistical physics

Complex systems are characterized by emergent and collective phenomena of many interacting units. Fundamental understanding of these systems and the Micro-Macro paradigm, comes from Statistical Physics together with Computational Methods, Quantum Mechanics, Information Theory, Complex Networks, Big Data analysis and the Theory of Dynamical Systems, which includes the study of nonlinear dynamics, chaos and the effect of fluctuations and random events on system's evolution.

This research line of exploratory nature is the backbone of IFISC: we develop new concepts and methods for the study of Complex Systems, and we analyze generic phenomena such as synchronization, phase transitions, nonequilibrium instabilities, spatiotemporal pattern formation, and the dynamics and evolution of complex networks.

COMPUTING LAB

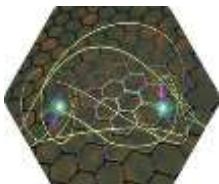
The Computing Services Unit manages the computational resources at IFISC. Capabilities to perform intensive numerical calculations are provided by an IBM iDataPlex cluster with 48 dx360M4 diskless nodes and a total of 576 computational cores and 1.8 TB of RAM configured for High Throughput Computing (HTC). This is complemented by two servers with 256GB of RAM used for memory intensive scientific calculations.

Big Data storage and management is handled using a MongoDB non-relational database on two servers, one with 16 cores, 512 GB of RAM, 2 2TB SSD for indexes and 20 2TB SSD for data and the other with 20 cores, 256GB of RAM, 2 2TB SSD for indexes and 20 4TB HD for data.

A Data repository is available on a IBM DS4700 disk cabinet with 96 TB of raw storage capacity, connected via fiber channel to four 8-core servers and using GPFS as file system. Private Cloud virtualization is implemented as a opennebula cluster with a 4 compute nodes each with 36 cores, 384GB of memory and 4TB disk and a management node with 16 cores, 96GB of memory and 16TB disk. IFISC network is complemented with an NFS and a backup server, about 100 linux desktops, mac and windows desktops and laptops and a number of peripherals, and it is integrated to provide a transparent environment.

ELECTRONICS LAB

The Nonlinear Electronics Lab focuses on the application of nonlinear dynamics to a variety of topics including synchronization of chaotic systems and information processing based on delay-coupled dynamical systems. The Nonlinear Electronics Lab currently offers a diversity of circuits and systems for the study and demonstration of chaos and bifurcation phenomena (including Autonomous Boolean Networks, Chua, Mackey-Glass and Rössler oscillators), chaos synchronization, and the study of networks with delay-coupled nonlinear elements for information processing.



Transport and Information in Quantum Systems

Understanding of Quantum Complex Phenomena plays a key role in the development of Quantum Technologies identified as one of the most strategic areas for future research and innovation.

In this research line, we are devoted to questions related to 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

Within this line of research, we explore complex phenomena in photonics, filling the gap between Modern Photonic Sources and Functional Complex Systems. Our Nonlinear Photonics Lab, working alongside a strong theoretical team, aims to gain an in-depth understanding of complex phenomena and to provide novel solutions from communication to information processing, transferring knowledge to the Information and Communication Technologies (ICT) domain.

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.

PHOTONICS LAB

Since 2009 a Photonics Laboratory of highest standards has been established. The lab is equipped with a Faraday cage for electromagnetic shielding and houses several experiments of delay-coupled lasers and laser arrays, optoelectronic systems, as well as photonic information processing systems using the latest technology to characterize the optical emission with multi-Gigahertz bandwidth: in the temporal domain via fast detectors and 40 GHz analog bandwidth real-time oscilloscope, and in the spectral domain via a 44 GHz signal and spectrum analyzer. In addition, high-resolution optical characterization can be performed via heterodyne techniques and different spectrometers. Finally, optical and electrical laser modulation can be implemented with arbitrary waveforms up to 92 GigaSamples/second.

**Nonlinear dynamics in fluids**

Fluid flows occur in a huge range of scales, from blood capillaries to atmospheric weather systems. The way in which substances are transported has large impacts, e.g., on how pollutants arrive to distant locations, plankton meets the nutrients, or into the whole heat balance involved in the Earth climate.

At IFISC 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

Living systems are the paradigm of complex systems, with nonlinear interactions occurring at all spatial and temporal scales, from molecules and genes to the planetary scales defining the global biosphere. One of the focus of our research is 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. Another focal issue in our studies is understanding brain function, which requires approaches 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 of social systems

Social systems are prominent examples of Complex Systems, emergent phenomena, and the Micro-Macro paradigm. Today's main societal changes and challenges arise from the feedback loop that entangles society with Information and Communication Technologies (ICT) as a prototypical socio-technical system.

In this line of research 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.

1.2 “MARIA DE MAEZTU” EXCELLENCE AWARD

In 2018, IFISC was awarded the “**Unidad de Excelencia María de Maeztu**” distinction, for the period 2018-2022, entering the selective **SOMMa Alliance**. The award was granted by the Agencia Estatal de Investigación (AEI), belonging to the Ministry of Science, Innovation and Universities, after a highly selective process and a thorough evaluation according to the highest standards by an international panel.

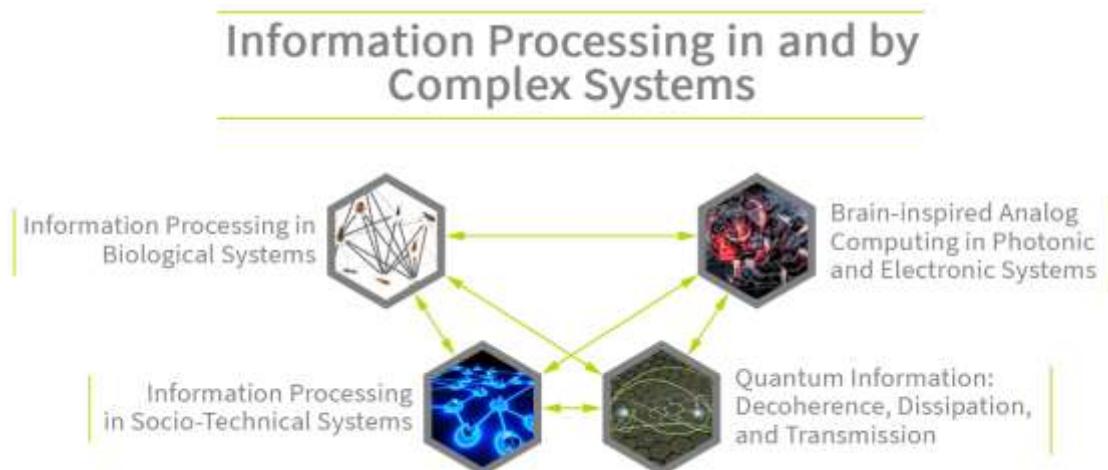
According to the Ministry, being awarded as "Severo Ochoa" or "María de Maeztu" represents "the recognition and accreditation of the best centers and units that stand out for their international impact and the relevance of their results obtained in the last four years". Moreover, it targets "the financing of strategic research programmes with the aim of consolidating their scientific capacities and contributing to their international leadership".

All distinguished centers and units stand out for the international impact of their scientific contributions, their postgraduate teaching activity, their innovative capacity and their intense relationship with the social and economic environment. They are categorized as world-class entities with highly competitive frontier research programs that are capable of attracting international talent.

The units that have been selected in the "María de Maeztu" category, like IFISC, receive a total funding of 2,000,000 Euros during four years plus eight contracts for pre-doctoral researchers and access to funding sources restricted to the units of excellence.

This award consolidated IFISC as a reference institute in the research field of complex systems and allowed a growth of approximately 30% in personnel with respect to 2018.

The research project associated to the MdM award covers the activities of the entire institute defining a strategic plan and focusing the research effort for the period 2018 – 2022. The following scheme summarizes the research lines on which the María de Maeztu award focusses:



Complex systems can efficiently perform multitude of tasks utilizing very different substrates and a wide variety of network topologies and non-linearities. *Characterizing and understanding information processing in and by complex systems, from both fundamental and practical perspective, is a challenging task for the next years.*

IFISC – MdM PERSONNEL



All **IFISC researchers** contribute to the MdM scientific program, highlighting the institute's goal of establishing a working environment that seeks coherence and integration from diversity, interactions and scientific dialogue.

Personnel that has been hired during 2021 within the MdM program:

POSTDOCTORAL RESEARCHERS:



Andre Röhm



Sungguen Ryu



Lucia S. Ramirez



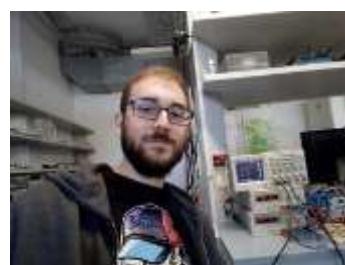
Giulia Ruzzene



Andrea Tabi



Christos Charalambous

**Pere Mujal**PHD STUDENTS:**Javier Aguilar****Miguel Alvarez****Marco Cattaneo****Irene Estébanez****Rodrigo Martínez****Mar Ferri****Giovanni Donati****Thomas Louf****Maria Mtnez.-Barbeito****Alejandro Almodóvar****Beatriz Arregui****Javier Galván**



Jorge Medina



Annalisa Caligiuri



Juan I. de Gregorio



Fernando Diaz



Alex Giménez

PROJECT MANAGER: **Simona Obreja**



COMMUNICATION AND DISSEMINATION: **Adrian García**



COMPUTING LAB TECHNICIAN: **Eduard Solivellas**



1.3. IFISC SERVICE UNIT: DataAnalytics@IFISC



Relying on the experience gained in research projects and contracts with companies, IFISC has created **DataAnalytics@IFISC** as a **service unit** devoted to data mining and big data analysis.

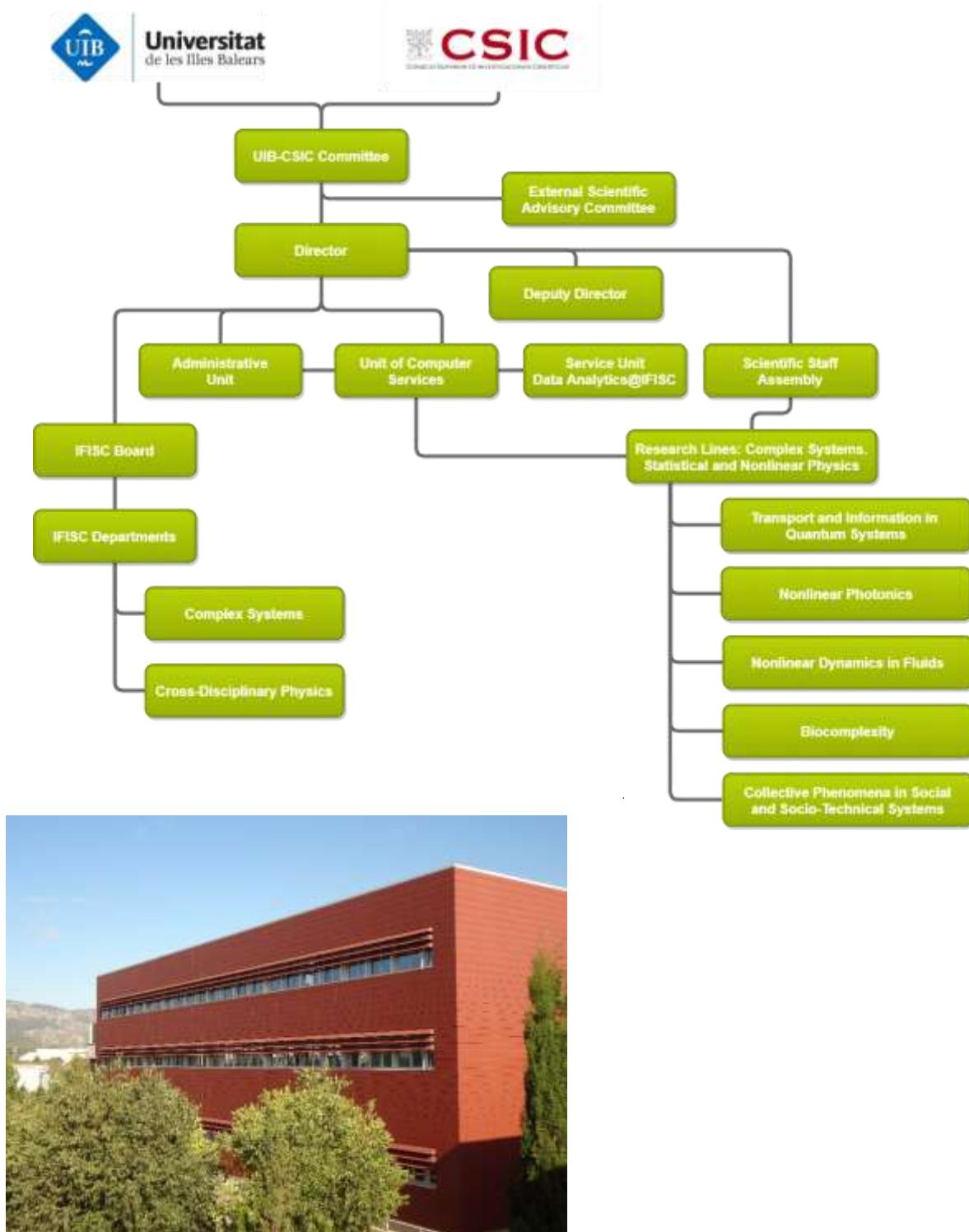
IFISC know-how includes analysis of data from social networks, mobile phone and credit card records, transport networks at the urban scale, air transport, census and surveys, electoral results in the space, electrocardiograms, electro and magneto encephalograms, marine currents and animal populations. Previous results include works on population levels, mobility, transport and tourism, land use, economic inequalities in urban areas, epidemic spreading, delay propagation in air transportation, heart arrhythmia and encephalogram series analysis using machine learning, hospital emergency demand, and marine megafauna migrations and spatial connectivity studied with satellite data.

Data Analytics@IFISC provides solutions to CSIC, UIB and external entities based on big data for computational social sciences, ecology and biomedicine, including:

- Sampling from our databases and the preparation of reports based on aggregated data.
- Development of new analysis methods ad hoc including machine learning techniques.
- Consulting on social, economic and technical questions through Big Data analytics.



1.4 IFISC STRUCTURE CHART



1.5 2021 REPRESENTATIVE RESEARCH RESULTS

Here are some research results published during 2021. They are representative of the different research lines and thus illustrate the range of topics studied at IFISC.

Algorithmic Approaches for Assessing Irreversibility in Time Series: Review and Comparison

Massimiliano Zanin and David Papo

Entropy, 23, 11, 1474

Given a system, or more generally a time series representing the observable dynamics of a system, the first step is usually to try to characterise it through one or more metrics. Among these, tests assessing its irreversible nature are gaining attention. Time irreversibility is formally defined as the lack of invariance of the statistical properties of a system under the operation of time reversal; more intuitively, it can be described as whether a time series can or cannot be recognised from its time-reversed version. Assessing irreversibility in time series is not an easy task, due to its many aetiologies and to the different ways it manifests in data. It is thus not surprising that several numerical methods have been proposed in the last decades, based on different principles and with different applications in mind. The question that any researcher will thus have to face is: given some data, what is the best test that ought to be applied?

In this work we provide some guidelines by describing the main tests designed to detect the irreversible nature of time series, and evaluated eight of them under different conditions, including varying time series length, and presence of noise and outliers. We further evaluate the probability of incurring in false positives and the computational cost of each of them. We propose the possibility of creating ensemble methods, i.e., combining multiple tests together to compensate for individual deficiencies; and discuss the implications of the differences between tests in real-world scenarios, like the discrimination of control subjects and patients from the irreversibility of their brain activity – see Fig. 1. The described metrics and tests form a complex landscape: no metric is strictly better than all the other ones; the computational cost is not proportional to the performance; and some tests even benefit from the presence of noise.

As a complement to this review, we made public a Python software library with the described tests, freely available at <https://gitlab.com/MZanin/irreversibilitytestslibrary>. These software implementations have been used to obtain all results included in this review, including the computational costs. In order to simplify the use of the library, it includes an example program *UsageExample.py*, which creates a time series using a logistic map, and sequentially executes all available tests with different parameters. We recommend the interested reader to start by checking this program. We welcome readers to send us comments, suggestions and corrections, ideally using the *Issues* feature of GitLab; and we further welcome new contributions to the library, like new metrics and tests, provided they have been peer reviewed and are already coded in Python.

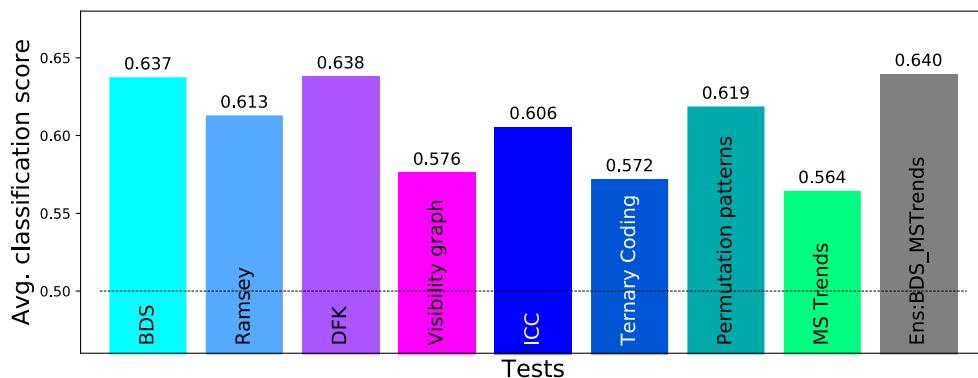


Fig. 1. Classification scores obtained in the task of classifying EEG recordings according to the corresponding group (control subjects vs. patients suffering from alcoholism), by using the output (i.e., the *p*-value) of each irreversibility test on individual time series (channels) as feature. The classification has been performed using Random Forest models with a 10-fold cross-validation.

Path Laplacians versus fractional Laplacians as nonlocal operators on networks

Estrada, Ernesto
New Journal of Physics 23, 073049.

There are many real-world systems in physics, chemistry, biology and social sciences where interactions occur not only at short scale, but where non-local ones are decisive. In many of these systems these interactions occur in the framework of a complex network. While local interactions are well described by graph-theoretic operators such as the adjacency and the Laplacian ones, those occurring at non-local spatial levels are more difficult to describe mathematically. In 2012 two groups proposed two different approaches to describe non-local interactions in networks. Mateos and Riascos (*Phys. Rev. E* **86**, 2012, 056110) proposed the use of fractional powers of the graph Laplacian and Estrada defined the so-called d-path Laplacian operators (*Lin. Algebra App.* **436**, 2012 3373–91).

In the current work we study and compare nonlocal diffusion processes on networks based on these two different kinds of approaches. We prove that a nonlocal diffusion process on a network based on the path Laplacian operator always converges faster than the standard diffusion. The nonlocal diffusion based on the fractional powers of the graph Laplacian frequently converges slower than the local process. Additionally, the path-based diffusion always displays smaller average commute time and better diffusive efficiency than the local diffusive process. On the contrary, the fractional diffusion frequently has longer commute times and worse diffusive efficiency than the standard diffusion process. Another difference between the two processes is related to the way in which they operate the diffusion through the nodes and edges of the graph. The fractional diffusion occurs in a backtracking way, which may leave the diffusive particle trapped just behind obstacles in the nodes of the graph, such as a weighted self-loop. The path-diffusion operates in a non-backtracking way, which may represent through-space jumps that avoids such obstacles. We show that the fractional Laplacian cannot differentiate between three classes of brain cellular tissues corresponding to healthy, inflamed and glioma samples. The path Laplacian diffusive distance correctly classifies 100% of the mentioned samples. These results point out to the potential areas of applications of both kinds of nonlocal operators on networks.

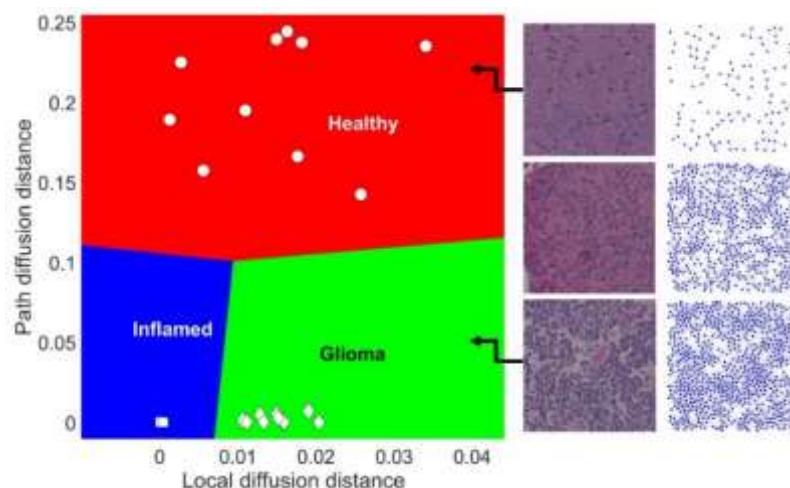


Fig. Illustration of the perfect classification of cellular samples of glioma, inflamed and healthy tissues using geometric parameters derived from the d-path Laplacian operators.

Deep neural networks using a single neuron: folded-in-time architecture using feedback-modulated delay loops

Florian Stelzer, André Röhm, Raul Vicente, Ingo Fischer, Serhiy Yanchuk.
Nature Communications 12, 5164 (1-10).

Deep Neural Networks (DNNs) are powerful, versatile, and widely applied machine learning tools showing outstanding performance in a broad range of tasks, including image classification, object detection, or text generation. DNNs typically consist of multiple layers of neurons coupled in feed-forward architectures. In these architectures, thousands to millions of neurons are often required while the information propagates in only one direction: forward, from the input to the output.

In a collaboration with colleagues from TU Berlin (Germany) and the University of Tartu (Estonia), we introduced an approach for folding a deep neural network of arbitrary size into a single neuron with multiple time-delayed feedback loops. The network states emerge as a temporal unfolding of the neuron's dynamics. We can adapt the network's connection weights by modulating the amount of feedback within the loops. These connection weights are determined, i.e. learned, via a back-propagation algorithm.

This approach fully recovers standard Deep Neural Networks (DNN), encompasses sparse DNNs, and extends the DNN concept toward dynamical systems implementations. We named this new method Folded-in-time DNN (Fit-DNN). Its architecture is illustrated in Figure 1.

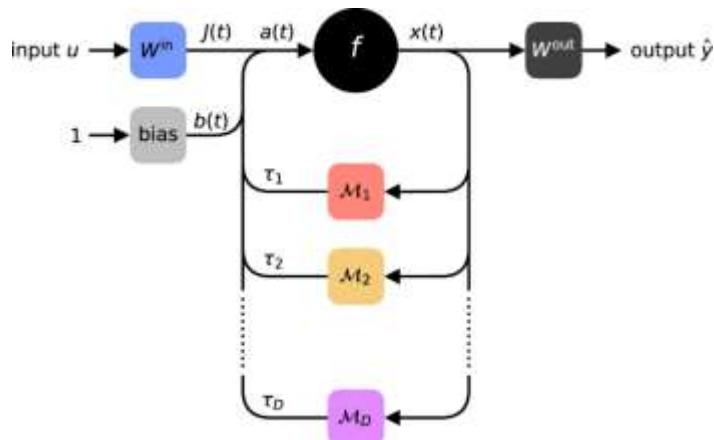


Figure 1: Fit-DNN architecture (from [1]).

Fit-DNN originates from an interdisciplinary mindset that draws its inspiration from the intersection of AI systems, brain-inspired hardware, dynamical systems, and analog computing. This might lead to a better understanding of DNN properties and DNN requirements and capabilities. For the related method of reservoir computing, based on fixed recurrent neural networks, folding-in-time concepts had already been successfully developed before [2]. Our Fit-DNN approach exhibits promising performance in a set of denoising and classification benchmark tasks, using popular datasets (MNIST, Fashion-MNIST, CIFAR-10, and cropped SVHN).

Fit-DNNs can reduce the required hardware drastically and offer a new perspective on how to construct trainable complex systems since only a single neuron and several delay lines need to be implemented. Delay systems inherently possess an infinite-dimensional phase space, so just one neuron with feedback is sufficient to fold and capture the entire complexity of the network.

The article has been selected for the Nature Communications Editors' Highlights webpage in the section of recent multidisciplinary research called "AI and machine learning." Moreover, it was covered by a Comment [3].

- [1] F. Stelzer, A. Röhm, R. Vicente, I. Fischer, S. Yanchuk., Nat Commun 12, 5164 (1-10) (2021). <https://doi.org/10.1038/s41467-021-25427-4>
- [2] L. Appeltant et al., Nat Commun 2, 468 (2011). <https://doi.org/10.1038/ncomms1476>
- [3] L. Jaurigue, K. Lüdge, Nat Commun 13, 227 (2022). <https://doi.org/10.1038/s41467-021-27715-5>.

Dynamical Phase Transitions in Quantum Reservoir Computing

Rodrigo Martínez-Peña, Gian Luca Giorgi, Johannes Nokkala, Miguel C. Soriano and Roberta Zambrini
Physical Review Letters 127, 100502

Unconventional computing is an interdisciplinary branch of science that aims to uncover new computing and information processing mechanisms in physical, chemical, and biological systems. When it comes to solving temporal tasks, a natural “computer” is represented by a system exhibiting rich dynamical properties. An example of such an approach can be found in reservoir computing (RC), an unconventional framework belonging to the broad family of machine learning, derived from recurrent neural networks but with the major advantage of low training cost and fast learning. For big-data processing, an exceptional playground where rich dynamics can be exploited is certainly provided by quantum systems, whose exponentially large number of degrees of freedom pushes them toward computational limits that are not achievable by classical systems. This is the potential envisaged in quantum reservoir computing (QRC). Although all the previous works in the field provide examples of functioning quantum reservoir computers, a fundamental issue remains open: what conditions must a physical system fulfill to be a good quantum reservoir computer? The aim of our work is to establish the relation between the operation regime of complex computing systems and the performance of QRC.

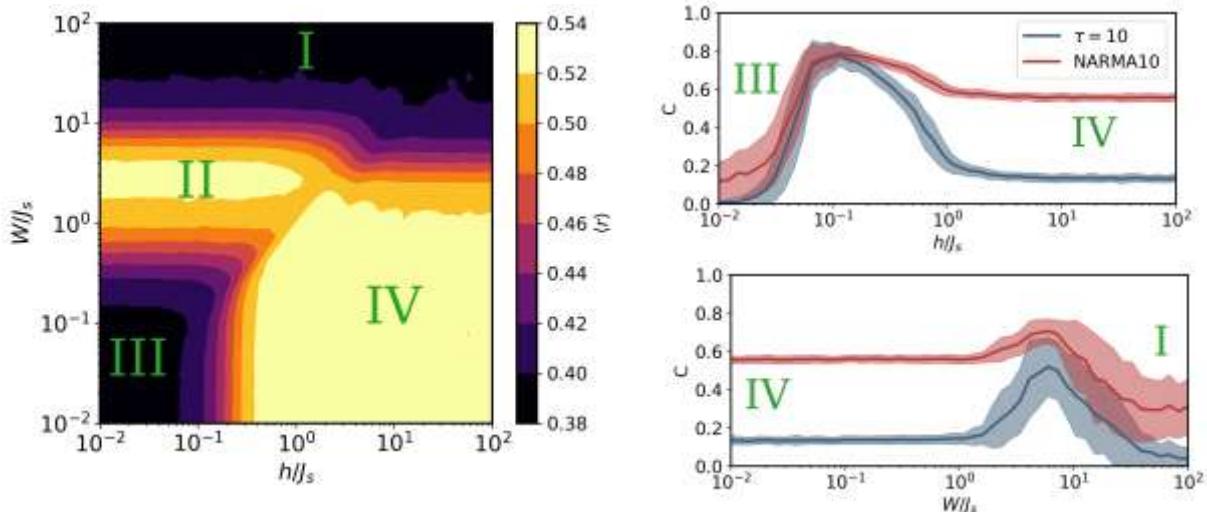


Figure 1. (a) Phase diagram of dynamical regimes for the Transverse-field Ising model. Parameters h and W are the homogeneous magnetic field and the strength of the random heterogeneous magnetic field, respectively (in units of the interaction strength J_s). (b) Capacity of the model to display memory up to 10 past steps, and to execute a nonlinear task known as NARMA10 in term of parameters h and W . In the upper plot $W/J_s = 0$ and in the lower plot $h/J_s = 10$.

Closed quantum systems exhibit different dynamical regimes, like many-body localization or thermalization, which determine the mechanisms of spread and processing of information, as represented by the phase diagram of Fig. 1 (a). We addressed the impact of these dynamical phases in QRC for networks of quantum spins. We established that the thermal phase is naturally adapted to the requirements of quantum reservoir computing and report an increased performance at the thermalization transition for the studied benchmark tasks (see region IV in Fig. 1 (b)). However localization, because of the presence of local conserved quantities, is detrimental for an optimal information processing performance due to a slow convergence (regions I and III in Fig. 1 (b)). Uncovering the underlying physical mechanisms behind optimal information processing capabilities of spin networks is essential for future experimental implementations and provides a new perspective on dynamical phases.

Fabry–Pérot interferometry with gate-tunable 3D topological insulator nanowires

Javier Osca, Kristof Moors, Bart Sorée and Llorenç Serra
Nanotechnology 32, 435002 (14pp)

A topological insulator (TI) material has the properties of a conventional insulator in the bulk but hosts topologically protected metallic states on the surface. The surface states have the peculiarity of behaving as massless Dirac fermions with a linear dispersion relation and a unique spin polarization that is tied to the momentum. The nontrivial topology of these TI materials is caused by strong spin–orbit coupling and a band inversion that lead to robust time-reversal symmetry protection of these surface states emerging within the bulk gap.

Nanowires of three dimensional topological insulator (3DTI) materials display remarkable magneto transport properties that can be attributed to their spin-momentum-locked surface states such as quasi ballistic transport and Aharonov–Bohm oscillations. Here, we focus on the transport properties of a 3DTI nanowire with a gated section that forms an electronic Fabry–Pérot interferometer that can be tuned to act as a surface-state filter or energy barrier (a). By tuning the carrier density and length of the gated section of the wire, the interference pattern can be controlled, and the nanowire can become fully transparent for certain topological surface-state input modes while completely filtering out others (b). We also consider the interplay of Fabry–Pérot interference with an external magnetic field (c), with which Klein tunneling can be induced, and transverse asymmetry of the gated section, e.g. due to a top-gated structure, which displays an interesting analogy with Rashba nanowires.

Due to its rich conductance phenomenology, we propose a 3DTI nanowire with a gated section as an ideal setup for a detailed transport-based characterization of surface states near the Dirac point, which could be useful towards realizing 3DTI nanowire-based topological superconductivity and Majorana bound states.

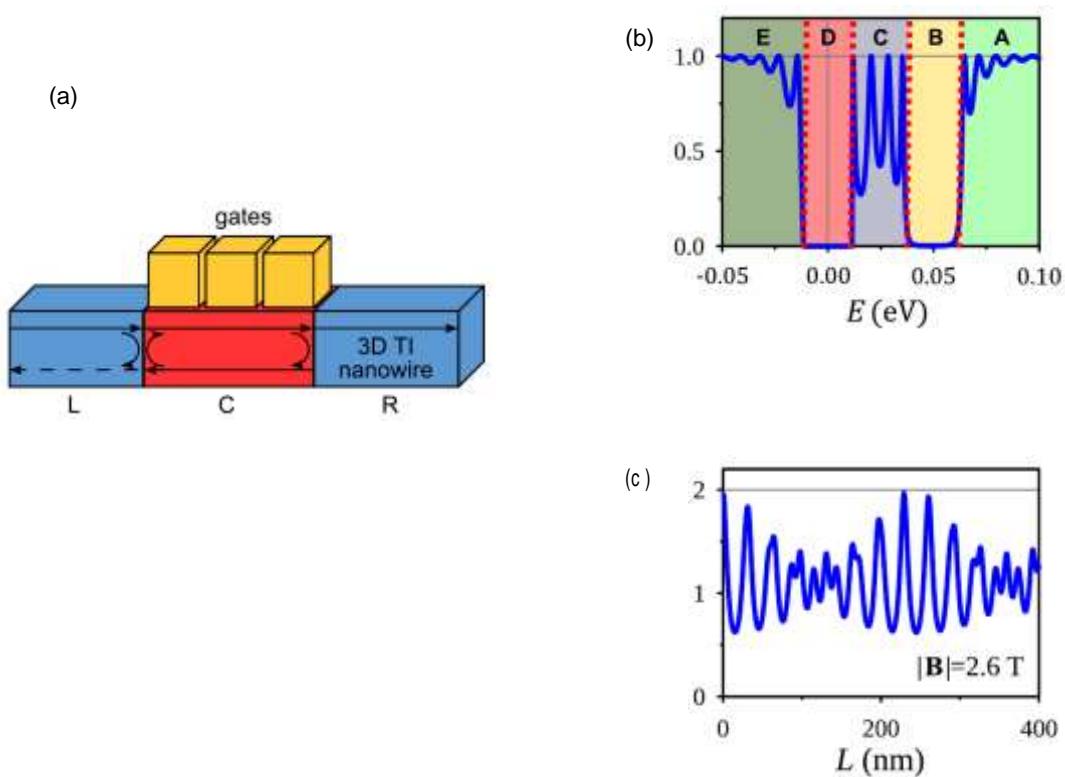


Figure 1: a) sketch of a 3DTI nanowire with a gated central section. b) linear conductance in units of e^2/h as a function of energy. c) magnetic field oscillations of conductance.

Lagrangian betweenness as a measure of bottlenecks in dynamical systems with oceanographic examples

Ser-Giacomi, E.; Baudena, A.; Rossi, V.; Follows, M.; Clayton, S.; Ruggero, V.; López, C.; Hernández-García, E.
Nature Communications 12, 4935.

The study of connectivity in networks has brought insights across many fields ranging from neurosciences to epidemic spreading or climate. One of the classical network measures, betweenness centrality, has demonstrated to be very effective in identifying nodes that act as focus of congestion or bottlenecks. Outside the network framework there is no obvious way to define betweenness. Nevertheless, the concept of bottleneck is equally present in dynamical systems and in fluid flows.

By using ideas that relate dynamical systems and network theory, we have provided a trajectory-based formulation of betweenness, called Lagrangian betweenness, which is computed in terms of Lyapunov exponents. This extends the concept of betweenness beyond network theory and relates hyperbolic points and heteroclinic connections in dynamical systems to the structural bottlenecks of the flow network associated with it.

We illustrate the use and meaning of the Lagrangian betweenness by identifying bottlenecks in ocean surface flows in the Adriatic sea or the Kerguelen region in the Southern Ocean (see the Figure). Also, by analyzing plankton abundance data from the Kuroshio region in the Pacific Ocean, we find significant spatial correlations between measures of biological diversity and betweenness, suggesting that ocean bottlenecks act as ecological hot spots.

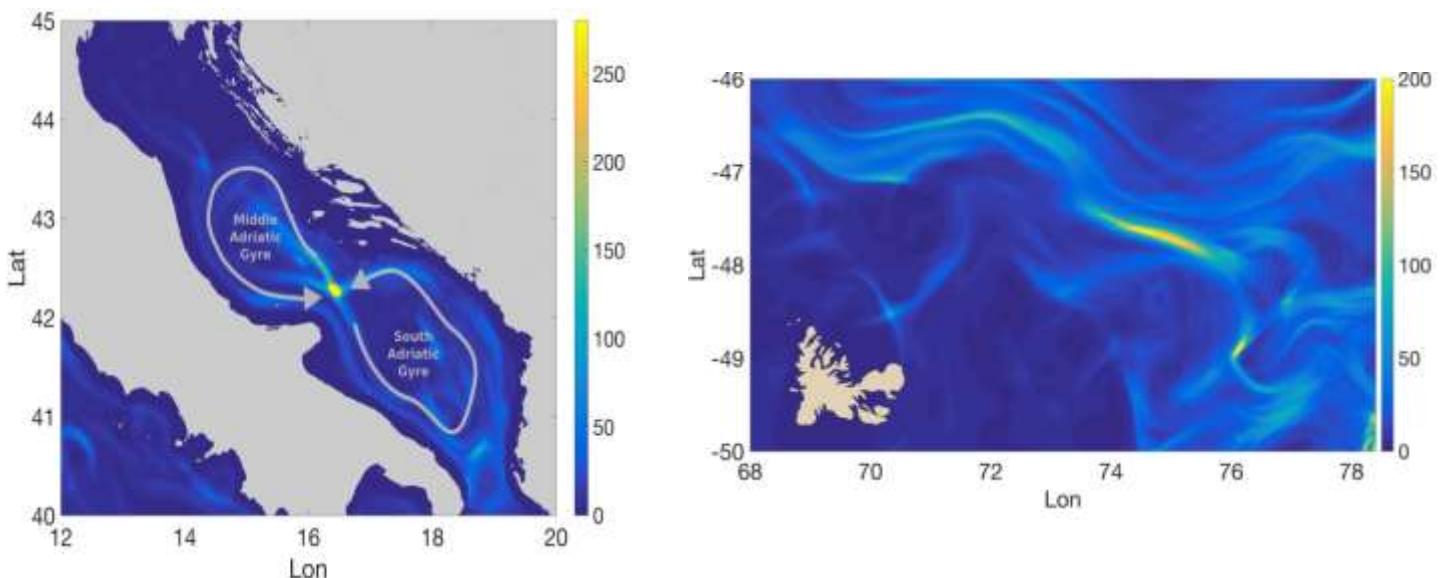


Figure. Two examples of betweenness field in the Adriatic sea (left panel) and in the Kerguelen region (right panel). Large values (yellow color) identify flow bottlenecks.

The global network of ports supporting high seas fishing

Jorge P Rodríguez, Juan Fernández-Gracia, Carlos M Duarte, Xabier Irigoién, Víctor M Eguiluz
Science Advances 7, eabe3470

The global ocean is a source for many ecosystem services, such as carbon sequestration, thermal regulation and others. Currently, oceans are facing many problems related to global anthropogenic disturbances – from global change to human activities in the ocean. Of particular interest are the problems related to the overexploitation of fisheries. Fish stocks can be protected via national regulations in exclusive economic zones (EEZ), which are the pieces of the ocean that are at a distance up to 200 nautical miles from the coast of a country. Beyond that, the ocean is composed by the so-called high seas, where weaker regulations in the form of international treaties are at play. These regions are also difficult to monitor. As a shared resource, fish stocks in the high seas are thus susceptible to the tragedy of the commons.

Here we use trajectories data for fishing vessels globally to assess the use of the high seas in terms of fishing. The data come from the automatic identification system (AIS) and includes the trajectories of 112,535 fishing vessels in 2014 (Fig. 1 a). In a first step we extract the fishing effort – measured as the time that vessels spend fishing – in cells of 0.5 degree in latitude and longitude in the high seas. We find that the effort is heterogeneously distributed, with distinct fishing hotspots. Specifically, fishing effort concentrates along narrow strips attached to the boundaries of EEZs with productive fisheries (Fig. 1 b), identifying a free-riding behavior that jeopardizes efforts by nations to sustainably manage their fisheries, perpetuating the tragedy of the commons affecting global fishery resources.

From the trajectories we also identify, via a network community detection method, 14 different regions that we call *fishing provinces* and represent the use of the ocean by fishing vessels (Fig. 1 a). These regions could serve as administrative regions and are different from the ones used by the Food and Agriculture Organization of the United Nations.

We infer the global network linking harbors supporting fishing vessels to the different fishing provinces, observing a modular structure, with vessels departing from a given harbor fishing mostly in a single province (Fig. 1 c). The top 16% of these harbors support 84% of fishing effort in high seas, with harbors in low- and middle-income countries ranked among the top supporters.

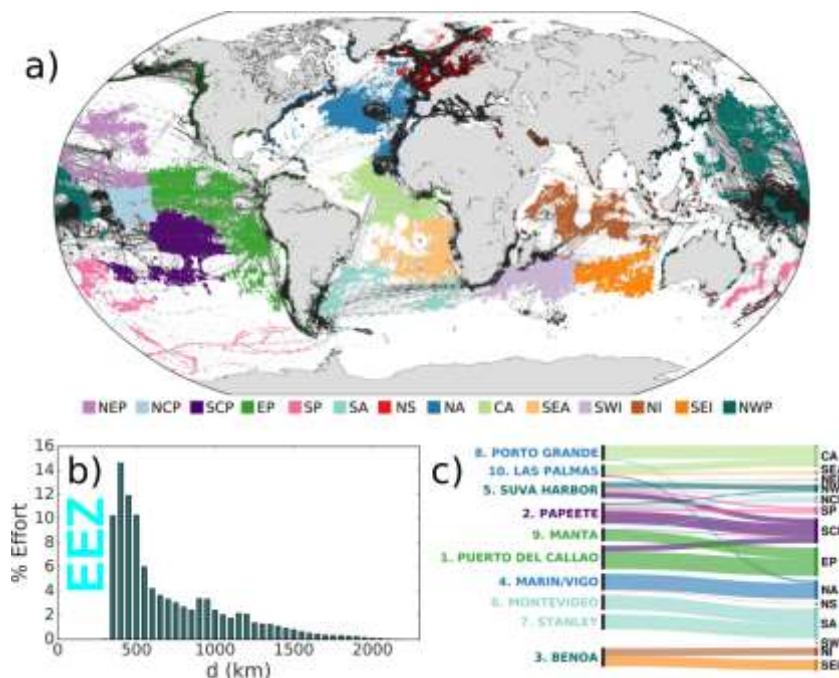
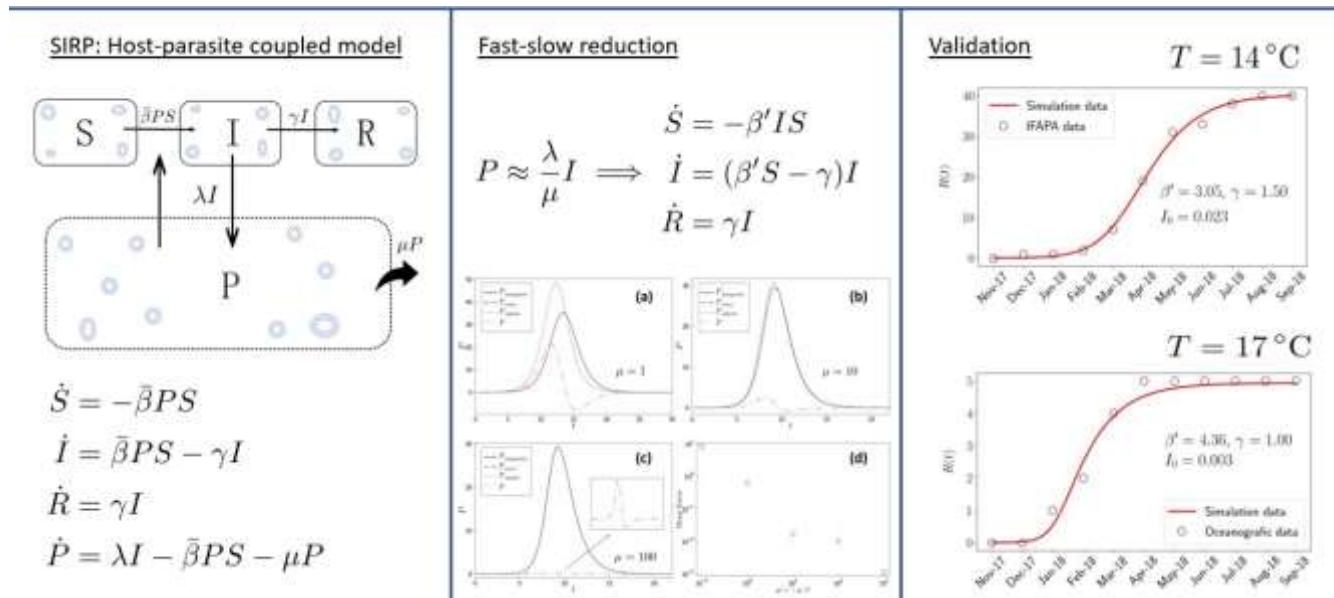


Fig. 1. a) Global fishing network composed of ports and high seas fishing provinces. Ports are depicted as circles with colors identified with the provinces they support. Gray traces represent the trajectories of the vessels connecting ports and fishing locations. b) Fraction of the global fishing effort in the high seas observed at a distance d to the closest shore; bars represent the fraction along bands of 50-km width. c) Bipartite network linking the top 10 harbors used by vessels operating in the high seas and the fishing provinces they exploit

Modelling parasite-produced marine diseases: The case of the mass mortality event of *Pinna nobilis*

A. Giménez-Romero, A. Grau, I.E. Hendriks, and M.A. Matías.
Ecological Modelling 459, 109705

A recent mass mortality event has caused the virtual extinction of the largest bivalve in the Mediterranean Sea, the noble pen shell (or fan mussel), *Pinna nobilis*, except in a few ecosystems with higher or lower salinity than the average, like the Mar Menor or Delta del Ebro. The extinction event, possibly related to Global Change, has been caused by the *Haplosporidium pinnae* parasite. The present paper discusses and analyzes a mathematical model to describe epidemics caused by parasites in bivalves. The SIRP model is a compartmental model that adds a Parasite compartment to a standard SIR model and does not consider neither recruitment nor the natural death of the bivalves. The goal is to use experimental available data to confront the validity of the model and obtain the relevant parameters corresponding to the *P. nobilis* epidemic. For this purpose there are available data from an unintended experiment in which pen shell individuals were kept in tanks in four different Spanish institutions to avoid their extinction, but, unfortunately, got infected. These data are very useful to be analyzed with the SIRP model, because the pen shell individuals were kept in conditions in which the mean-field approximation inherent to our compartmental model is valid, as the pen shells are separated a distance that is comparable or smaller than the average mean path of the parasites.



In trying to confront the model with the experimental data, one finds that there is an ambiguity, related to the problem known as parameter unidentifiability, or in other words, the available data are not enough to fit the model parameters. It turns out that the model can be simplified, if certain conditions with the relevant time scales of the problem are fulfilled, to an effective SIR model. Within this reduction, the infection process between immobile bivalves takes place through the parasites, but is replaced by an effective direct interaction between bivalves. In fact, a perfect fit to the available experimental data is obtained within the framework of the reduction to a SIR model. A study of temperature effects validates the technique used by the institutions that keep noble pen shells: cooling the water temperature of the tanks below some level (around 13 °C). The data show that the infection rate is reduced as temperature is lowered, and being the onset of an epidemic a threshold phenomenon, this explains this healing effect.

An ecological approach to structural flexibility in online communication systems.

María J. Palazzi, Albert Solé-Ribalta, Violeta Calleja-Solanas, Sandro Meloni, Carlos A. Plata, Samir Suweis, Javier Borge-Holthoefer.

Nature Communications 12, 1941

Human cognitive abilities are limited resources. Today, in the age of cheap information—cheap to produce, to manipulate, to disseminate—this cognitive bottleneck shapes the way in which we communicate and our perception of reality. The scarcity of our cognitive resources also translates into a hyper-competition between ideas/memes for visibility. At the same time, these incentives push actors to mutualistically interact with specific memes, seeking the virality of their messages. In turn, memes' chances to persist and spread are subject to changes in the communication environment.

In spite of all this complexity, in this work we analyzed several datasets covering human communications in online social platforms with the aim of understanding how these drivers –competition for attention and mutualistic interactions—shape their organization. We found that the underlying architecture of empirical actor-meme information ecosystems evolves into recurring emergent patterns. To bring to light the precise mechanisms causing this structural re-organization, we then proposed an ecology-inspired modelling framework. The model predicts—and the data confirm—that users' struggle for visibility is the main driver behind the formation of the observed patterns, inducing a re-equilibration of the network's mesoscale towards self-similar nested arrangements.

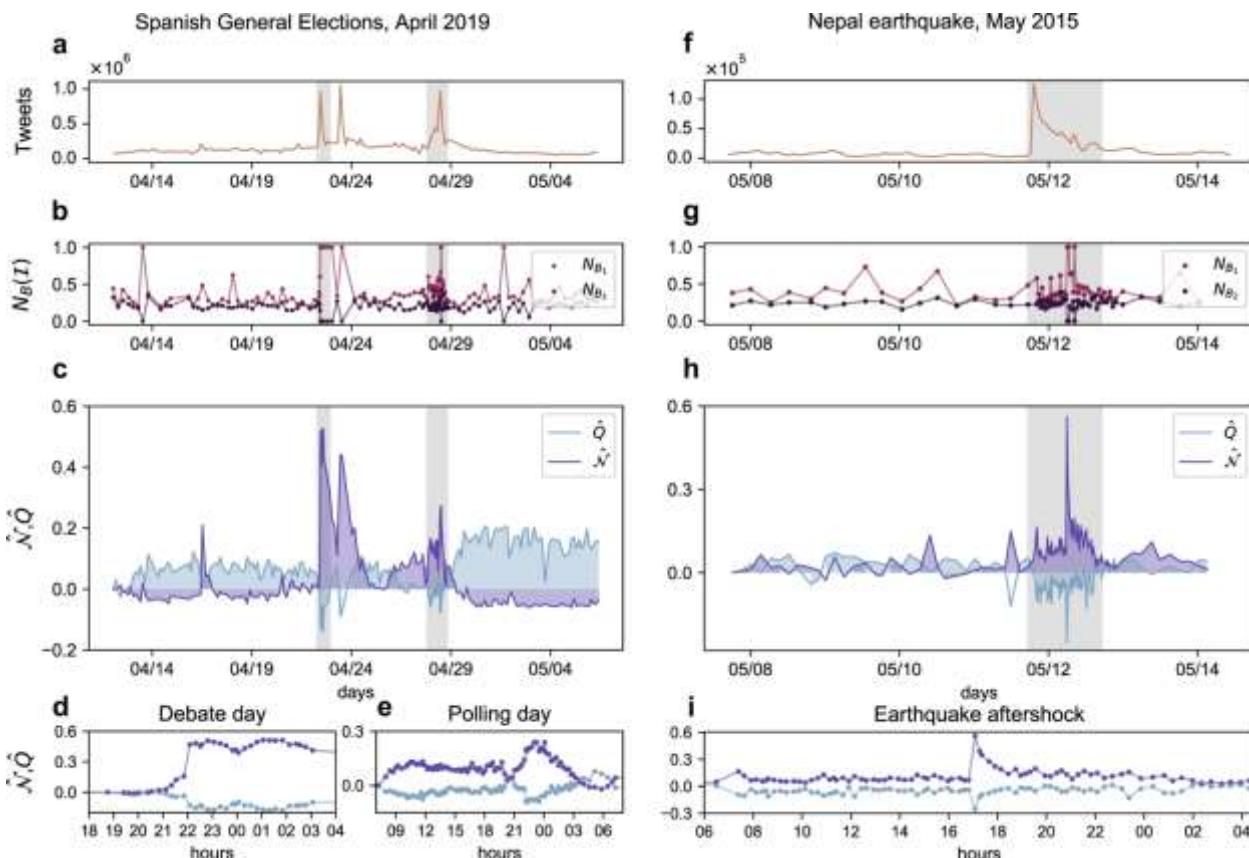


Figure. Online social networks data and structural analysis of the users-memes interaction networks. Here we show Twitter streams covering two different topics, i.e., Spanish general election of 2019 (panels a–e) and the 2015 Nepal earthquake (panel f–i), respectively. Spanning different time ranges and attracting varying levels of attention (see tweet volume in panels a and f), the information ecosystems self-organize in similar ways: a block organization dominates the system (positive modularity \hat{Q}), reflecting the separate interests of users until external events induce large-scale attention shifts, which rearrange completely the network connectivity towards a nested architecture (high nestedness \hat{N} , panels c and h). Note that, despite the predictable (Spain) vs. unpredictable (Nepal) nature of each stream, structural properties of the user-hashtag interaction networks are anti-correlated. For a closer view, we highlight specific time windows in each dataset with some identifiable events happening in them (panels d and e for the Spanish elections dataset and panel i for the Nepal earthquake). In each plot, measures of modularity and nestedness are shifted from their initial values. The panels b and g, corresponding to highlight the nested self-similar (in-block nestedness $N_b(I)$) arrangements at different scales.

A population-based controlled experiment assessing the epidemiological impact of digital contact tracing

Pablo Rodriguez, Santiago Grana, Eva Elisa Alvarez-Leon, Manuela Battaglini, Francisco Javier Darias, Miguel A. Hernan, Raquel Lopez, Paloma Llaneza, Maria Cristina Martin, RadarCovidPilot Group, Oriana Ramirez-Rubio, Adriana Romani, Berta Suarez-Rodriguez, Javier Sanchez-Monedero, Alex Arenas, and Lucas Lacasa
Nature Communications 12, 587

While Digital contact tracing (DCT) has been argued to be a valuable complement to manual tracing in the containment of COVID-19, by the time of publication of this work no empirical evidence of its effectiveness was available. Here, we reported the results of a 4-week population-based controlled experiment that took place in La Gomera (Canary Islands, Spain) between June and July 2020, where we assessed the epidemiological impact of the Spanish DCT app Radar Covid according to a number of pre-defined Key Performance Indicators (KPIs). After a substantial communication campaign, we estimated that at least 33% of the population adopted the technology and further showed relatively high adherence and compliance as well as a quick turnaround time. Importantly, the app detected about 6.3 close-contacts per primary simulated infection (twice as many as the average number traced by manual contact tracing), and a significant percentage of these were contacts with strangers (blind to manual contact tracing by construction).

Overall, these results provided experimental evidence of the potential usefulness of DCT during an epidemic outbreak in a real population, but it flagged that adoption was a critical bottleneck that could only be reverted with a sustained communication campaign.

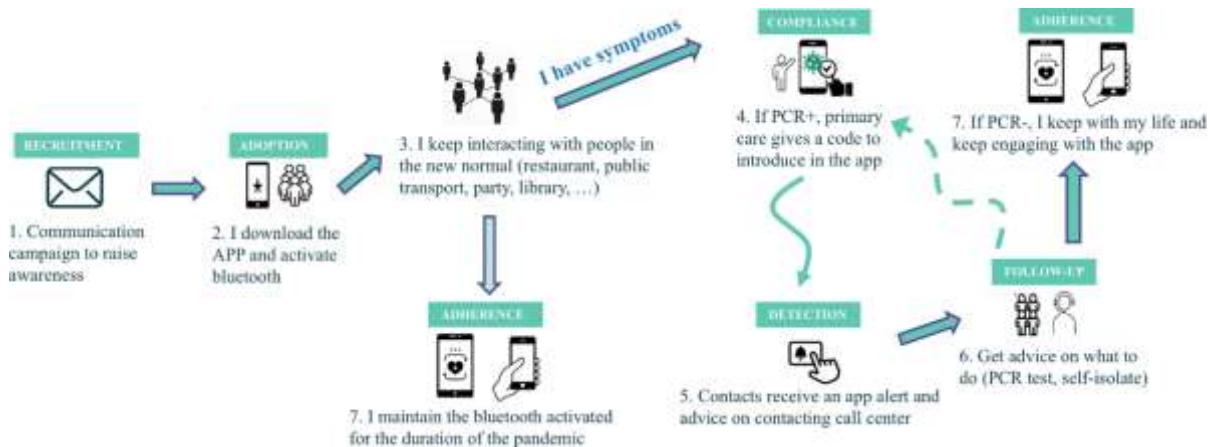


Figure: RadarCOVID's user journey, from the moment the user downloads the app until a close-contact is being notified by the app and what to do next.

This paper summarizes the results of a multi-institution research (US (Harvard), UK (QMUL), Spanish universities and the Ministry of Health and Economic affairs), on the design and experimental validation of Spanish digital contact tracing app RadarCOVID which was developed by the Secretary of State of Digitalization and Artificial Intelligence. A research led by IFISC's Lucas Lacasa, this study constitutes the flagship paper of the RadarCOVID app and is recognized worldwide as the first experimental validation of digital contact tracing technologies in the context of the COVID19 pandemic.

Capturing the Diversity of Multilingual Societies

T. Louf, D. Sánchez, J.J. Ramasco

Physical Review Research 3, 043146

Cultural diversity encoded within languages of the world is at risk, as many languages have become endangered in the last decades in a context of growing globalization. To preserve this diversity, it is first necessary to understand what drives language extinction, and which mechanisms might enable coexistence. In this work, we consider the processes underlying language shift through a conjunction of theoretical and empirical perspectives. A large-scale empirical study of spatial patterns of languages in multilingual societies using Twitter and census data yields a wide diversity. It ranges from an almost complete mixing of language speakers, including multilinguals, to segregation with a neat separation of the linguistic domains and with multilinguals mainly at their boundaries. To understand how these different states can emerge and, especially, become stable, we propose a population dynamics model in which coexistence of languages may be reached when learning the other language is facilitated and when bilinguals favor the use of the endangered language. A mean-field analysis for a single population uncovers interesting stable states of extinction and coexistence, including with bilinguals alone sustaining a minority language. As shown in Figure 1, simulations carried out in a metapopulation framework highlight the importance of spatial interactions arising from population mobility to explain the stability of a mixed state (Fig. 1C), or the presence of a boundary between two linguistic regions (Fig. 1B). Changes in the parameters regulating the relation between the languages can destabilize a system, which undergoes global transitions. According to our model, the evolution of the system once it undergoes a transition is highly history-dependent. It is easy to change the status quo but going back to a previous state may not be simple or even possible.



Figure 1: Polarization of French in Belgium, (A) from Twitter data, and stable states reached with our model (B) for a relatively low and (C) high ease to learn the other language. Polarization equals 1 when only French is spoken, and 0 when only Dutch is.

Geospatial distributions reflect temperatures of linguistic features

Henri Kauhanen, Deepthi Gopal, Tobias Galla, Ricardo Bermúdez-Otero
Science Advances, Sci. Adv. 2021; 7 : eabe6540

Since the biological emergence of modern language some 100,000 years ago human languages have diversified through processes of cultural evolution. Thousands of distinct languages are spoken today around the world. These languages display an enormous amount of variation in a combinatorial space spanned by a finite number of structural features. These features determine how individual words are formed, how words are combined into phrases and sentences, and which sounds and sound sequences are available in any given language.

It is natural to ask how features of a language evolve in time, and how stable or unstable individual features are in time. Quantifying this speed of linguistic change is challenging because the historical evolution of languages is sparsely documented. Consequently, traditional methods rely on phylogenetic reconstruction.

Here, we propose a model-based approach to the problem through the analysis of language change as a stochastic process combining vertical descent from one generation to another, spatial interactions, and mutations in both dimensions.

A notion of ‘linguistic temperature’ emerges naturally from this analysis as a dimensionless measure of the propensity of a linguistic feature to undergo change. Using data from the world atlas of language structures (WALS) we demonstrate how temperatures of linguistic features can be inferred from their present-day geospatial distributions, without recourse to information about their phylogenies.

Thus, the evolutionary dynamics of language, operating across thousands of years, leave a measurable geospatial signature. This signature licenses inferences about the historical evolution of languages even in the absence of longitudinal data.

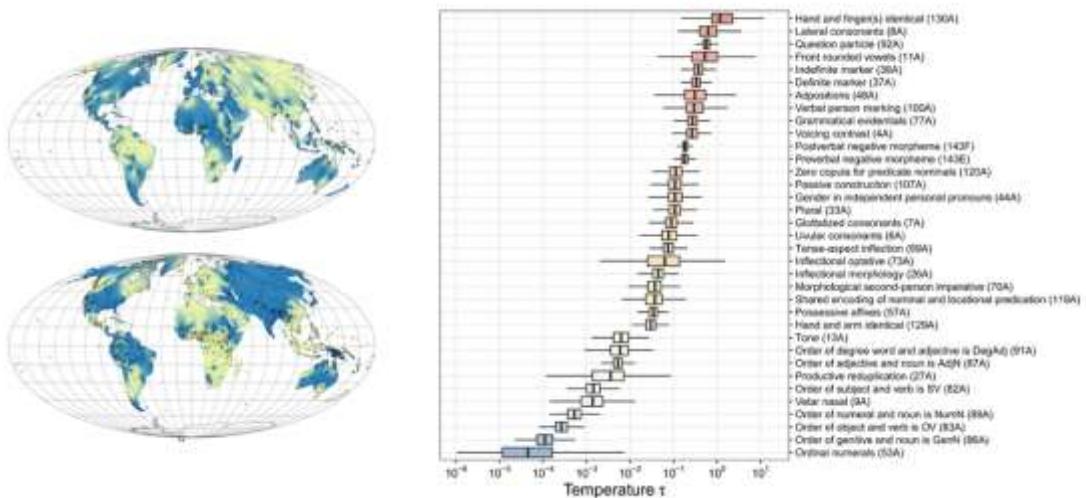


Figure 2 Left: Empirical distribution of WALS feature 37 A (definite marker), and WALS feature 83A (object-verb word order). Right: Estimated temperature for 35 WALS features.

2

PERSONNEL

2.1 PERMANENT SCIENTIFIC STAFF

| | |
|-------------------------|---|
| PERE COLET | CSIC Research Professor |
| VÍCTOR M. EGUILÚZ | CSIC Senior Researcher |
| ERNESTO ESTRADA | CSIC Research Professor (since May) |
| INGO FISCHER | CSIC Research Professor |
| TOBIAS GALLA | CSIC Tenured Scientist |
| DAMIÀ GOMILA | CSIC Tenured Scientist |
| EMILIO HERNANDEZ-GARCÍA | CSIC Research Professor, IFISC Director |
| LUCAS LACASA | CSIC Tenured Scientist (since November) |
| CRISTOBAL LÓPEZ | University Full Professor UIB |
| ROSA LÓPEZ | University Full Professor UIB |
| MANUEL MATÍAS | CSIC Senior Researcher |
| SANDRO MELONI | CSIC Tenured Scientist |
| CLAUDIO MIRASSO | University Full Professor UIB, IFISC Deputy Director |
| MAXI SAN MIGUEL | University Full Professor UIB |
| JOSE J. RAMASCO | CSIC Tenured Scientist |
| DAVID SÁNCHEZ | University Full Professor UIB |
| LLORENÇ SERRA | University Full Professor UIB, IFISC Academic Secretary |
| TOMAS SINTES | University Professor UIB |
| RAÚL TORAL | University Full Professor UIB |
| ROBERTA ZAMBRINI | CSIC Tenured Scientist |

Contribution of the permanent staff to the IFISC research lines:

Every senior researcher participates in the transversal line on Complex Systems: Statistical and Nonlinear Physics. In addition, typically a senior researcher participates in one or two other focused lines. This collaborative organization provides coherence and integration as well as interaction and bridges. It is an alternative to static schemes with disjoint groups of researchers devoted exclusively to one line of research. The following table summarizes the participation of the senior researchers in the different lines during 2020.

|  Coherence and Integration Interaction and Bridges | | Pere Colet | Víctor M. Egúiluz | Ernesto Estrada | Ingo Fischer | Tobias Galla | Damià Gomila | Emilio Hernández-García | Lucas Lacasa | Cristóbal López | Rosa López | Manuel Matías | Sandro Meloni | Claudio Mirasso | José J. Ramasco | David Sánchez | Maxi San Miguel | Llorenç Serra | Tomás Sintes | Raúl Toral | Roberta Zambrini |
|--|--|------------|-------------------|-----------------|--------------|--------------|--------------|-------------------------|--------------|-----------------|------------|---------------|---------------|-----------------|-----------------|---------------|-----------------|---------------|--------------|------------|------------------|
| 1) Complex Systems: Statistical and Nonlinear Physics | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| 2) Transport and Information in Quantum Systems | | | | | | | | | | x | | | | | x | x | | | | x | |
| 3) Nonlinear Photonics | | x | | x | | x | | | | | | | | x | | | | | | | |
| 4) Nonlinear Dynamics in Fluids. | | | | | | | | x | | x | | | | | | | | | | | |
| 5) Biocomplexity | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | | | x | x | | |
| 6) Collective phenomena in Social and Socio-technical Systems | | x | x | x | | x | | x | | | | x | | x | x | x | x | | | x | x |



2.2 TENURE TRACK AND SENIOR RESEARCH FELLOWS

| | |
|--------------------|---|
| MIGUEL C. SORIANO | Ramón y Cajal Fellow |
| GIAN LUCA GIORGI | Postdoctoral Contract Beatriz Galindo Program |
| KONSTANTIN KLEMM | Ramón y Cajal Fellow |
| MASSIMILIANO ZANIN | ERC Starting Grant |

2.3 SCIENTIFIC ASSOCIATES

JUAN CARLOS GONZÁLEZ-AVELLA
STEFANO LONGHI
HORACIO WIO

2.4 POSTDOCTORAL RESEARCH ASSOCIATES

| | |
|-----------------------|---|
| APOSTOLOS ARGYRIS | Postdoctoral Contract Project ADOPD |
| JOSEPH BARON | Postdoctoral Contract Project PACCS |
| CHRISTOS CHARALAMBOUS | Postdoctoral Contract Maria de Maeztu |
| GABOR DROTONS | Balearic Government Postdoctoral Contract |
| JUAN FERNANDEZ GRACIA | CAIB Postdoctoral Contract |
| EVA LLABRÉS | Postdoctoral Contract Project ESPOM |
| GONZALO MANZANO | Juan de la Cierva Fellow |
| JOHANN MARTINEZ | Postdoctoral Contract Project Distancia COVID |
| PERE MUJAL | Postdoctoral Contract Project QUAREC |
| CHARLES N. DE SANTANA | Postdoctoral Contract La Caixa/UPF |
| FELIPE E. OLIVARES | Postdoctoral Contract Project ARTIC |

| | |
|-----------------------|--|
| SILVIA ORTIN | Postdoctoral Contract Project ADOPD |
| TOMASZ J. RADUCHA | Postdoctoral Contract Project SOTECSYS |
| LUCIA S. RAMIREZ | Postdoctoral Contract Maria de Maeztu |
| GIULIA RUZZENE | Postdoctoral Contract Maria de Maeztu |
| SUNGGUEN RYU | Postdoctoral Contract Maria de Maeztu |
| ANDRE RÖHM | Postdoctoral Contract Maria de Maeztu |
| ANDREA TABI | Postdoctoral Contract Maria de Maeztu |
| ROELAND VAN DE VIJSEL | Postdoctoral Contract Project SUMAECO |
| FATIMA Z.E. VELASQUEZ | Postdoctoral Contract FACE |

2.4 PHD STUDENTS

| | |
|---------------------|--|
| DAVID ABELLA | Contract Projects Complexity1 + PACCS |
| JAVIER AGUILAR | Maria de Maeztu Contract and CAIB |
| ALEJANDRO ALMODOVAR | Maria de Maeztu Contract |
| MIGUEL ALVAREZ | FPI Contract Maria de Maeztu |
| BEATRIZ ARREGUI | FPI Contract Maria de Maeztu |
| NASSIMA BENCHTABER | FPI Contract Project TQM@NANO |
| ALBERT CABOT | FPI Fellow Balearic Government |
| ANNALISA CALIGIURI | Maria de Maeztu Contract |
| VIOLETA CALLEJA | FPI Fellow Balearic Government |
| MARCO CATTANEO | Maria de Maeztu Contract |
| JUAN I. DE GREGORIO | Maria de Maeztu Contract |
| REBECA DE LA FUENTE | FPI Contract Project LAOP |
| FERNANDO DIAZ | FPI Contract Maria de Maeztu |
| GIOVANNI DONATI | Maria de Maeztu Contract |
| NOEMIE EHSTAND | Contract Marie Curie Network CAFE |
| CRISTIAN ESTARELLAS | Contract Project DECAPH |
| IRENE ESTÉBANEZ | Maria de Maeztu Contract |
| MAR FERRI | Maria de Maeztu Contract |
| JAVIER GALVAN | FPI Contract Maria de Maeztu |
| JORGE GARCÍA BENI | Contract Project QUARESC associated to Ramon y Cajal |
| ALEX GIMENEZ | Contract Project SUMAECO |
| MIRKO GOLDMANN | Contract Marie Curie Network Postdigital |
| ADRIA LABAY | Contract associated to the Beatriz Galindo Program |
| GUILLEM LLODRA | Contract Project “Aprendizaje Automático Cuántico” |
| ERJIAN LIU | Beijing Jiaotong University, China |
| THOMAS LOUF | Maria de Maeztu Contract |

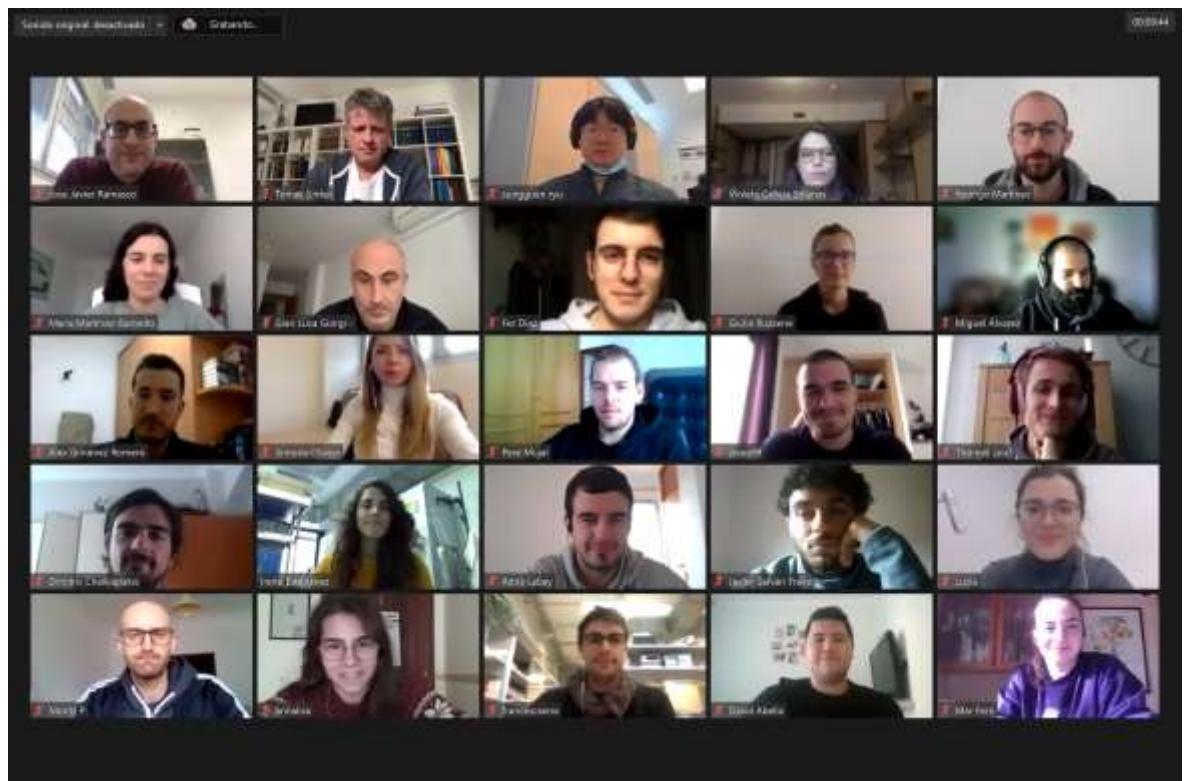
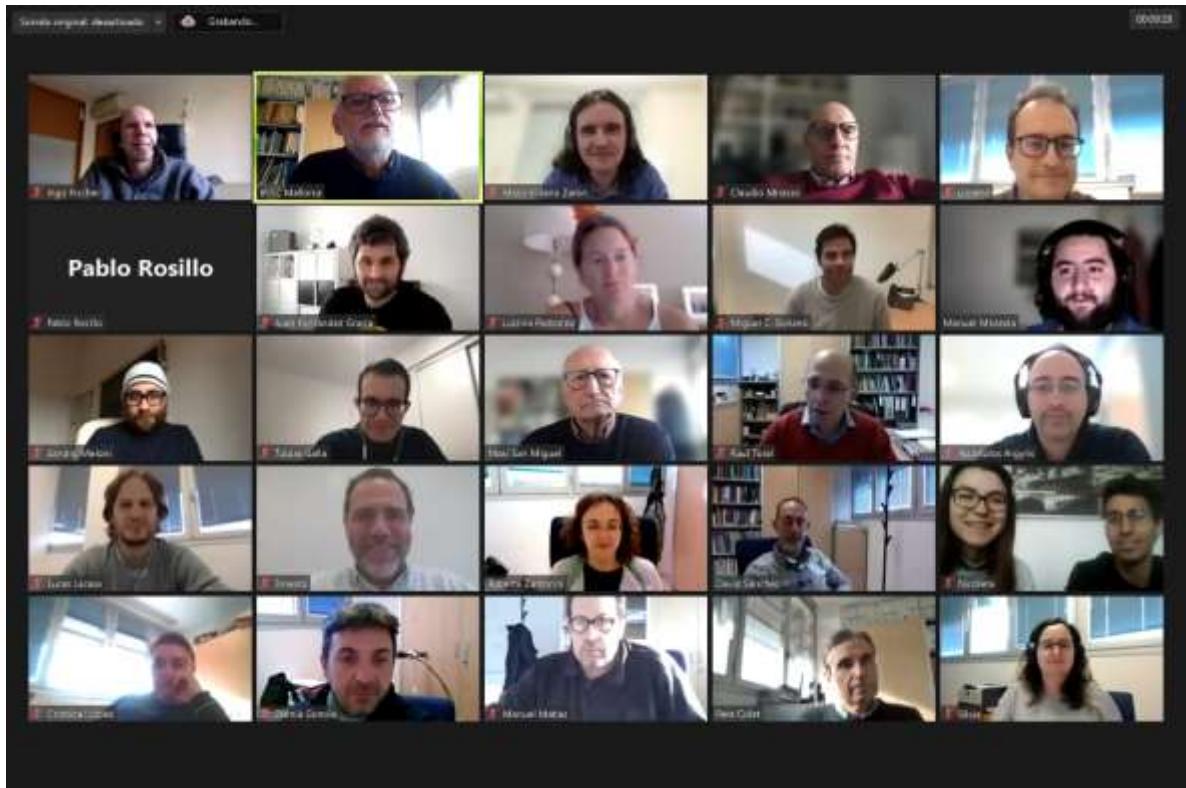
| | |
|-------------------------|--|
| MARIA MARTINEZ BARBEITO | Maria de Maeztu Contract |
| RODRIGO MARTÍNEZ PEÑA | Maria de Maeztu Contract |
| MATTIA MAZZOLI | FPI Fellow Balearic Government |
| JORGE MEDINA | FPI Contract Maria de Maeztu |
| MANUEL MIRANDA | FPI Contract Project OPERADORES |
| JESUS A. MORENO | FPI Contract Project PACCS |
| PABLO MORENO | FPI Contract Project SUMAEKO |
| LUISINA PASTORINO | Contract Project ARTIC |
| JAIME SANCHEZ CLAROS | FPI Fellow Balearic Government |
| SOMAYE SHEYKHALI | Contract Project CAASE |
| MORITZ PFLÜGER | Contract Project Complex Photonics |
| LUCAS R. TALANDIER | Contract Marie Curie Network Postdigital |

2.5 TECHNICAL AND ADMINISTRATIVE SUPPORT

| | |
|--------------------|--|
| ROBERTO J. ALCARAZ | Computing Lab Data Engineer |
| MIQUEL ARTIGUES | Computing Lab Data Engineer |
| INMA CARBONELL | Accountant |
| JONATHAN FERRER | Lab Technician |
| ADRIAN GARCÍA | Communication and Dissemination |
| JUAN MANUEL GARCIA | Lab Technician |
| JOSEP MATEU | Administration Unit Head IFISC Manager |
| SIMONA OBREJA | Project Manager |
| MARTA OZONAS | IFISC Secretary |
| SERGI ROMERO | Computing Lab Data Engineer |
| FRANCESC SERRA | Lab Technician |
| EDUARD SOLIVELLAS | Computing Lab Technician |
| RUBEN TOLOSA | Computing Lab Technician |
| ANTONIA TUGORES | Data Engineer |

2

PERSONNEL



2.6 VISITORS

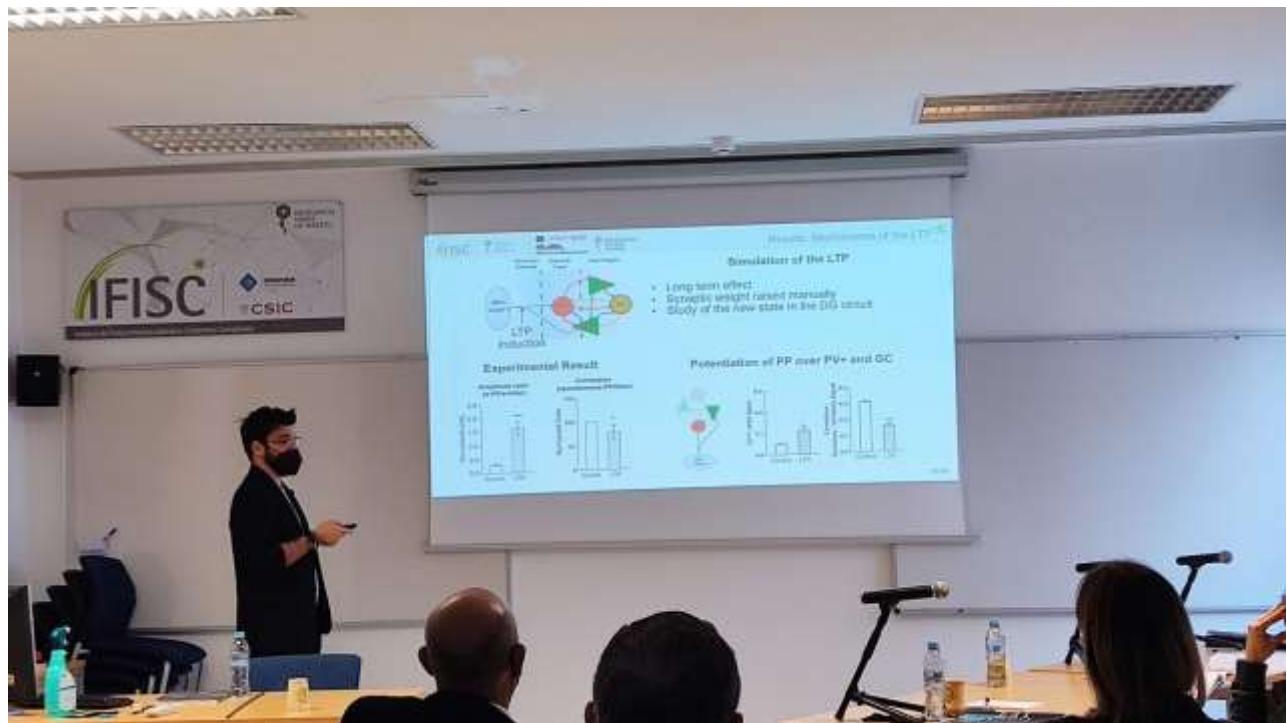
LONG-TERM VISITORS (more than one month)

| | |
|-----------------------|--|
| ANDREU ARINYO I PRATS | Institut de Computació de la Republica Checa (January - July) |
| ALBERTO PEREZ | Higher School of Economics, Moscow, Russia (January-Dec.) |
| MURIELLE V. TCHAKUI | Univ. of Yaounde, Cameroon (Sept.- Nov.) |
| ERIC D. DONGMO | Univ. of Yaounde, Cameroon (Sept. - Nov.) |
| FEDERICO VAZQUEZ | Univ. Buenos Aires, Argentina (Sept.- Nov.) |
| CARLOS MELIAN | LTH, Switzerland.(Oct.- Nov.) |
| JOSE M. GUTIERREZ | IFCA, Santander, Spain (Oct..- Dec.) |
| IAGO PEREZ | Univ. de la Republica de Uruguay (Oct.-Nov.) |



**SHORT-TERM VISITORS
(Less than one month)**

| | |
|--------------------|--|
| CLAUDIO GALLICCHIO | Univ. de Pisa, Italy (September) |
| JAN ROMBOUTS | KU Leuven, Belgium (September) |
| SHRADHHA GUPTA | Postdam Institute for Climate Impact Research (September) |
| BENJAMÍN CARRERAS | Univ. Alaska, USA. (October) |



2.7 MASTER AND COLLABORATION STUDENTS

In addition to the IFISC personnel, master and collaboration students have been also involved in IFISC research:

2020-2021 IFISC Master

OLA ALI
JOAN ANTICH
GORKA BUENVARON
RUBEN CALVO
MARIA TERESA CORZO
MAR CUEVAS
FERNANDO DIAZ
PAU ESTEVE
ROSA FLAQUER
BENJAMIN M. FRIED
JACOPO GIORGI
TERESA LAZARO
JORGE MAMPEL
CARLES M. MARTORELL
MARTA PEDROSA
BARTOLOME PONS
MIGUEL RODRIGUEZ GOMEZ
ALEXANDRA SERNA

2021-2022 IFISC Master

RAUL LOPEZ MARTIN
JOSE M. RAMOS FERNANDEZ
JOSE A. ALMANZA MARRERO
MIGUEL A. GONZALEZ CASADO
DIMITRIOS CHALKIADAKIS
DANIEL CEBRIAN LACASA
ALFREDO CRESPO OTERO
MUSTAPHA BOUSALKIA
NICOLETA KYOSOVSKA
SARA OLIVER BONAFOUX
JAUME LLABRES RUBIO
MIQUEL DURAN POU
PABLO ROSILLO RODES
ENRIQUE ROZAS GARCIA
CARLSON M. BUTH
LINA E. NAVARRO ALVARADO
JUAN M. RODRIGUEZ DIAZ
AKSHAY TIWARI
HIRA ALI

Collaboration students

ELEONORA BERNASCONI
ANTONIO SANNIA

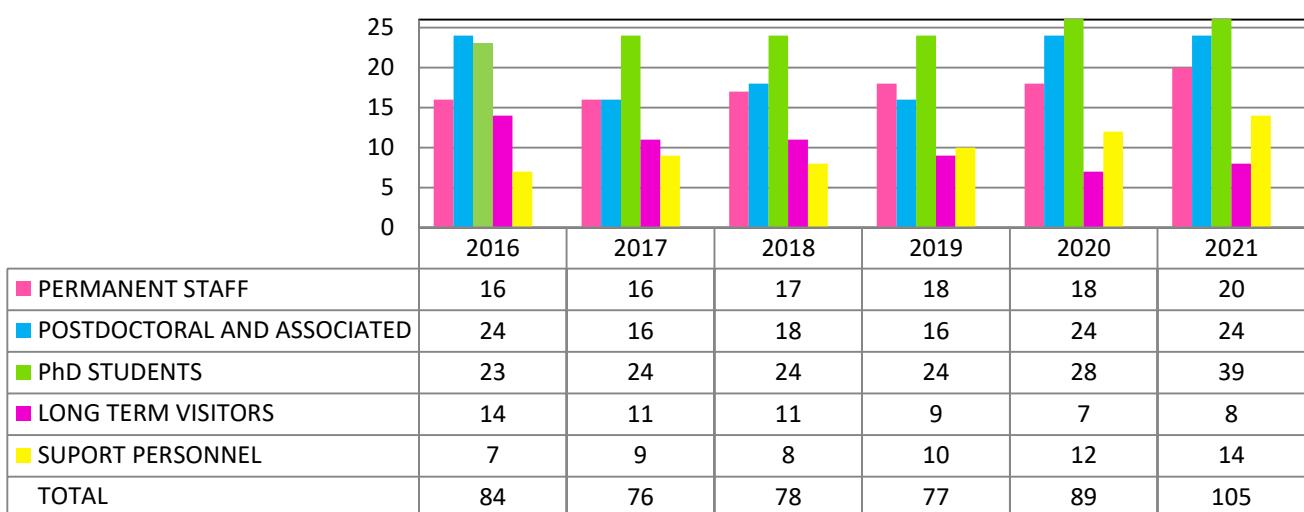
ERASMUS+ mobility student, Univ. Genova, Italy (March-Sept.)
ERASMUS+ University of Calabria, Italy (September)

2.8 HUMAN RESOURCES OVERVIEW

HUMAN RESOURCES IFISC 2021

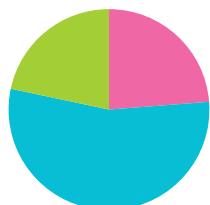
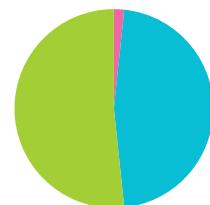
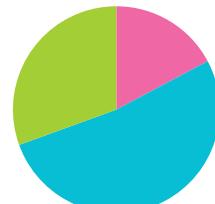
| | Total | Male | Female |
|----------------------|-------|------|--------|
| Permanent staff | 20 | 18 | 2 |
| Postdoctoral fellows | 24 | 18 | 6 |
| PhD students | 39 | 28 | 11 |
| Long-term visitors | 8 | 7 | 1 |
| Support personnel | 14 | 10 | 4 |
| Total | 105 | 81 | 24 |

PERSONNEL IFISC 2016-2021



VISITING SCIENTISTS AT IFISC 2016-2021

| | | Short visits | Long visits | Total visits |
|--|-------------------|--------------|-------------|---------------------|
| | SPAIN | 34 | 1 | 35 |
| | EUROPE | 78 | 28 | 106 |
| | REST OF THE WORLD | 31 | 31 | 62 |
| | TOTAL | 143 | 60 | 208 |

Short visits**Long visits****Total visits**

2

PERSONNEL

3

RESEARCH PROJECTS AND FUNDING

DURING 2021 IFISC HAS RECEIVED FUNDING VIA THE ACTIVE RESEARCH PROJECTS LISTED IN THE FOLLOWING PAGES. IN BRIEF:

- European Commission Framework Program projects: 7
- Spanish National Plan: 9
- Collaboration Networks: 7
- Research Contracts: 2

Grand total budget of active projects in 2021: 8.333.802 € (including 2.000 k€ MdM)

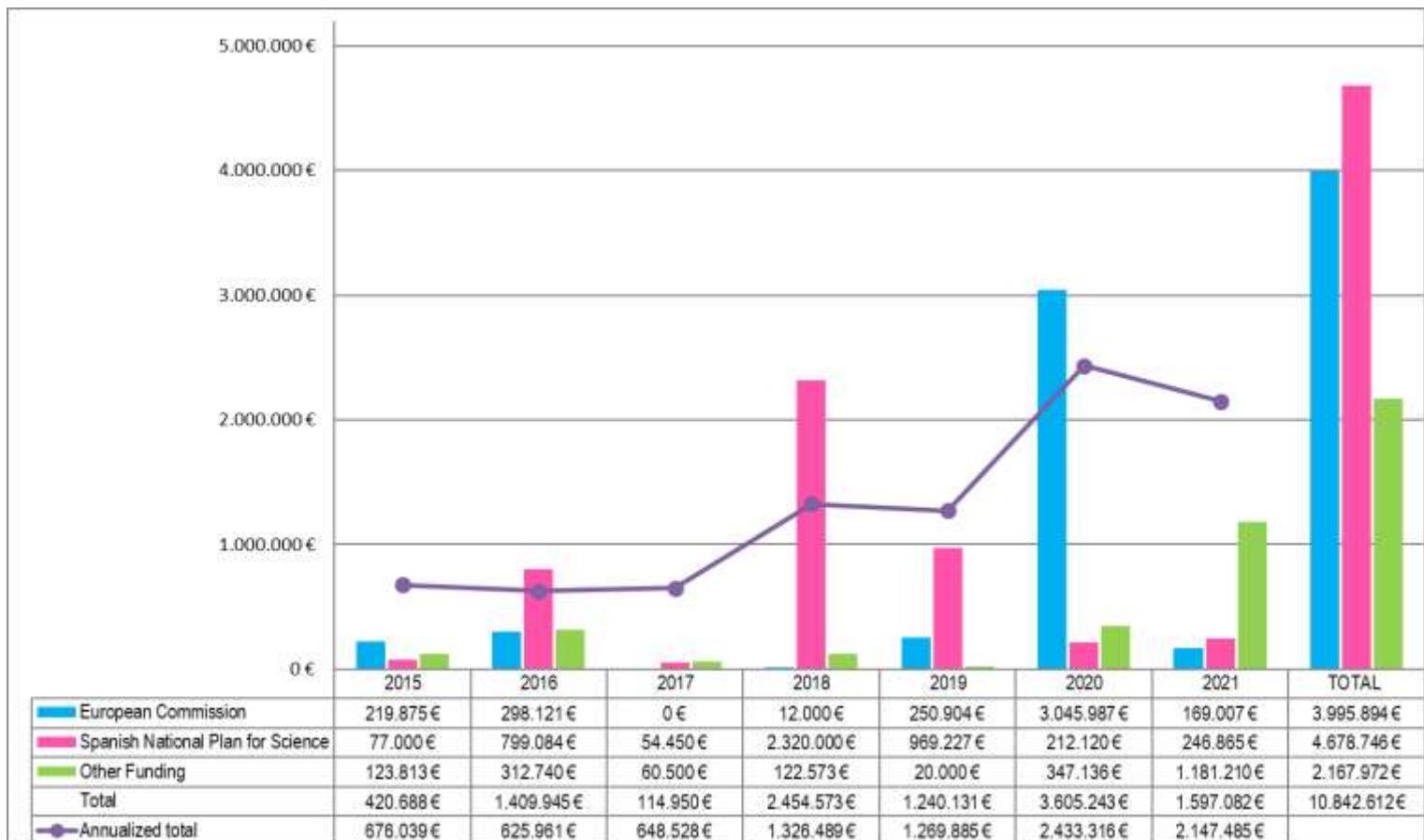
Average yearly project funding in 2015-21: 1.548.944 €

Average EC funding in 2015-21: 36,85 % of total (excluding MdM)

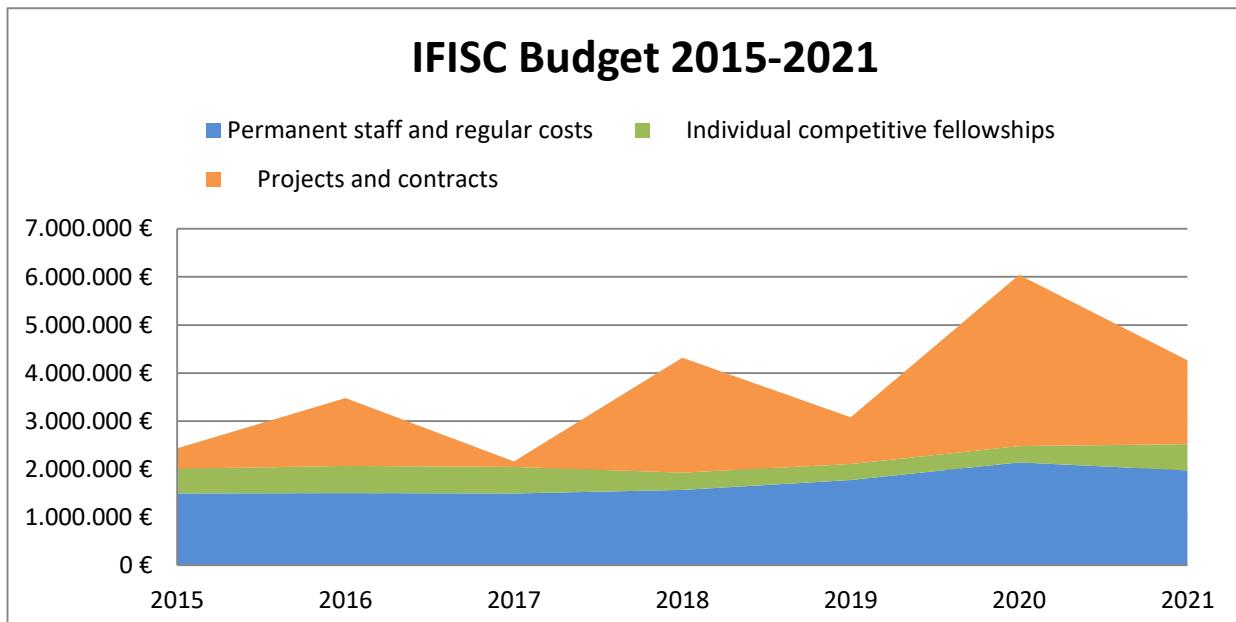
BUDGET FIGURES FOR THE PERIOD 2015-2021 ARE SUMMARIZED IN THE FOLLOWING TABLE

(With budget of a project assigned to the year it is granted. The *Annualized total* is the sum of one-third of the budget granted in that year and in the two previous years):

BUDGET IFISC'S RESEARCH PROJECTS 2015-2021 (IN €)



IFISC also receives external funding in terms of individual competitive predoctoral and postdoctoral fellowships, as specified in the following table and figure. There, 'total external funding' includes these fellowships together with the budget of research projects and contracts. 'Total IFISC budget' includes the total external funding together with costs of permanent staff and regular budget contributions from UIB and CSIC.



2015-21 yearly-average total budget : **3.664.338 €**

2015-21 yearly-average of total external funding: **1.958.950 €**

2015-21 average ratio of financing from external sources: **53.46 %**

2015-21 individual competitive Pre and Postdoc fellowships **23.50 % of competitive funding**

3.1 RESEARCH FUNDED BY THE EUROPEAN COMMISSION

CAFE

Climate Advanced Forecasting of sub-seasonal Extremes. Marie Skłodowska-Curie Innovative Training Network. CSIC. [813844]. IFISC Principal Investigator: Emilio Hernández- García (2019-2023) .
Budget: 250.904,88 €

ADOPD

Adaptive Optical Dendrites. Program H2020-EU1.2.1. [899265] IFISC Principal Investigators: Claudio Mirasso and Ingo Fischer. (2020-2023) Budget: 955.250 €

VPP4ISLANDS

Vitual Power Plant for Interoperable and Smart Islands. Innovation Action [957852] IFISC Principal Investigator: Pere Colet. (2020-2024) Budget: 309.903 €

POST-DIGITAL

Neuromorphic computing in photonic and other nonlinear media. Marie Skłodowska-Curie Initial Training Network [860360] IFISC Principal Investigators: Claudio Mirasso and Ingo Fischer. (2020-2024) Budget: 483.810 €

ARCTIC

Air Transport as Information and Computation. European Research Council Starting Grant [851255] IFISC Principal Investigator: Massimiliano Zanin. (2020-2025) Budget: 1.297.024 €

DYNDEEP

Dynamics of Temporal Networks: Memory and Deep Learning. Special Action. IFISC Principal Investigator: Lucas Lacasa. (2021-2023) Budget: 93.202 €

Climb-Out

ChiLd MicroBes predict how to stay away from Obesity. EU Contract. IFISC Principal Investigator: Claudio Mirasso (2021-2022). Budget: 75.805 €

3.2 RESEARCH PROJECTS OF THE SPANISH NATIONAL PLAN FOR SCIENCE**MdM – IFISC**

Accreditation of IFISC as “Maria de Maeztu, Unit of Excellence”. Principal Investigator: Claudio Mirasso. (2018-2022) Budget: 2.000.000 €

Next4Mob

Next Generation Tools for advanced mobility solutions. Strategic Line Project. IFISC Principal Investigator: Jose J. Ramasco (2021-2024) Budget: 62.340 €

DECAPH

Dendrite-based Computation Applied to Photonics Systems. [PID2019-111537GB-C21 y C22]. IFISC Principal Investigators: Apostolos Argyris, Ingo Fischer and Claudio Mirasso. (2020-2022) Budget: 104.060 €

PACCS

Physics approach to complexity in sociotechnical systems. [RTI2018-093732-B-C2]. Principal Investigators: Maxi San Miguel, Raul Toral, Jose J. Ramasco and Sandro Meloni (2019-2021). CSIC Budget: 133.100 €. UIB Budget: 151.250 €

SuMaECO

Sustainability of marine coastal ecosystems in the context of global change in the Mediterranean sea: Modeling and simulations. [RTI2018-095441-B-C22]. Principal Investigators: Damia Gomila and Tomas Sintes. (2019-2021). CSIC Budget: 196.020 €

QUARESC

Quantum Machine Learning using reservoir computing. [PID2019-109094GB-C21] IFISC Principal Investigators: Miguel C. Soriano and Roberta Zambrini (2020-2023) Budget: 104.060 €

OLGRA

Operadores Laplacianos en grafos y redes con repulsores/attractores y dinámicas relacionadas. [PID2019-107603GB-I00] IFISC Principal Investigator: Ernesto Estrada. (2020-2023) Budget: 27.830 €

MISLAND

Modelling Island Ecological Complexity in the context of global change. [PID2020-114324GB-C22] IFISC Principal Investigators: Lucas Lacasa and Victor M. Eguiluz (2021-2024) Budget: 84.095 €

QuTTNAQMa

Transporte cuántico y termodinámica: nuevas avenidas en materiales cuánticos. [PID2020-117347GB-I00] IFISC Principal Investigators: Rosa López and Llorenç Serra. (2021-2024) Budget: 72.600 €

3.3 OTHER PUBLIC FUNDING**ESPOM**

Ecosystemic services in posidonia oceanica meadows. Balear Government [PRD2018/18] IFISC Principal Investigator: Tomas Sintes. (2020-2023) Budget: 50.000 €

NouLloguer

Influence of new models of vacation renting on residential housing: ICT Data economic analysis. Balear Government. [PED2018/43] IFISC Principal Investigator: Jose Ramasco. (2020-2023). Budget: 60.671 €

QUAREC

Machine learning with quantum reservoir computing. Balear Government. [PRD2018/47] IFISC Principal Investigator: Roberta Zambrini. (2020-2023) Budget: 99.750 €

Distancia – COVID

Impact of social distancing measures on the spreading of COVID-19 pandemics in Spain. Proyecto Intramural Especial [CSIC-COVID-19] IFISC Principal Investigator: Jose Ramasco (2020-2021) Budget: 96.375 €

iCOOP**Reinforcement of research and training on power grid instability control.**

Programa CSIC de Cooperación Científica para el Desarrollo (i-COOP+) [COOPB20476] IFISC Principal Investigator: Pere Colet. (2020-2022) Budget: 34.308 €

MOREHOUSE

Modeling hOusing maRkets dynamics thanks to Emerging and HeterogeneoUs data SourcEs. CSIC – CRNS. PICS Project. [2018FR0031]. Principal Investigator: Jose J. Ramasco. (2019-2021). CSIC Budget: 20.000 €

CAFECONMIEL**Corpus Automático y Fenómenos de Contacto en Mallorca:**

Inteligencia, Entrenamiento y Lengua. Ajudes Especials de Recerca, desenvolupament tecnològic i innovació del Govern Balear. IFISC Principal Investigator: David Sánchez (2021-2024) Budget: 47.510 €

MACTOPE**Materia Cuántica Topológica: Precisión y Energía.** [PDR2020/12]

Ajudes Especials de Recerca, desenvolupament tecnològic i innovació del Govern Balear. IFISC Principal Investigator: Rosa López (2021-2023) Budget: 37.200 €

FACE**Fair Computational Epidemiology.** [SGL2021-03] Project

associated to the CSIC Interdisciplinary Thematic Platform on Global Health. IFISC Principal Investigator: Jose J. Ramasco. (2021-2022) Budget: 1.080.000 €

3.4 RESEARCH CONTRACTS

Xylella

Teledetección multiespectral y machine learning para determinar síntomas y extensión de la Xylella fastidiosa en almendros. Principal Investigator: Jose J. Ramasco. (2020-2021) Budget: 6.031,85 €

Població flotant

Estudi de població flotant a través de Twitter. In collaboration with the Balear Government. IFISC Principal Investigator: Jose J. Ramasco (2021) Budget: 8.250 €

3.5 RESEARCH PROJECTS AND COLLABORATION NETWORKS WITH PARTICIPATION OF IFISC MEMBERS

IN-TREE

INCT in Interdisciplinary and Transdisciplinary Studies in Ecology and Evolution. CNPq, CAPES, FAPESB Brazil. IFISC Principal Investigator: Emilio Hernández García. (2016-2022)

MOBILITY2030

Sustainable and healthy urban mobility. CSIC Interdisciplinary Thematic Platform (PTI). Principal Investigator at IFISC: J.J. Ramasco

Global Health

Global Health. CSIC Interdisciplinary Thematic Platform (PTI). Principal Investigator at IFISC: J.J. Ramasco

AIHUB

HUB CSIC for fomenting the research and services on Artificial Intelligence. CSIC Interdisciplinary Thematic Platform (PTI). Principal Investigator at IFISC: J.J. Ramasco

QTEP

Quantum Technologies Platform. CSIC Interdisciplinary Thematic Platform. Principal Investigators at IFISC: Roberta Zambrini and Llorenç Serra.

Neuro – Aging

Entender el envejecimiento desde la I+D+i. CSIC Interdisciplinary Thematic Platform (PTI+). IFISC Principal Investigator: Claudio Mirasso (2021-2022)

COVID-SHINE

Understanding the spatio-temporal social determinants on health to improve agent-based modelling of recurrent COVID-19 outbreaks. [SR20-00386] La Caixa Foundation. IFISC Principal Investigator: Victor M. Eguiluz. (2021-2022)

3.6 NON-DISCLOSURE AND COLLABORATION AGREEMENTS WITH NON-ACADEMIC INSTITUTIONS



4

IFISC
SEMINARS

4

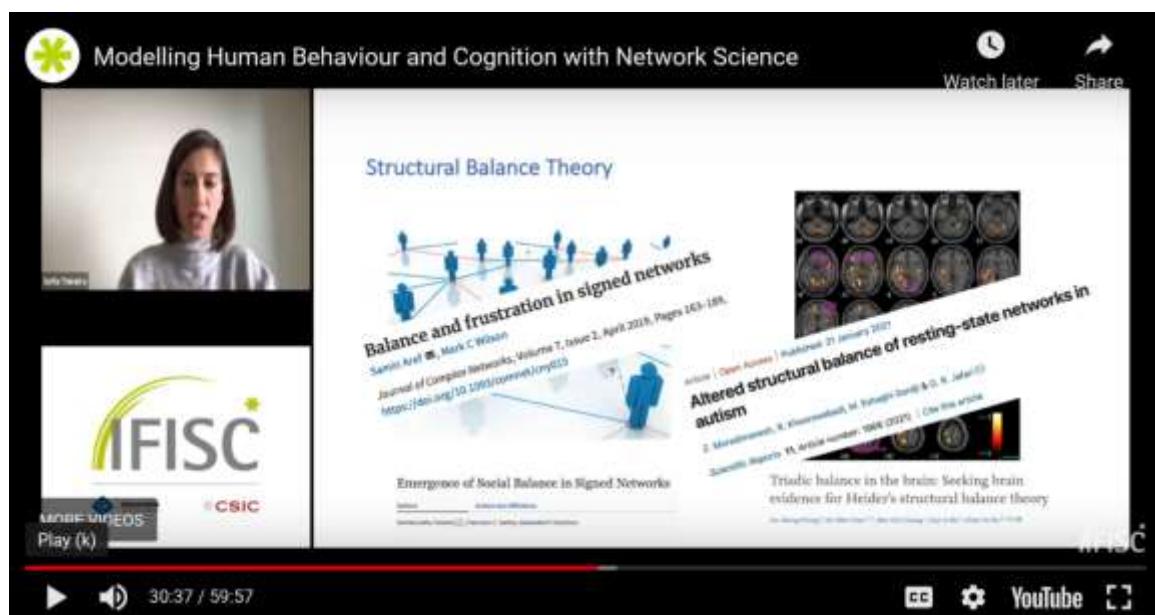
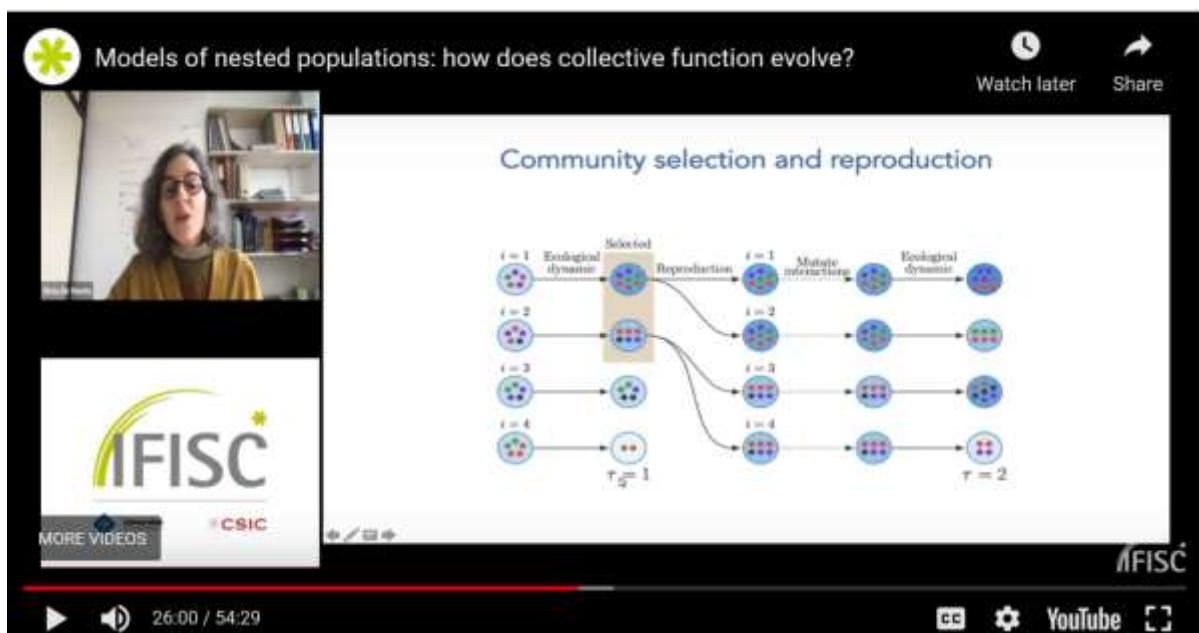
IFISC SEMINARS

Coordinators:

Tobias Galla
Llorenç Serra (until July)
Sandro Meloni (from August)

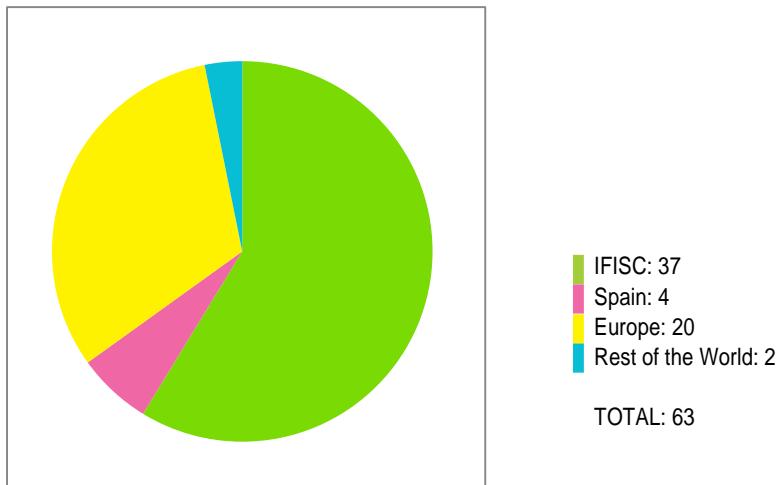
A total of 63 seminars, including weekly regular seminars and talks, were given at IFISC in 2021. The full list of seminars can be found at the website: <http://ifisc.uib-csic.es/en/events/seminars/> as well as in the Appendix of this report.

Seminars are broadcasted live and recorded. They are globally available at <http://ifisc.uib-csic.es/en/events/seminars/>, and also on our youtube channel <https://www.youtube.com/user/IFISCseminars/>



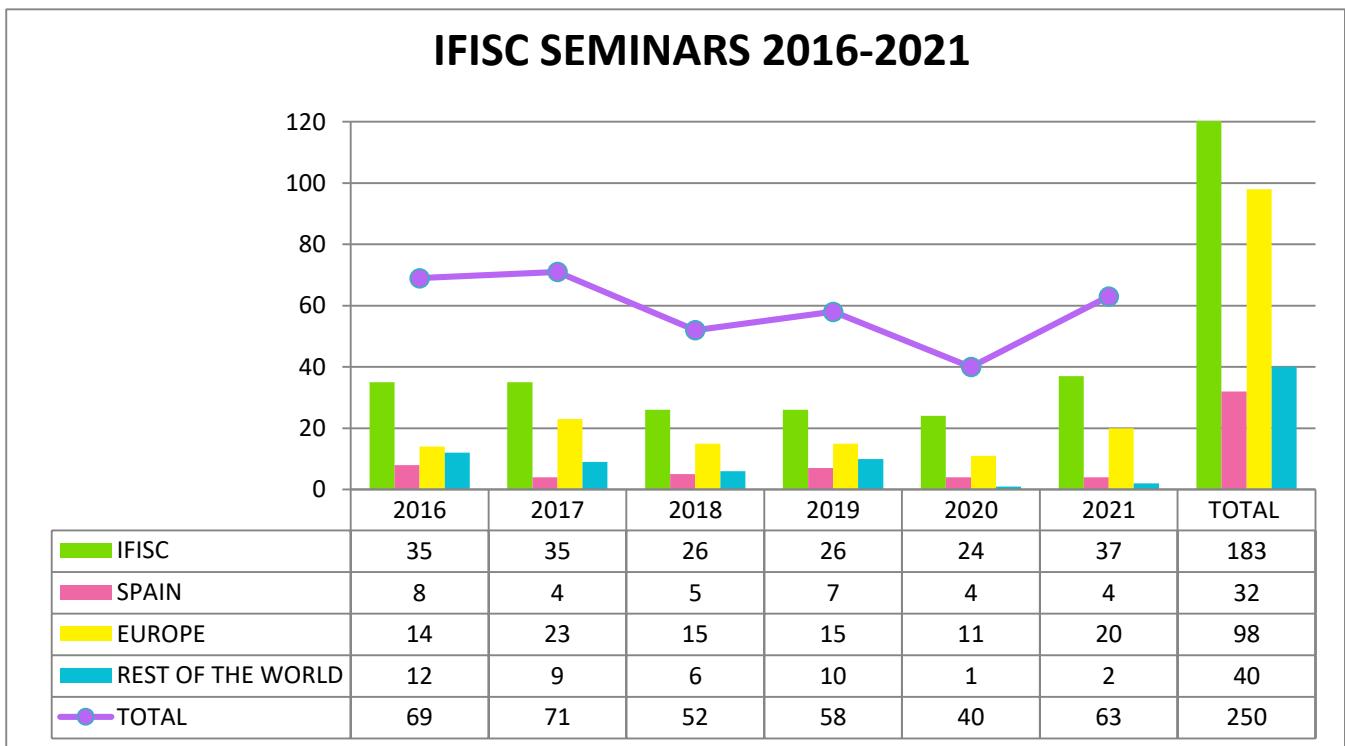
The following graphs show the distribution of seminars by geographical provenance of the speaker for 2021 and for the previous years:

PROVENANCE OF SPEAKERS AT IFISC SEMINARS 2021



IFISC SEMINARS 2016-2021

IFISC SEMINARS 2016-2021



5

PUBLICATIONS

IFISC RESEARCH RESULTS HAVE BEEN REPORTED IN THE FOLLOWING PUBLICATIONS DURING 2021:

- Papers in indexed journals: **125**
- Other publications: **18**

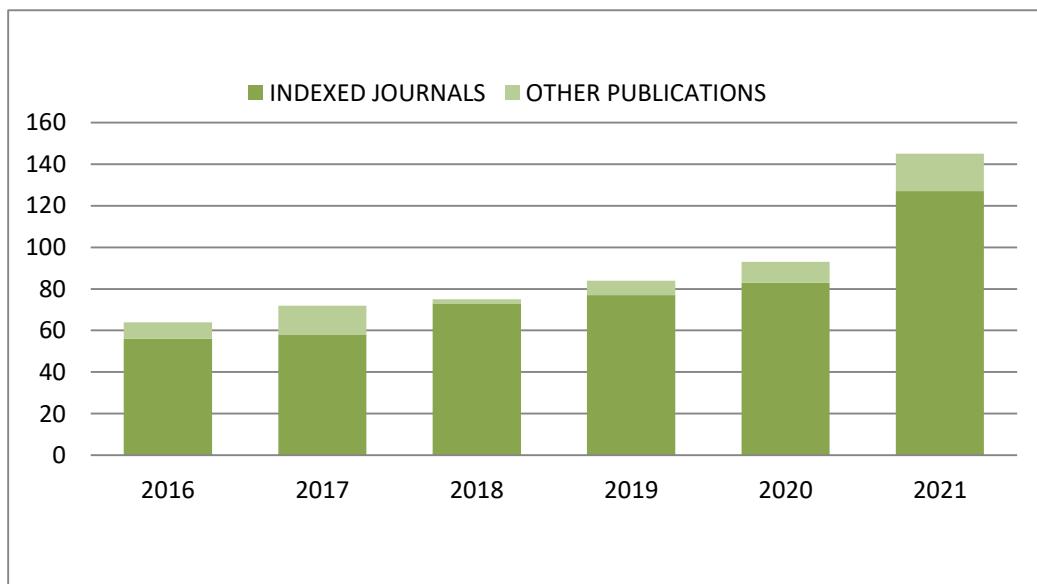
The following tables place these numbers in the context of the publication activity during the past years, specifying the main journals in which IFISC papers are published. It is a strategic commitment of IFISC to target cross-disciplinary research areas lying outside the domain of traditional physics. The success in this objective is highlighted in the tables by indicating the number of publications in *non-physics journals*.

With respect to publications in high impact journals, in 2021 IFISC has published 1 paper in Nature, 2 papers in Science, 4 papers in Nature Communications, 3 in Science Advances, 1 paper in Nature Reviews, 1 in Nature Methods, 1 in Nature Photonics, 1 in Nature Machine Intelligence, 1 paper in Physical Review X, and 4 papers in Physical Review Letters.

- Non Physics Journals: **40**
- High Impact Journals: **19**

Full listing of publications and links to the full text are available here: <http://ifisc.uib-csic.es/en/publications/> and in the Appendix of this Report.

IFISC PUBLICATIONS 2016-2021



| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | TOTAL |
|--------------------|-----------|-----------|-----------|-----------|-----------|------------|------------|
| INDEXED JOURNALS | 56 | 58 | 73 | 77 | 83 | 125 | 472 |
| OTHER PUBLICATIONS | 8 | 14 | 2 | 7 | 10 | 18 | 59 |
| TOTAL | 64 | 72 | 75 | 84 | 93 | 145 | 532 |

JOURNALS WITH THE LARGEST NUMBER OF PUBLICATIONS

| IFISC PUBLICATIONS | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | TOTAL |
|-----------------------------------|------|------|------|------|------|------|-------|
| Physics journals | | | | | | | |
| Physical Review E | 9 | 4 | 10 | 8 | 3 | 9 | 43 |
| Physical Review B | 5 | 4 | 5 | 2 | 5 | 7 | 28 |
| Chaos | 2 | 5 | 4 | 4 | 8 | 5 | 28 |
| New Journal of Physics | 5 | 3 | 4 | 3 | 2 | 5 | 22 |
| Optics Letters | 2 | 1 | 0 | 0 | 7 | 5 | 15 |
| Physical Review Letters | 1 | 1 | 3 | 1 | 2 | 4 | 12 |
| Physical Review A | 3 | 3 | 0 | 1 | 2 | 2 | 11 |
| | | | | | | | |
| Multidisciplinary journals | | | | | | | |
| Scientific Reports | 7 | 11 | 3 | 9 | 5 | 8 | 43 |
| Plos One | 2 | 1 | 4 | 0 | 3 | 0 | 10 |
| Nature Communications | 0 | 0 | 0 | 2 | 2 | 4 | 8 |
| | | | | | | | |
| IEEE journals | | | | | | | |
| Other non-physics journals | 2 | 1 | 0 | 2 | 4 | 3 | 12 |
| Other non-physics journals | 7 | 7 | 13 | 21 | 11 | 40 | 99 |

The journals included in the “other non-physics journals” category are the following:

Biosciences:

Trends in Ecology and Evolution, Journal of Theoretical Biology, Bulletin of Mathematical Biology, Journal of the Royal Society Interface, Interface Focus, eLife, PLoS Computational Biology, PLoS Genetics, Ecological Complexity, Ecological Modelling, Ecography, Biomolecules, Ecography, NPJ Systems Biology and Applications, Frontiers in Neuroscience, Frontiers in Medicine, Computer Methods and Programs in Biomedicine, Environmental Microbiology, The ISME Journal, Global Ecology and Biogeography, Biological Conservation, Viruses, Cybergeo, Methods in Ecology and Evolution, Theoretical Population Biology, Journal of Theoretical Biology, Briefings in Bioinformatics, and Ecological Applications.

Earth sciences:

Journal of Geophysical Research, Nonlinear Processes in Geophysics, ICES Journal of Marine Science, Earth Science Dynamics, Progress in Oceanography, Frontiers in Earth Science, Frontiers in Marine Science, Journal of Marine Systems, Tellus, Ocean Science, and Journal of Climate.

Sociotechnical and Social systems:

Palgrave Communications, Journal of Economic Interaction and Coordination, Transportation Research, Journal of Air Transport management, International Journal of Electrical Power and Energy Systems, Built Environment, Games and Economic Behaviour, and Journal of Transport Geography.

Data science, Neuroscience and Machine learning:

Mathematical models and Methods in the Applied Sciences, Frontiers in Neuroinformatics, Neuroimage, Neural Networks, EPJ Data Science, Cognitive Computation, Nature Machine Intelligence, Neurocomputing, IEEE Transactions on Neural Networks, Emerging topics in Artificial Intelligence, Communications in Nonlinear Science and Numerical Simulation, IMA Journal of Applied Mathematics, JAMA Network Open, Human Brain Mapping, Frontiers in Systems Neuroscience, Frontiers in Robotic and AI, Research Synthesis Methods, Brain Topography, Brain Sciences, and Applied Network Science.

5

PUBLICATIONS

6

CONFERENCES AND WORKSHOPS

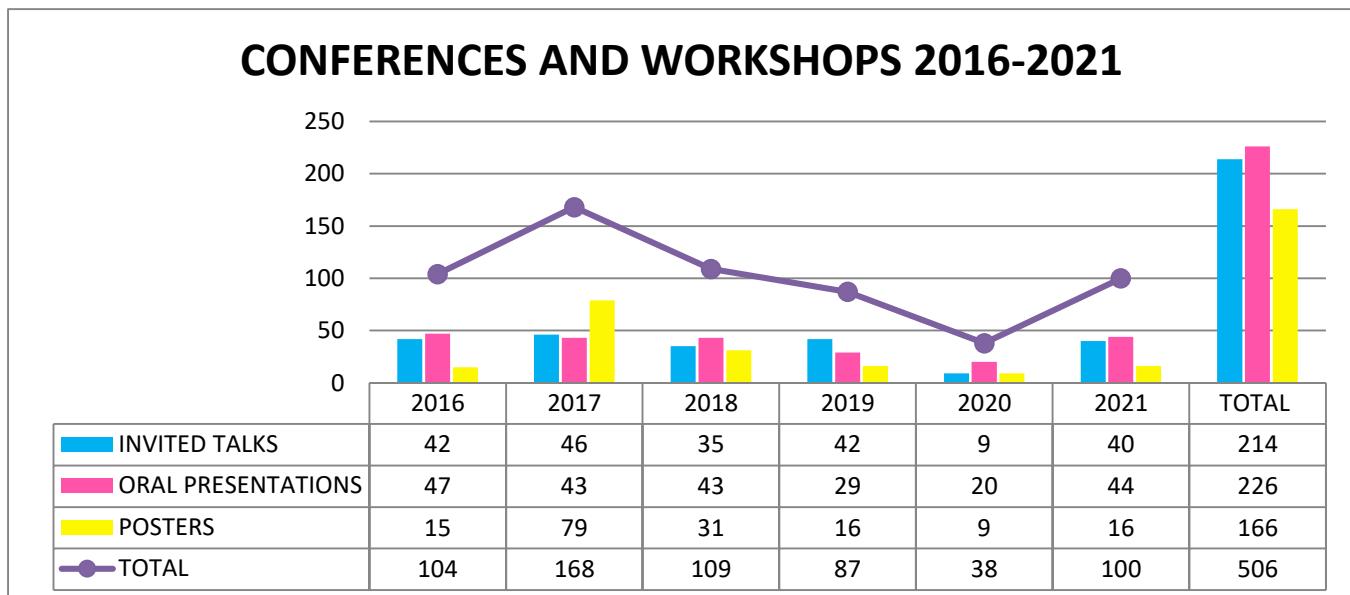
6

CONFERENCES AND WORKSHOPS

6.1 PRESENTATIONS AT SCIENTIFIC CONFERENCES 2021

- Invited talks: **40**
- Oral presentations: **44**
- Posters: **16**
- Total: **100**

Full listing in the Appendix of this Report.



6.2 ORGANIZATION OF CONFERENCES AND WORKSHOPS

Calleja-Solanas, Violeta

- **Member of the scientific and organizing Committee of the I FisEs Joven 2021 event by GEFENOL.**
- **Member of the Organizing Committee of the Conference on Complex Systems 2021 Warm-Up event by Young Researchers of the Complex Systems Society.**

Cornelles Soriano, Miguel

- **Program Committee Member. Emerging Topics in Artificial Intelligence (ETAI).**
- **Organizing committee of the Workshop: Deep Learning in Unconventional Neuromorphic Hardware.**
- **Member of the technical program committee of the International Symposium on Physics and Applications of Laser Dynamics, IS-PALD 2021.**

Estébanez, Irene

- **Organizing committee of the Workshop: Deep Learning in Unconventional Neuromorphic Hardware.**

Meloni, Sandro

- **Elected Member of the Steering Committee of the Conference on Complex Systems, CCS2021.**

Ramasco, Jose J.

- **Elected Member of the Steering Committee of the Conference on Complex Systems, CCS2021.**
- **UrbanSys2021.**
Satellite workshop to the Conference on Complex Systems CCS2021 hold in Lyon, France.

Sánchez, David

- **Organizing committee of the Energy and Information Transport in Non-Equilibrium Quantum Systems.**
Kavli Institute for Theoretical Physics (University of California, Santa Barbara).

Toral, Raul

- **Codirector of the conference Statistical Physics of Complex Systems (Trieste).**

6

CONFERENCES AND WORKSHOPS

Víctor M. Eguíluz and Juan Fernández-Gracia

- **Co-chair and member of the organizing committee of ECONET2021: V Symposium on ecological networks**

7

OTHER ACTIVITIES

7.1 PhD PROGRAM

IFISC participates in the PhD Program in Physics of the University of the Balearic Islands. During 2021, 39 PhD students developed their research project at IFISC, and 3 PhD thesis were completed and successfully defended:

Synchronization and collective phenomena in quantum dissipative systems

Cabot, Albert (supervisors: Zambrini, Roberta; Giorgi, Gian Luca)

November 29

Study on the role of inhibition on granule cells of the dentate gyrus in the propagation of activity and computation in the hippocampus

Estarellas Martín, Cristian (supervisors: Mirasso, Claudio; Canals, Santiago)

November 19

Human mobility: data analysis, theory and models

Mazzoli, Mattia (supervisors: Colet, Pere; Ramasco, Jose J.)

July 26

7.2 SURF@IFISC

The Summer Undergraduate Research Fellowships program is part of one of the IFISC commitments. For the 2021 program we received 67 applications from 26 universities and 6 countries. The following six were selected:

Miguel Angel González Casado, from the Autónoma University of Madrid, Spain

Dimitrios Chalkiadakis, from the University of Crete, Greece

Elsa Rodríguez García, from the Complutense University of Madrid, Spain

Guillermo Pérez de Arenaza Pozo, from the Politecnica University of Madrid, Spain

Bernat Ramis Vich, from the Politecnica University of Catalunya, Spain

Jorge Valencia Gómez, from the University of the Balearic Islands, Spain

7.3 IFISC MASTER

IFISC Master in *Physics of Complex Systems*

<https://ifisc.uib-csic.es/master/>

In October 2012 IFISC started a Master program in Physics of Complex Systems. It is a one year (60 ECTS) official Master of the University of the Balearic Islands, in collaboration with CSIC. The courses provide an innovative entry point to Complex Systems fundamentals and applications and introduce the students in the research lines developed at IFISC. For the 2020-2021 academic course 18 students of 5 different nationalities and 12 different universities are registered in the master.

In the year 2021, 12 master thesis were defended. They are listed in the Appendix of this Report.

This is the 2020-2021 Master syllabus:

Structural module courses (39 credits):

| | |
|---|--|
| Complex networks (3 credits) | V. M. Egiluz, S. Meloni |
| Cooperative and critical phenomena (6 credits) | T. Sintes, E. Hernández-García |
| Dynamical systems and chaos (6 credits) | M. Matías, K. Klemm |
| Introduction to complex systems (3 credits) | M. San Miguel, E. Hernández-García, R. Zambrini |
| Pattern formation (3 credits) | D. Gomila |
| Scientific presentation and visualization (3 credits) | J. J. Ramasco, S. Meloni |
| Stochastic processes (3 credits) | P. Colet, R. Toral |
| Stochastic simulation methods (6 credits) | R. Toral, P. Colet |
| Quantum physics for complex systems (6 credits) | L. Serra, R. Zambrini |

Specific module courses (9 credits minimum)

| | |
|--|------------------------------|
| Collective phenomena in social dynamics (3 credits) | M. San Miguel, J. J. Ramasco |
| Information theory (3 credits) | D. Sánchez |
| Modelling and dynamics of neural systems (3 credits) | C. Mirasso |
| Non equilibrium collective phenomena (3 credits) | C. López |
| Nonlinear photonics (6 credits) | I. Fischer; M.C. Soriano |
| Quantum and nonlinear optics (3 credits) | R. Zambrini, Gianluca Giorgi |
| Quantum transport and quantum noise (3 credits) | R. López |
| Spatiotemporal dynamics (3 credits) | D. Gomila |
| Statistical physics in biological systems (3 credits) | T. Sintes |
| Systems biology (3 credits) | M. Matías, T. Galla |
| Turbulence and nonlinear phenomena in fluid flows (3 credits) | C. López |

Master thesis (12 credits)

Responsible: P. Colet

7.4 OTHER POSTGRADUATE COURSES

Other Postgraduate Courses taught in 2021

The following courses were also taught in the Master of Advanced Physics and Applied Mathematics, University of the Balearic Islands:

- **Cooperative and critical phenomena**

Tomàs Sintes, Emilio Hernández-García

- **Stochastic simulation methods**

Pere Colet, Raúl Toral

- **Scientific presentation and visualization**

José J. Ramasco

- **Spintronics**

Rosa López, Llorenç Serra, David Sánchez

- **Electronic nanostructures**

David Sánchez, Llorenç Serra

Course at the Master Degree in Physics of Data, University of Padova, Italy:

- **Life Data Epidemiology**

Sandro Meloni

7.5 MEMBERS OF EDITORIAL BOARD OF SCIENTIFIC JOURNALS



Physical Review Letters.

Zambrini, Roberta (divisional associate editor)

Complex Networks.

Estrada, Ernesto (editor in chief)

Ecological Complexity.

Hernandez-Garcia, Emilio (advisory board)

Advances in Complex Systems.

Klemm, Konstantin

Frontiers in Physics (Interdisciplinary Physics).

Eguiluz, V.M. (associate editor)
Wio, Horacio (advisory board)

Proceedings of the Royal Society A: Mathematical, Physical and Engineering Sciences, The Royal Society.

Estrada, Ernesto (associate editor)
Zambrini, Roberta

PLoS ONE.

Meloni, Sandro
Ramasco, Jose J.

European Physical Journal Special Topics.

Colet, Pere

Scientific Reports.

Zanin, Massimiliano
Ramasco, J.J.



Entropy.

San Miguel, Maxi (complexity section)
Soriano, Miguel C. (topic editor)
Sánchez, David
López, Cristobal
Wio, Horacio

Chaos, Solitons and Fractals.

Zanin, Massimiliano
Toral, Raul



Complexity.

San Miguel, Maxi
Zanin, Massimiliano

PeerJ.

Zanin, Massimiliano

SIAM Journal of Applied Mathematics.

Estrada, Ernesto (associate editor)

AppliedMath (MDPI).

Estrada, Ernesto

MATCH: Communications in Mathematical and in Computer Chemistry.

Estrada, Ernesto

Journal of Physics Complexity (IOP).

Maxi San Miguel, Claudio Mirasso, Ingo Fischer (guest editors on Focus Issue on Complex Systems approaches to information processing)

Physica A.

Wio, Horacio S. (advisory board)

Nonlinear Theory and Its Applications (NOLTA), IEICE.

Soriano, Miguel Cornelles (guest associate editor)

Mathematics (MDPI).

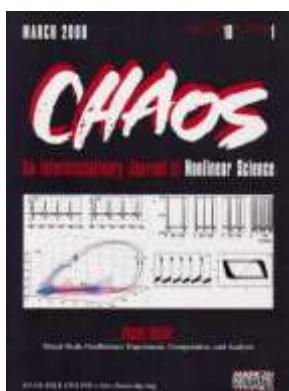
Estrada, Ernesto

Chaos: An Interdisciplinary Journal of Nonlinear Science.

Fischer, Ingo (advisory board)

European Physical Journal B.

Wio, Horacio S.



7.6 SCIENTIFIC COMMITTEES

Calleja-Solanas, Violeta

- **Elected member of the advisory board of the Young Researchers of the Complex Systems Society.**
- **Elected member of the council of the Complex Systems Society.**

Colet, Pere

- **Member of the Board and Treasurer of the Topical Group on Statistical and Nonlinear Physics (GEFENOL) of the Spanish Physical Society.**

Fischer, Ingo

- **Elected Member of IEEE Task Force on Reservoir Computing.**

Ramasco, Jose J.

- **Elected member of the council of the Complex Systems Society.**
- **President COMSOTEC. Spanish Association for the Study of SocioTechnical Systems.**
Ramasco, J.J
- **Member of the "Grupo Trabajo Multidisciplinar" to assess the Ministry of Science.**
Group created by the Ministry of Science to get assessment during the pandemic.
- **Coordinator PTI Mobility 2030 of CSIC.**
The PTI Mobility 2030 has been created in CSIC to face the challenges in mobility for the next decade.

San Miguel, Maxi

- **Vice-chair of IUPAP C3 Commision on Statistical Physics.**
- **Chair of the International Scientific Advisory Board of the Internet Interdisciplinary Institute (IN3) of the Open University of Catalunya (UOC).**

Zambrini, Roberta

- **Vice-president of the Non-linear and Quantum optics group (GEOCONL) of the Real Sociedad Española de Física (RSEF).**
- **Member of the BSC's Access Committee.**
Reviewer del Barcelona Supercomputing Center-Centro Nacional de Supercomputación.
- **Member of the panel of Global Area Materia (CSIC).**
- **"Gestora" of AEI evaluation panel in Physics, Physics and Applications.**

7.7 RESEARCH STAYS IN OTHER CENTERS

During 2021 IFISC Researchers visited 7 external research centers.

These visits are listed in the Appendix to this Report.

7.8 'WOMEN IN SCIENCE' ACTIVITIES

Participation of IFISC in the 11F: International Day of Women and Girls in Science 2021.

The United Nations General Assembly decided to proclaim 11 February as International Women's and Girls' Day in Science with the goal of achieving full and equal access to science for girls and women.

February 11, 2018 was a turning point to become aware of the existing situation of inequality and the lack of presence of women in scientific and technological careers in the Balearic Islands. Thus, a group of women linked to these sectors decided to organize themselves into a working group to elaborate a proposal document or roadmap to eliminate the gender gap in the STEM field. As a result of this initiative, the 11F Balearic Islands women's platform was born, in which IFISC (UIB-CSIC) participated again for the 2021 edition.



The objective of the Platform is to give a face and a voice to women who, from institutions, companies or individually, develop their professional and academic activity especially in the field of the STEM sectors, which include science, technology, engineering and mathematics. These women can be a role model for the new generations of girls, with the idea of motivating interest, promoting scientific and technical vocations among girls and thus contribute to breaking the gender gap that currently also exists in the field of science and technology.



As of February 11, 2021, 23.9 % of the IFISC research staff were women. By category, women represented 31 % of doctoral students, 25 % of postdoctoral researchers and 11 % of permanent research staff. The award of the María de Maeztu Unit of Excellence fostered further initiatives at IFISC for a broader participation of female in STEM including the creation of a Gender equality and woman empowerment committee composed by IFISC researchers Roberta Zambrini and Miguel Cornelles Soriano. This committee has contributed to greater gender equality in the IFISC working environment through a number of actions such as promoting gender balance in hiring procedures and awarded fellowships, getting involved in initiatives at national and international level or promoting the participation of female speakers in seminars and colloquia. A team is starting to prepare an equality plan of the institute.

IFISC staff also participated in the activity "**Just Chatting with women scientists**", an online activity organized by **11F Balears** in which Balearic Islands researchers answered questions, chatted and interacted with attendees via the Twitch streaming website.

7.9 OTHER**Quantum Thermodynamics website.**

Responsible and moderator of the website <https://qtd.ifisc.uib-csic.es>
Zambrini, Roberta

Coordinator of T10 of CSIC white paper.

Zambrini, Roberta

Participation in CSIC 'white books' on Strategic Topics and challenges:**- Theme 5: Brain, mind and behaviour.**

Have contributed: C. Mirasso, C. Lopez and E. Hernandez-Garcia

- Theme 10: Digital and complex information.

Coordinated by R. Zambrini. Other contributors: I. Fischer, M.C. Soriano, Ll. Serra, J.J. Ramasco, S. Meloni, D. Sanchez, A. Garcia.

- Theme 11: Artificial Intelligence, Robotics and Data Science.

Have contributed: J.J. Ramasco, A. Argyris, M.C. Soriano, I. Fischer, S. Meloni, C. Mirasso, V.M. Eguiluz, P. Colet, D. Gomila, T. Galla, M. San Miguel, R. Toral

- Theme 13: Ocean Science Challenges for 2030.

Have contributed: E. Hernandez-Garcia and C. Lopez

8

OUTREACH ACTIVITIES

8.1 POSTER WEEK

The IFISC Poster Party is an annual activity where PhD students and postdoctoral researchers of IFISC present their research in a poster format. In a relaxed atmosphere, you can get to know first-hand what the young researchers at IFISC are working on.

This year, due to health restrictions for the Covid-19 pandemic, the Poster Party changed its format. For one whole week, the posters of the participants were hung in the IFISC hallways as usual, but an online modality was added: the posters were also available for viewing through the webpage of IFISC. To replace the explanations of the authors themselves, each of them prepared a short video explaining the research carried out and the conclusions of the study. Questions to the authors were done personally in their offices or via email.

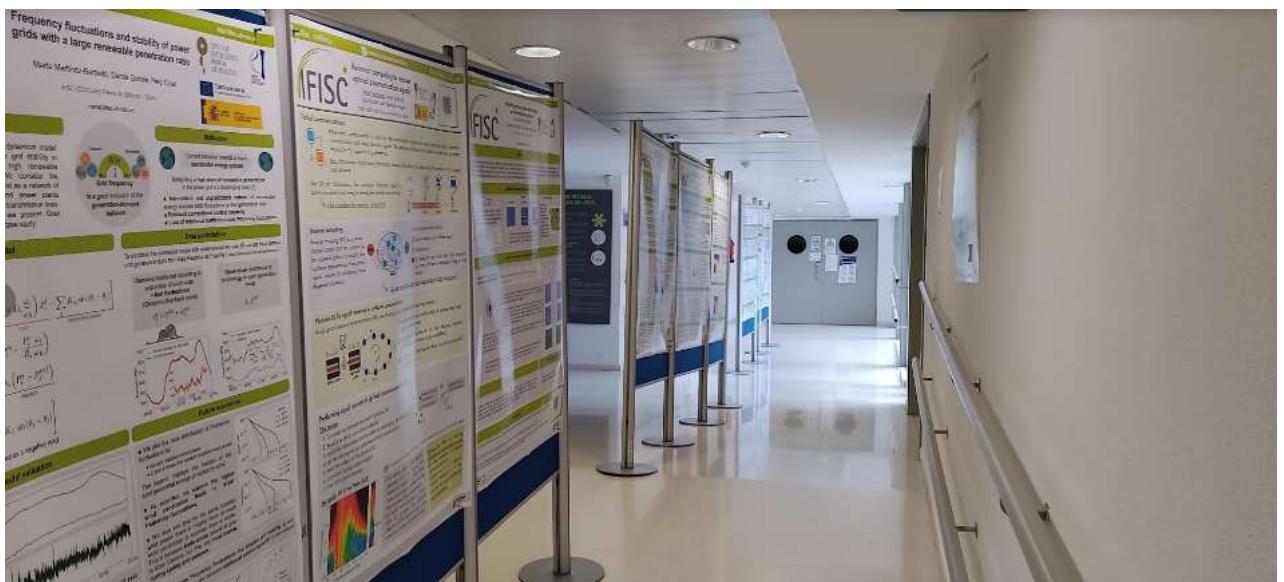
<https://ifisc.uib-csic.es/research/ifisc-poster-party-2021/>



NONLINEAR PHOTONICS

1st place
Reservoir computing to recover optical communication signals - Irene Estébanez

2nd place
Time-delay reservoir computing with silicon microring resonator - Giovanni Donati

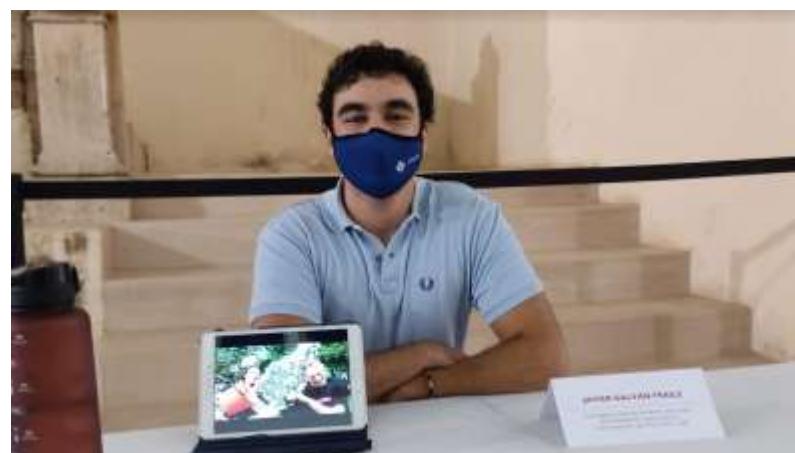


8.2 EUROPEAN RESEARCHER'S NIGHT

The European Researchers' Night is a science outreach project promoted by the European Commission as part of the Marie Skłodowska-Curie actions of the Horizon 2020 programme, and has been taking place simultaneously in more than 300 European cities since 2005. Its main objective is to bring researchers closer to citizens so that they can learn about their work, the benefits they bring to society and their impact on everyday life.

On the occasion of the celebration of the European Researchers' Night, IFISC participated in the scientific dissemination activities organised by the CSIC Representation in the Balearic Islands.

The event took place in the historic centre of Palma, on September 24th at Ca n'Oleo from 18:30 to 21:00. Among the activities one was '*Speed Dating*'. This activity, aimed at the general public, featured scientific staff from centres belonging to and associated with the CSIC Representation in the Balearic Islands, including IFISC pre-doctoral researchers María Martínez-Barbeito, Javier Galván and Annalisa Caligiuri, who explained in 5 minutes what their research work consists of.



8.3 OTHER EVENTS

Webinar: Visualitzar per entendre la COVID: un bot de telegram

The pandemic caused by the SARS-CoV-2 virus has made clear, more than ever, the need for accurate, updated and visually attractive information to understand and analyze the epidemiological and health care situation. For this reason, there have been different projects to complement the data provided by the administrations. One of them is *Covid19gram*, a telegram bot developed by IFISC technician Antònia Tugores and mathematicians of UIB Jaume Perelló and Biel Frontera. In this talk, on January 13th, they analyzed the different indicators associated with the disease and the difficulties and solutions provided to develop the bot. The webinar was part of the series of talks "Aquí Fem Mates".

Visit of the University Center of Calvià (CUC)

The University Center of Calvià (CUC) is a municipal service that depends on the City Council of Calvià. The purpose of the CUC is to promote the access and continuity of post-compulsory studies, as well as to facilitate tools and resources as a complement for the acquisition of personal, academic and pre-employment skills, to students of 4th ESO, baccalaureate, training cycles, etc.

Through the "Vocational Internships for Secondary School Students" program, on July 9 a student visited the IFISC facilities and was given an informative talk on complex systems and the science carried out at the institute.

Webinar: YouTube o papel: todos los ángulos de la divulgación

The Summer Conference for students of the Royal Spanish Society of Physics is the professional and personal development event of the RSEF Student Group. Designed by and for undergraduate, master and doctoral students in physics from all over Spain, it took place from July 13 to 15 in an on-line format, and dealt with a wide range of topics: experimental and theoretical physics, popularization, business...

This talk, given by IFISC outreach technician Adrián García, reviewed the role of social networks as a way to disseminate scientific content and what it is like to work on it within a research institute.



8.4 OUTREACH MATERIALS

The Youtube 'IFISC outreach' playlist (<https://bit.ly/3enKSYz>) contains many outreach videos on topics related to IFISC research lines.

Also in 2021, some outreach articles were published in different media:

- ¿A más seguidores, más éxito?: las matemáticas detrás de los 'influencers' y de las redes sociales. Estrada, Ernesto. Periódico ABC, Sección ABCdario de la Matemáticas, 17 May (2021)
- Un nuevo demonio de Maxwell. Manzano, Gonzalo. Investigación y Ciencia (Scientific American), 539, 12-14 (2021)
- Un mundo nuevo allí abajo. Sánchez, David. The Conversation, 3 October (2021)
- Redes matemáticas para entender conflictos sociales. Estrada, Ernesto. El País, 14 October (2021)
- Los límites matemáticos de la amistad, la enemistad y el Big Data. Estrada, Ernesto. Periódico ABC, Sección ABCdario de la Matemáticas, 25 October (2021)

8.5 VOCES, CSIC BALEARIS

IFISC (UIB-CSIC) and the Institutional Representation of CSIC in the Balearic Islands joined forces and created "Voces, CSIC Balears", a bimonthly podcast for the dissemination of science. Through interviews with scientists working at CSIC's centres in the Balearic Islands (IMEDEA CSIC-UIB, IFISC UIB-CSIC and ICTS SOCIB), it aims to increase the visibility of the science carried out in the region.

In 2021, 16 interviews were published through the science outreach podcast platform Podcastidae. Of these interviews, 6 were with IFISC researchers:

- **Redes complejas, fútbol y alquileres | VOCES, CSIC BALEARIS #01 | Johann Martínez**



- **Votos, salud y pesca | VOCES, CSIC BALEARS #04 | Juan Fernández**
- **Percolación, jamming y física estadística | VOCES, CSIC BALEARS #07 | Lucía Ramírez**
- **Reservoir Computing, IA y física cuántica | VOCES, CSIC BALEARS #09 | Rodrigo Martínez**
- **Inteligencia artificial, láser y Reservoir Computing | VOCES, CSIC BALEARS #13 | Irene Estébanez**
- **Redes complejas, química matemática y COVID | VOCES, CSIC BALEARS #15 | Ernesto Estrada**

The podcasts have been downloaded a total of 1.374 times. The audience comes mainly from Spain (83%) followed by Brazil (3%) and Argentina (3%). Within Spain, 30% of listeners come from the Balearic Islands, followed by Madrid (13%), Catalonia (13%) and Andalusia (7%).



8.6 PRESS & MEDIA

News about IFISC and its research results are regularly posted in the 'News' section of the web site: <https://ifiscuib.csic.es/en/news/>.

IFISC research has also received attention from newspapers and other media. During 2021, IFISC activities produced 151 press releases and appearances in written and digital press (national and international), and 6 clips on radio and TV. See the full lists in the Appendix.



EN CORTO

El IFISC analiza el hundimiento de los microplásticos desde la superficie hasta el fondo marino

Un estudio con participación del Institut de Física Interdisciplinari i Sistemes Complexos (IFISC) analiza los parámetros que influyen en el hundimiento de los microplásticos desde la superficie hasta el fondo marino. Sólo el 1% de los microplásticos flota en la superficie. • R.L.



Plásticos de una playa.

dBalears

16 abril 2021 09:16

Investigadors de la UIB analitzen la importància dels retards en els fluxos d'informació cerebral

dBalears | 16 abril 2021



PHYS.ORG

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NOVEMBER 26, 2021

In the quantum realm, not even time flows as you might expect

by University of Bristol

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Science Magazine

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Disease outbreak simulations reveal influence of “seeding” by multiple infected people

October 14, 2021 in Technology and Engineering

0

Home / Physics / Quantum Physics

NOVEMBER 26, 2021

In the quantum realm, not even time flows as you might expect

Diari de la UIB

Diari de la UIB > Mètodes

Augmentar la potència de sortida dels làsers trencant-ne la simetria

Un estudi internacional amb participació de l'IFISC (CSIC-UIB) obre la porta a reduir l'escalfament dels làsers i obtenir més potència òptica màxima emesa

En els làsers de semiconductors de gran obertura es possible obtenir perfils d'intensitat lluminosa més uniformes si se'n deforma intencionadament l'obertura òptica. Un equip internacional de la Universitat Tecnològica de l'Est (l'Institut de Microelectrònica i Fotònica de Varsòvia, la Universitat Tècnica de Berlín i l'IFISC (UIB-CSIC) presenta aquells resultats a Òptica.¹ A més, la recerca ha estat destacada en la secció News and Views del número de novembre de la prestigiosa revista *Nature Photonics*.²



Des que s'inventaren els làsers, sempre hi ha hagut esforços per

SOCIAL MEDIA IMPACT SUMMARY**TWITTER @IFISC_mallorca**

Total Followers 2.624 (29% increase of number of followers in 2021)



<http://www.facebook.com/ifisc>

Facebook fans: 1.086 (3% increase of fan number in 2021)

62% men / 38% women

Mostly located in Spain, Brazil and Mexico



<http://www.youtube.com/user/IFISCseminars>

Visualizations: 39.271 in 2021 of a total of 233.238

YouTube subscribers: 1.954 (28% increase of subscribers in 2021)

85% men / 15% women

Mostly located in USA, Spain, Mexico and India



<https://www.linkedin.com/company/ifisc-institute-for-cross-disciplinary-physics-and-complex-systems-csic-uib->

Total Followers: 533

8

OUTREACH ACTIVITIES

APPENDIX

APPENDIX

a.4. IFISC seminars and talks 2021

In the electronic version of this report, titles are hyperlinked to the recording of the seminar, if available.

- January 13
Control of chimera states in oscillator networks
Giulia Ruzzene, IFISC
- January 21
Frequency fluctuations and stability of power grids with a large renewables penetration ratio
María Martínez Barbeito, IFISC
- January 26
Influence of measurements on Continuous Variable Quantum Reservoir Computing
Jorge García Bení, IFISC
- January 27
Collision models can efficiently simulate any multipartite Markovian quantum dynamics
Marco Cattaneo, IFISC
- February 3
Evolutionary games and the social dynamics of language
Henri Kauhanen, University of Konstanz, Germany
- February 4
Interacting particle systems with mobility and demographic dynamics as biological models.
Alejandro Almodóvar, IFISC
- February 10
Deriving a generalised Landau-Lifschitz-Gilbert equation from a system+bath Hamiltonian
Janet Anders, University of Exeter, UK
- February 17
Understanding species interactions and community stability under changing environments
Andrea Tabi, IFISC
- February 24
Optical coupling of quantum-dot micropillar lasers with perspective towards neuromorphic computing
Xavier Porte, Femto-ST, France
- March 4
Applications of random matrix theory in models of ecological and social interactions
Joseph W. Baron, IFISC
- March 10
Evolutionary dynamics on multicopy plasmids
Hildegard Uecker, Max-Planck Institute for Evolutionary Biology, Plön, Germany
- March 17
Perturbations both trigger and delay seizures due to generic properties of slow-fast relaxation oscillators
Alberto Pérez, Universitat Politècnica de Catalunya, Spain
- March 24
Learning about natural selection in populations evolving under recombination, with an application to epistasis between SARS-CoV-2 genes
Erik Aurell, KTH -- Royal Institute of Technology, Stockholm, Sweden
- April 14
Inverse Percolation and Random Sequential Adsorption with multisite occupation
Lucía Ramírez, IFISC
- April 21
Building continuous time crystals from rare events
Pablo Hurtado, University of Granada, Spain
- April 28
Statistical physics approaches to network meta-analysis
Annabel Davies, The University of Manchester, UK
- April 30
Multicompartmental model of CA3 and CA1 hippocampal regions
Jaime Sánchez Claros, IFISC
- May 5
Languages as complex systems
Els Heinsalu, National Institute of Chemical Physics and Biophysics, Estonia
- May 12
Evidence of glassy phases in large interacting ecosystems with demographic noise
Ada Altieri, Laboratoire Matière et Systèmes Complexes (MSC), Université de Paris, France
- May 19
A neural network contained in a single node: Folding a Deep Neural Network in Time using Feedback-Modulated Delay-Loops
André Röhm, IFISC
- May 26
Rough landscapes and glass dynamics: from inference to machine learning
Chiara Cammarota, La Sapienza University of Rome, Italy
- June 2
Rapid Evolution of SARS-CoV-2 Challenges Human Defenses
Carlos M. Duarte, King Abdullah University of Science and Technology (KAUST), Arabia Saudi
- June 9
When is a network tree-like and how does it help in exploring dynamics?
Konstantin Klemm, IFISC
- June 16
Physics for neuromorphic computing
Julie Grollier, CNRS/Thales lab, Palaiseau, France
- June 23
Thermodynamics of Gambling Demons: Theory and Experiment
Gonzalo Manzano, IFISC
- June 30
Complex Systems and COVID19: three practical cases on how science made (or didn't make) its way into policy
Lucas Lacasa, Queen Mary University of London, UK
- July 6
Information processing in homophilic and heterophilic social networks: simple vs. complex contagion
Fernando Díaz Díaz, IFISC
- July 7
Open quantum generalization of Potts-Hopfield Neural Networks
Eliana Fiorelli, Institute for Quantum Information, Aachen University, Germany
- July 14
How to compute using quantum versions of random walks
Viv Kendon, Durham University, UK
- July 16
Effects of control limitations on the power grid fluctuations
Marc Sadurní Parera, IFISC
- July 21
Detecting zealots in the Noisy Voter Model using Bayesian inference
Miguel Álvarez Sanchez, IFISC

| | | |
|--|---|--|
| July 21 Gender & Science: Why do we need to problematize it? What can we do? Maria Bustelo, Universidad Complutense de Madrid, Spain | September 27 Unveiling predictive coding mechanisms through computational modeling Javier Galván, IFISC | October 27 Evolutionary Game Theory with payoff fluctuations: Bet-Hedging Rubén Calvo Ibáñez, IFISC |
| July 26 Human mobility: data analysis, theory and models Mattia Mazzoli, IFISC | September 29 Non Markovian effects with emphasis on the voter model with aging Raul Toral, IFISC | November 3 Photonic reservoir computing in optical communications: does it have a chance against digital signal processing? Apostolos Argyris, IFISC |
| August 30 Travelling pulses in Type-I excitable media Pablo Moreno Spiegelberg, IFISC | September 30 A compartmental model for vector transmitted diseases: an application to <i>Xylella fastidiosa</i> Rosa Flaquer Galmés, IFISC | November 17 Modelling Human Behaviour and Cognition with Network Science Sofia Teixeira, University of Lisbon, Portugal |
| August 31 Mobility-based interventions for epidemic containment Jesus A. Moreno Lopez, IFISC | October 4 Advanced concepts for transient computing: concepts and implementation Mirko Goldmann, IFISC | November 19 Study on the role of inhibition on granule cells of the dentate gyrus in the propagation of activity and computation in the hippocampus Cristian Estarellas Martín, IFISC |
| September 1 The propagation of SARS-CoV-2 variants in England: interplay between social dynamics and epidemiological features Beatriz Arregui García, IFISC | October 6 Impact of Urban Structure on Infectious Disease Spreading Javier Aguilar Sanchez, IFISC | November 24 Effects of habitat fragmentation on diversity patterns in a heterogeneous environment Viviane Moraes de Oliveira, Departamento de Física – UFRPE, Univ. Recife, Brazil |
| September 8 Cell Migration in Cancer Metastasis Marta Pedrosa García-Moreno, IFISC | October 8 Understanding migrations in Central America and Mexico using geolocated data Miguel Rodríguez Gómez, IFISC | November 29 Synchronization and collective phenomena in quantum dissipative systems Albert Cabot, IFISC |
| September 14 The role of bistability and time delay in the coordination of the cell cycle Jan Rombouts, KU Leuven, Belgium | October 13 Open science in the IPCC Sixth Assessment Report and opportunities for machine learning Jose Manuel Gutierrez Llorente, IFCa, CSIC - University of Cantabria, Spain | December 1 Memories as attractor neural networks Francesca Schönsberg, SISSA, Trieste, Italy |
| September 15 Unraveling the role of node metadata in network robustness: the feature-based percolation model Oriol Artimo, Fondazione Bruno Kessler, Italy | October 20 Does learning converge to equilibrium in generic games? Marco Pangallo, Sant'Anna School of Advanced Studies, Pisa, Italy | December 15 Models of nested populations: how does collective function evolve? Silvia de Monte, ENS Paris, France |
| September 21 Scattering of topological kink-antikink states in bilayer graphene structures Nassima Benchabher, IFISC | October 20 A normal form for excitable vegetation dynamics Carles Martorell, IFISC | December 20 Dynamical approach to microbial communities abundance data Somaye Sheykali, IFISC |
| September 22 Inter-specific interactions in seagrass meadows: a microscopic numerical approach. Eva Llabrés, IFISC | October 21 Data-driven classification of animal trajectories Jorge Medina, IFISC | |
| September 23 Deep Randomized Neural Networks Claudio Gallicchio, University of Pisa, Italy | October 22 Statistical Physics in a 3 state extended voter model Teresa Lázaro Sánchez, IFISC | |
| | October 22 Spontaneous synchronization in spin systems Lucía Rodrigo Bort, IFISC | |

a.5. Publications

In the electronic version of this report, titles are hyperlinked to the summary and PDF file of the publications

a.5.1 Indexed Publications

High-speed harvesting of random numbers

Fischer, Ingo; Gauthier, Daniel J. Science 371 (6532), p. 889-890

The soundscape of the Anthropocene ocean

Duarte, CM; Chapuis, L; Collin, SP; Costa, DP; Devassy, RP; Eguiluz, VM; Erbe, C; Gordon, TAC; Halpern, BS; Harding, HR; Havlik, MN; Meekan, M; Merchant, ND; Miksis-Olds, JL; Parsons, M; Predragovic, M; et al Science 371, eaba4658

The global network of ports supporting high seas fishing

Rodríguez, Jorge P; Fernández-Gracia, Juan; Duarte, Carlos M; Irigoien, Xabier; Eguíluz, Víctor M Science advances 7, eabe3470

Geospatial distributions reflect temperatures of linguistic features

Kauhanen, Henri; Gopal, Deepthi; Galla, Tobias; Bermúdez-Otero, Ricardo Science Advances 7, eabe6540 (p. 1-10)

Anatomy of digital contact tracing: Role of age, transmission setting, adoption, and case detection

Moreno López, Jesús A.; Arregui García, Beatriz; Bentkowski, Piotr; Bioglio, Livio; Pinotti, Francesco; Boëlle, Pierre-Yves; Barrat, Alain; Colizza, Vittoria; Poletto, Chiara Science Advances 7, eabd8750

Reply to: Caution over the use of ecological big data for conservation

Queiroz, N.; Humphries, N.E.; Couto, A.; Vedor, M.; da Costa, I.; Eguiluz, V.M.; et.al. Nature, 595, 7866, (p. 20-28)

Reply to: Shark mortality cannot be assessed by fishery overlap alone

Queiroz, N.; Humphries, N.E.; Couto, A.; Vedor, M.; da Costa, I.; Eguiluz, V.M.; et.al. Nature, 595, 7866, (p. 8-16)

A population-based controlled experiment assessing the epidemiological impact of digital contact tracing

Rodríguez, P.; Graña, S.; Álvarez-León, E.E.; Battaglini, M.; Darias, F.J.; Hernán, M.A.; López, R.; Llaneza, P.; Martín, M.C.; Radar Covid Pilot Group; Ramirez-Rubio, O.; Romaní, A.; Suárez-Rodríguez, B.; Sánchez-Monedero, J.; Arenas, A.; Lacasa, L. Nature Communications 12, 587

An ecological approach to structural flexibility in online communication systems

Palazzi, María J.; Solé-Ribalta, Albert; Calleja-Solanas, Violeta; Meloni, Sandro; Plata, Carlos A.; Suweis, Samir; Borge-Holthoefer, Javier. Nature Communications 12, 1, 1941

Deep neural networks using a single neuron: folded-in-time architecture using feedback-modulated delay loops

Stelzer, Florian; Röhm, Andre; Vicente, Raul; Fischer, Ingo; Yanchuk, Serhiy Nature Communications 12, 5164 (1-10)

Lagrangian betweenness as a measure of bottlenecks in dynamical systems with oceanographic examples

Ser-Giacomi, E.; Baudena, A.; Rossi, V.; Follows, M.; Clayton, S.; Vasile, R.; Lopez, C.; Hernandez-Garcia, E. Nature Communications 12, 4935 (1-14)

The AIMe registry for artificial intelligence in biomedical research

Julian Matschinske,, Massimiliano Zanin, Olga Zolotareva, Jan Baumbach & David B. Blumenthal Nature Methods 18, 10, p. 1128-1131

The spectrum of early career physics

Feng, Chao-Hui; Moravec, Emily; Nanut, Tara; Raducha, Tomasz; Reshef, Orad; Sivakumar, Chandrasekar; Williams, LaNell A. Nature Reviews Physics 3, 12, p. 722-776.

Coexistence of dynamical delocalization and spectral localization through stochastic dissipation

Weidemann, Sebastian; Kremer, Mark; Longhi, Stefano; Szameit, Alexander Nature Photonics 15, 576–581

Predicting hidden structure in dynamical systems

Gauthier, Daniel J.; Fischer, Ingo Nature Machine Intelligence 3, 281–282

Experimentally Detecting Quantized Zak Phases without Chiral Symmetry in Photonic Lattices

Jiao, Zhi-Qiang; Longhi, Stefano; Wang, Xiao-Wei ; Gao, Jun; Zhou, Wen-Hao ; Wang, Yao ; Fu, Yu-Xuan; Wang, Li; Ren, Ruo-Jing; Qiao, Lu-Feng; Jin, Xian-Min Physical Review Letters 127, 147401 (1-7)

Dynamical phase transitions in quantum reservoir computing

Martínez-Peña, Rodrigo; Giorgi, Gian Luca; Nokkala, Johannes; Soriano, Miguel C.; Zambrini, Roberta

Physical Review Letters 127, 100502 (1-7)

Collision models can efficiently simulate any multipartite Markovian quantum dynamics

Cattaneo, Marco; De Chiara, Gabriele; Maniscalco, Sabrina; Zambrini, Roberta; Giorgi, Gian Luca

Physical Review Letters 126, 130403 (1-8)

Thermodynamics of Gambling Demons

Manzano, Gonzalo; Subero, Diego; Maillet, Olivier; Fazio, Rosario; Pekola, Jukka P.; Roldán, Édgar Physical Review Letters 126, 080603

Quantum dynamics of Bose-polaron in a d-dimensional Bose Einstein condensate

M. Miskeen Khan, H. Terças, J. T. Mendonça, J. Wehr, C. Charalambous, M. Lewenstein, M. A. Garcia-March Physical Review A 103, 023303

Synchronization and Non-Markovianity in open quantum systems

Karpat, G; Yalçınkaya, İ; Çakmak, B; Giorgi, G. L.; Zambrini, R Physical Review A 103, 062217 (1-10)

- Phase transitions in a non-Hermitian Aubry-André-Harper model**
 Longhi, Stefano
Physical Review B 103, 054203 (1-12)
- Scattering of topological kink-antikink states in bilayer graphene structures**
 Benctaber, N.; Sánchez, D.; Serra, L.
Physical Review B 104, 155303 (1-9)
- Non-Hermitian skin effect beyond the tight-binding models**
 Longhi, Stefano
Physical Review B 104, 125109 (1-11)
- Asymmetric arms maximize visibility in hot-electron interferometers**
 Clarissa J Barratt, Sungguen Ryu, Lewis A Clark, H-S Sim, Masaya Kataoka, Clive Emery
Physical Review B 104, 035436
- Non-Hermitian Maryland model**
 Longhi, Stefano
Physical Review B 103, 224206 (1-12)
- rf-Signal-induced heating effects in single-electron pumps composed of gate-tunable quantum dots**
 Sungguen Ryu, H-S Sim, Young-Seok Ghee, Bum-Kyu Kim, Myung-Ho Bae, Nam Kim, Suk-In Park, Jindong Song
Physical Review B 103, 205422
- Spectral deformations in non-Hermitian lattices with disorder and skin effect: A solvable model**
 Longhi, Stefano
Physical Review B 103, 144202 (1-10)
- Network and geometric characterization of three-dimensional fluid transport between two layers**
 de la Fuente, Rebeca; Drotos, Gabor; Hernández-García, Emilio; López, Cristóbal
Physical Review E 104, 065111 (1-12)
- Traveling pulses in Class-I excitable media**
 Arinyo-i-Prats, Andreu; Moreno-Spiegelberg, Pablo; Matias, Manuel A.; Gomila, Damià
Physical Review E 104, L052203
- Consensus, polarisation and coexistence in a continuous opinion dynamics model with quenched disorder**
 Baron, Joseph William
Physical Review E 104, 044309
- Beyond the adiabatic limit in systems with fast environments: A tau-leaping algorithm**
 Berrios-Caro, Ernesto; Galla, Tobias
Physical Review E 104, 014122
- Standard and inverse site percolation of straight rigid rods on triangular lattices: Isotropic and perfectly oriented deposition and removal**
 Ramirez, Lucia Soledad; Pasinetti, Pedro Marcelo; Lebrecht, Walter; Ramirez-Pastor, Antonio Jose
Physical Review E 104, 1, 014101
- Persistent individual bias in a voter model with quenched disorder**
 Baron, Joseph William
Physical Review E 103, 052309
- Species exclusion and coexistence in a noisy voter model with a competition-colonization tradeoff**
 Martínez-García, Ricardo; López, Cristóbal; Vazquez, Federico
Physical Review E 103, 032406
- Zealots in multi-state noisy voter models**
 Khalil, Nagi; Galla, Tobias
Physical Review E 103, 012311
- Persistent individual bias in a voter model with quenched disorder**
 Baron, Joseph William
Physical Review E 103, 5, 052309
- Games in Rigged Economies**
 Seoane, L.F.
Physical Review X, 031058
- Capturing the diversity of multilingual societies**
 Louf, Thomas; Sánchez, David; Ramasco José J.
Physical Review Research 3, 043146
- Neutral Theory for competing attention in social networks**
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- Path Laplacians versus fractional Laplacians as nonlocal operators on networks**
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- Leveraging network analysis to evaluate biomedical named entity recognition tools**
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- Simplifying functional network representation and interpretation through causality clustering**
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Scientific Reports 11, 21096
- Loss of structural balance in stock markets**
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- Local characterization of transient chaos on finite times in open systems**
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- Fabry-Pérot interferometry with gate-tunable 3D topological insulator nanowires**
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- Time-Delay Identification Using Multiscale Ordinal Quantifiers**
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- Model-free inference of unseen attractors: Reconstructing phase space features from a single noisy trajectory using reservoir computing**
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 Zanin, Massimiliano
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- Characteristic signatures of Northern Hemisphere blocking events in a Lagrangian flow network representation of the atmospheric circulation**
 Ehstand, Noémie; Donner, Reik; López, Cristóbal; Hernández-García, Emilio
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- Modeling financial distress propagation on customer-supplier networks**
 Nin, J; Salbanya, B; Fleurquin, P; Tomas, E; Arenas, A; Ramasco, JJ
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 Jamshid Ardalankia, Jafar Askari, Somaye Sheykhalii, Emmanuel Haven and G. Reza Jafari
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a.5.2 Other Publications

Exploiting transient dynamics of a time-multiplexed reservoir to boost the system performance

Goldmann, Mirko; Mirasso, Claudio R.; Fischer, Ingo; Soriano, Miguel C.

Proceedings of the International Joint Conference on Neural Networks 2021

DOI: 10.1109/IJCNN52387.2021

The Fluctuation-dissipation Theorem Today

Special Research Topic, Frontiers in Physics (2021) .

Edited by Fernando A. Oliveira, Ewa Gudowska-Novak & Horacio S. Wio

Drug resistance in infectious diseases

Several Authors. IFISC contributor: Galla, Tobias

In Challenges in biomedicine & health, vol. 4, challenge 3 (edited by: Mario Delgado & María Moros)

From genes & circuits to behaviour

Several Authors. IFISC contributor: Mirasso, Claudio

In Brain, Mind and Behaviour, vol. 5, challenge 2 (Edited by Eloísa Herrera & José Antonio Esteban)

Cognition, collective behaviors & consciousness

Several Authors. IFISC contributors: Hernandez-Garcia, E.; Lopez, C.; Mirasso, C. in Brain, Mind and Behaviour, vol. 5, challenge 3 (edited by Herrera E. and Esteban, J.A.)

Advanced Photonics

Several Authors. IFISC contributors: Cornelles Soriano, Miguel; Fischer, Ingo; Zambrini, Roberta
In Digital and Complex Information, vol 10, challenge 2 (edited by Roberta Zambrini and Gemma Rius)

Quantum Computing

Several Authors. IFISC contributors: Serra, Llorenç; Zambrini, Roberta
In Digital and Complex Information, vol 10, challenge 3 (edited by Roberta Zambrini and Gemma Rius)

Open Science: reproducibility, transparency and reliability

Several Authors. IFISC contributor: García Candel, Adrian
In Digital and Complex Information, vol 10, challenge 6 (edited by Roberta Zambrini and Gemma Rius)

Digital Humanities

Several Authors. IFISC contributor: Sanchez, David
In Digital and Complex Information, vol 10, challenge 7 (edited by Roberta Zambrini and Gemma Rius)

Machine learning and data science

Several Authors. IFISC contributors: Ramasco, Jose J. (coordinator); Argyris, Apostolos; Colet, Pere; Cornelles Soriano, Miguel; Fischer, Ingo; Gomila, Damià; Eguiluz, Victor M.; Mirasso, Claudio; Meloni, Sandro
In Artificial Intelligence, robotics and data science, vol. 11, challenge 3 (Edited by Sara Degli Esposti & Carles Sierra)

Computational Social Models

Several Authors. IFISC contributors: Galla, Tobias; San Miguel, Maxi; Toral, Raul
In Artificial Intelligence, robotics and data science, vol. 11, challenge 5 (Edited by Sara Degli Esposti & Carles Sierra)

Multiagent Systems

Several Authors. IFISC contributor: San Miguel, Maxi
In Artificial Intelligence, robotics and data science, vol. 11, challenge 2 (Edited by Sara Degli Esposti & Carles Sierra)

Computational Cognitive Models

Several Authors. IFISC contributors: Galla, Tobias; Mirasso, Claudio; San Miguel, Maxi; Toral, Raul
In Artificial Intelligence, robotics and data science, vol. 11, challenge 5 (Edited by Sara Degli Esposti & Carles Sierra)

Low-Power sustainable hardware for AI

Several Authors. IFISC contributors: Argyris, Apostolos; Mirasso, Claudio In Artificial Intelligence, robotics and data science, vol. 11, challenge 7 (Edited by Sara Degli Esposti & Carles Sierra)

Sustained & integrated ocean observation

Several Authors. IFISC contributor: Lopez, Cristobal In Ocean Science Challenges for 2030, vol. 13, challenge 1 (edited by Ananda Pascual & Diego Macías)

Oceans of big data and artificial intelligence

Several Authors. IFISC contributors: Hernández García, Emilio; Lopez, Cristobal; Ramasco, Jose J. In Ocean Science Challenges for 2030, vol. 13, challenge 8 (edited by Ananda Pascual & Diego Macías)

Data Analysis of Frequency Fluctuations in the Balearic Grid Before and After Coal Closure

Martínez-Barbeito, María; Gomila, Damià; Colet, Pere ENERGY 2021: The Eleventh International Conference on Smart Grids, Green Communications and IT Energy-aware Technologies , 13-18

Enhancing optical output power by breaking VCSEL circular symmetry

Czyszanowski, T. G.; Brejnak, A.; Gebski, M.; Sokół, A. K.; Marciniak, M.; Pruszyńska-Karbownik, E.; Wasiak, M.; Muszalski, J.; Lott, J. A.; Fischer, I. Vertical-Cavity Surface-Emitting Lasers XXV, K. D. Choquette and C. Lei, eds. 11704, 117040D (1-10)

a.5.3. Books

Reservoir Computing: Theory, Physical Implementations, and Applications

Nakajima, Kohei; Fischer, Ingo (Editors) Springer, 2021. Natural Computing Series.

Digital and complex information, vol. 10

Roberta Zambrini and Gemma Rius (Topic coordinators) Series "CSIC Scientific challenges: towards 2030". CSIC 2021

a.6. Presentations at conferences and academic centers

a.6.1 Invited talks at conferences and workshops

Ultrafast photonic reservoir computing: From fundamental properties to real-world applications.

Machine Learning Photonics (Lake Como School of Advanced Studies), Italy.

Cornelles Soriano, Miguel.

March 15 - 19

Advances in fiber-based time-delay reservoir computing.

CLEO Conference on Lasers and Electro-Optics 2021, San Jose, CA, USA.

Argyris, Apostolos; Fischer, Ingo

May 10

Networks everywhere. Postcards from network theory.

Mathematics in Society, organized by TUM Mathematics Students.

Munich, Germany

Estrada, Ernesto

May 12

Postcards from network theory.

Edinburgh Mathematical Society, UK.

Estrada, Ernesto

May 21

Traveling Pulses in Class-I Excitable Media.

SIAM Conference on Applications of Dynamical Systems (SIAM DS21) .

Gomila, Damià; Arinyo-i-Prats, Andreu; Moreno-Spiegelberg, Pablo; Matías, Manuel A.

May 23 - 27

Data analysis of frequency fluctuations in the Balearic grid before and after coal closure.

Energy 2021, Special Track on Modeling Dynamics of Power Grids. Valencia, Spain.

Colet, Pere

May 30 – June 3

Vulnerabilities of democratic electoral systems: zealot and media-susceptibility.

Annual meeting of the Society for Mathematical Biology, University of California Riverside, USA.

Raducha, Tomasz

June 13 - 17

Coevolution dynamics of opinion and social network.

Annual meeting of the Society for Mathematical Biology, University of California Riverside, USA.

San Miguel, Maxi
June 14 - 17

Communicability functions in complex networks. Theory and applications.

Congreso de Ecuaciones Diferenciales y Aplicaciones/Congreso de Matemática Aplicada, Gijón, Spain.

Estrada, Ernesto
June 18

Neuromorphic computing in telecommunications.

NMP2021 Neuromorphic Photonics, 11th Optoelectronics and Photonics Summer School. Monte Bondone, Trento, Italy.

Argyris, Apostolos;
June 20 - 26

Complex Dynamics of Delay Systems.

NMP2021 Neuromorphic Photonics, 11th Optoelectronics and Photonics Summer School. Monte Bondone, Trento, Italy.

Soriano, Miguel Cornelles
June 20 - 26

Quantum reservoir computing.

Cargese School of Quantum Information and Quantum Technology, Cargese, France.

Zambrini, Roberta; Soriano, Miguel

June 21 - 25

Collision models can efficiently simulate any multipartite Markovian quantum dynamics.

Mathematical Physics, Dynamical Systems and Infinite-Dimensional Analysis, Moscow, URSS.

Cattaneo, Marco; De Chiara, Gabriele; Maniscalco, Sabrina; Zambrini, Roberta; Giorgi, Gian Luca
July 2

An inhibitory gating mechanism operated by synaptic plasticity regulates information transmission between the dentate gyrus and CA3.

Computational Neuroscience Meeting (CNS2021): Dissecting the role of interneurons in mnemonic functions using computational modelling approaches.

Mirasso, C.; Estarellas, C.; Canals, S.
July 3 - 7

Quantum reservoir computing with complex networks.

International Workshop on Quantum Artificial Intelligence. Shanghai Qi Zhi Institute, China.
Zambrini, Roberta
July 7 - 9

Andreev drag effect in Coulomb coupled quantum dots.

Frontiers of Quantum and Mesoscopic Thermodynamics FQMT21, Prague, Czech Republic.
Sánchez, David
July 18 - 24

Scattering of topological kink-antikink states in bilayer graphene.

Frontiers of Quantum and Mesoscopic Thermodynamics, Prague, Czech Republic.
Serra, Llorenç
July 18

Quantum reservoir computing.

Emerging Topics in Artificial Intelligence (ETAI), SPIE Optics + Photonics 2021, San Diego, California, USA.
Zambrini, Roberta
August 1 - 5

Marine protected areas buffer the effect of climate change on community structure.

Ecological Society of America (ESA), USA.
Andrea Tabi, Luis J. Gilarranz, Serguei Saavedra
August 2 - 6

Beating Carnot efficiency with periodically driven chiral conductors.

KITP Conference: Transport and Efficient Energy Conversion in Quantum Systems. Los Angeles, California, USA.
Sungguen Ryu, Rosa López, Llorenç Serra, David Sanchez
August 31

Quantum reservoir computing and extreme learning machine.

Summer School on Quantum and Quantum-Inspired Computing , UIMP (Universidad Internacional Menéndez Pelayo, Santander, Spain).
Zambrini, Roberta
September 6 – 10

Non-markovian effects in stochastic modelling: the role of aging.

Topical Problems of Nonlinear Wave Physics, NWP-2021, Nizhny Novgorod, Russia.
Toral, Raul
September 19 – 22

Effects of high penetration of renewables in power grid synchronization and frequency fluctuations.

Topical Problems in Nonlinear Wave Physics NWP-2021, Nizhny Novgorod, Russia.
Colet, Pere
September 19 - 22

Power grid frequency fluctuations in scenarios of large penetration of renewables.

Conference on Complexity in Power Grids - From Science to Practice, Potsdam, Germany.
Colet, Pere
September 28 - 30

Machine Learning and Neuromorphic Computing: Why Physics and Complex Systems are Indispensable.

84th Annual Meeting of the DPG and DPG Meeting of the Condensed Matter Section, Symposium: Advanced neuromorphic computing hardware: Towards efficient machine learning, Germany.
Fischer, Ingo
September 29

Resilience and efficiency of the power grid with high penetration of renewable energy sources: The Balearic Islands as a case study.

PhysCon 2021, Minisymposia on Control of Power Grids, Shanghai, China.
Colet, Pere
October 4 - 8

The biased voter model.

Workshop on Sociophysics: Social Phenomena from a Physics Perspective, ICTP-SAIFR, São Paulo, Brazil.
Toral, Raul
October 18 – 22

Coevolution dynamics of opinion and social network.

Workshop on Sociophysics: Social Phenomena from a Physics Perspective, International centre for Theoretical Physics, São Paulo, Brasil.
San Miguel, Maxi
October 18

Mission and Initiatives of young researchers Complex Systems Society (yrCSS).

CSS Chapters Workshop at Conference on Complex Systems CCS 2021, Lyon, France.
Calleja-Solanas, Violeta
October 28

Critical Interventions: Mobility-Based Thresholds for Epidemic Containment.

Conference on Complex Systems, CCS 2021, Lyon, France.
Moreno López, Jesús Arturo; Hernando, Alberto; Meloni, Sandro; Ramasco Sukia, José Javier
October 29

Regulation of inhibitory circuits in the dentate gyrus: role on temporal coding and pattern separation.

Spanish Society for Neuroscience Meeting, Workshop: Binding cell assemblies into memory engrams, Lleida, Spain.
Mirasso, Claudio; Estarellas, Cristian; Canals, Santiago
November 3 - 5

Stability and diversity in random ecologies: the physicists frustration.

ECONET 2021: V Symposium on Ecological Networks. Palma, Spain.
Galla, Tobias
November 10 - 12

From understanding complex laser dynamics to information processing.

Symposium on Physics and Applications of Laser Dynamics 2021 (IS-PALD 2021), Saitama University, Japan.
Fischer, Ingo
November 16 – 18

Modelling coral growth with clonal rules and hydrodynamics.
Clonal growth rates and marine landscapes: from seagrass to coral reefs; King Abdullah University of Science and Technology, KAUST, Saudi Arabia.
 Llabrés, Eva; Sintes, Tomàs
 December 2 - 10

Extracting coral reefs features from data.
Workshop on clonal growth rates and marine landscapes: From Seagrasses to Coral Reefs. Red Sea Research Center, King Abdullah University of Science and Technology, Saudi Arabia.
 Giménez-Romero, Alex; Matías, Manuel A.
 December 8

Complex dynamics in clonal organisms.
Workshop on clonal growth rates and marine landscapes: From Seagrasses to Coral Reefs. Red Sea Research Center, King Abdullah University of Science and Technology, Saudi Arabia.
 Sintes, Tomàs
 December 8

A new model for pattern formation in coral reefs.
Workshop on clonal growth rates and marine landscapes: From Seagrasses to Coral Reefs. Red Sea Research Center, King Abdullah University of Science and Technology, Saudi Arabia.
 Álvarez, Miguel; Gomila, Damià; Matías, Manuel A.
 December 8

Lagrangian Flow Networks. Combining network theory and dynamical systems to characterize physical and ecological connectivity in fluid flows.
XVIII International Workshop on Instabilities and Nonequilibrium Structures, Valparaíso, Chile.
 Hernandez-Garcia, E.
 December 10

Numerical sampling rare of rare trajectories.
XVIII International Workshop on Instabilities and Nonequilibrium Structures, Valparaíso, Chile.
 Toral, Raul
 December 6 - 10

A Journey into the Variational Formulation for the Kardar-Parisi-Zhang Growth Model.
XVIII International Workshop on Instabilities and Nonequilibrium Structures, Valparaíso, Chile.
 Wio, H.S.; Rodriguez, M.A.; Gallego, R.; Deza, R.R.; Revelli, J.A.
 December 6 - 10

a.6.2 Other talks at conferences and workshops

Chiral and Topological states due to potential inversion in bilayer graphene.
Thermodynamics of quantum systems and processes, Lake Como School of Advanced Studies. Como, Italy.
 Benchabir, Nassima
 March 22 - 26

Risk of establishment of Pierce's disease in main wine-producer regions worldwide.
*3rd European Conference on *Xylella fastidiosa*.*
 Giménez Romero, Alex; Galván, Javier; Montesinos, Marina; Bauzà, Joan; Godefroid, Martin; Fereres, Alberto; Ramasco, Jose; Matías, Manuel; Moralejo, Eduardo
 April 26 - 30

Sinking microplastics in the water column: simulations in the Mediterranean Sea.
European Geosciences Union General Assembly 2021.
 de la Fuente, R.; Drotos, G.; Hernandez, E.; Lopez, C.; van Sebille, E.
 April 26

Detection and tracking of atmospheric blocks: a Lagrangian flow network approach.
European Geosciences Union General Assembly 2021
 Ehstand, N.; Donner, R.; Lopez, C.; Hernandez-Garcia, E.
 April 30

Optimal monitoring of the ocean surface by observing the transport crossroads.
European Geosciences Union General Assembly 2021
 Hernandez-Garcia, E.; Baudena, A.; Ser-Giacomi, E.; Lopez, C.; d'Ovidio, F.
 April 30

Lagrangian betweenness: detecting fluid transport bottlenecks in oceanic flows.
European Geosciences Union General Assembly 2021
 Ser-Giacomi, E.; Baudena, A.; Rossi, V.; Follows, M.; Vasile, R.; Lopez, C.; Hernandez-Garcia, E.
 April 30

Nonlinear forced change and nonergodicity: The case of ENSO-Indian monsoon and global precipitation teleconnections.

European Geosciences Union General Assembly 2021
 Drotos, G.; Bodai, T.; Ha, K.-J., Lee, J.-Y.; Chung, E-S.
 April 30

Collision models can efficiently simulate any multipartite Markovian quantum dynamics.
ICE 6 - Quantum Information in Spain.
 Cattaneo, Marco; De Chiara, Gabriele; Maniscalco, Sabrina; Zambrini, Roberta; Giorgi, Gian Luca
 May 11

Injection Locking and Coupling Large VCSEL Arrays via Diffraction in an External Cavity.
Nonlinear Dynamics of Semiconductor Lasers 2021, WIAS Berlin. Germany.
 Moritz Pflüger, Daniel Brunner, Tobias Heuser, Stephan Reitzenstein and Ingo Fischer.
 June 16 - 18

Vulnerabilities of democratic electoral systems.
Democracy out of the balance: a Networks Perspective satellite during Networks 2021, Indiana, USA.
 Raducha, Tomasz
 June 25

Dinámica de orden y formación de consenso en Multi-State Voter Models.
XVIII Taller Regional de Física Estadística y Aplicaciones a la Materia Condensada (TREFEMAC 2021) Cordoba, Argentina.
 Ramirez, Lucia S.; San Miguel, Maxi; Galla, Tobias
 June 28

Travelling pulses in Class-I excitable media.
NoLineal 20-21. 12th International Conference on Nonlinear Mathematics and Physics.
 Moreno Spiegelberg, Pablo
 June 30 – July 2

Vulnerabilities of democratic electoral systems.
11th Polish symposium on Physics in Economy and Social Sciences, Warsaw, Poland.
 Raducha, Tomasz
 July 1 - 3

Biased voter model: How persuasive a small group can be?.
11th Polish symposium on Physics in Economy and Social Sciences, Warsaw, Poland.
 Czaplicka, Agnieszka; Charalambous, Christos; Toral, Raul; San Miguel, Maxi
 July 1 - 3

Thermodynamics of Gambling Demons and Quantum Martingale Theory.
TIQuR 2021. Thermodynamics and Information in the Quantum Regime.
 Manzano, Gonzalo
 July 7 - 9

OTU ecological dynamics models from longitudinal abundance data.
Networks 2021: A Joint Sunbelt and NetSci conference. Indiana University, Bloomington, IN, USA
 Sheykali, Somaye; Fernández-Gracia, Juan; Duarte, Carlos M.; Irigoien, Xabier; M. Eguíluz, Víctor
 July 8

The global network of ports supporting high seas fishing.
Networks 2021: A joint Sunbelt and NetSci conference. Indiana University, Bloomington, IN, USA
 Rodríguez, Jorge P; Fernández-Gracia, Juan; Duarte, Carlos M.; Irigoien, Xabier; Eguíluz, Víctor M.
 July 8

Exploiting transient dynamics of a time-multiplexed reservoir to boost the system performance.
Conference on Neural Networks 2021. Shenzhen, China
 Goldmann, Mirko; Mirasso, Claudio R.; Fischer, Ingo; Soriano, Miguel Cornelles
 July 18 - 22

Analog information processing with time-multiplexed optoelectronic systems.
Emerging Topics in Artificial Intelligence (ETAI) 2021. San Diego, California, USA
 Goldmann, Mirko; Fischer, Ingo; Soriano, Miguel Cornelles
 August 1 -5

Thermodynamics of Gambling Demons.
Third EPS Conference "Statistical Physics of Complex Systems", ICTP/SISSA Trieste, Italy.
 Manzano, Gonzalo; Subero, Diego; Maillet, Olivier; Fazio, Rosario; Pekola, Jukka P.; Roldán, Édgar
 September 8 - 10

Characteristic signatures of blocking events in a Lagrangian flow network representation of the atmospheric circulation.
Atmospheric Blocking Virtual Workshop 2021. Munich, Germany.
 Ehstand, Noémie; Donner, Reik V.; López, Cristóbal; Hernández-García, Emilio
 September 27 -29

Thermodynamics of Gambling Demons: Theory and Experiment.
QTD 2021. Quantum Thermodynamics Conference. Geneva, Switzerland.
 Manzano, Gonzalo
 October 4 - 8

Using batteries for frequency control in power grids.
Physcon2021. Fudan University, Shanghai, China
 Ruzzene, Giulia; Gomila, Damia; Colet, Pere
 October 7

Aging effects in Schelling Segregation Model.
Conference on Complex Systems, CCS 2021, Lyon, France.
 Abella-Bujalance, David
 October 25

Structural Predictors for Species Survival in Ecological Networks.
Conference on Complex Systems CCS 2021, Lyon, France.
 Calleja-Solanas, Violeta; Hernández García, Emilio; Meloni, Sandro
 October 25

Anatomy of digital contact tracing: Role of age, transmission setting, adoption, and case detection.
Conference on Complex Systems, CCS 2021, Lyon, France.

Moreno Lopez, Jesus A.; Arregui García, Beatriz; Bentkowski, Piotr; Boglio, Livio; Pinotti, Francesco; Boelle, Pierre-Yves; Colizza, Vittoria; Poletto, Chiara
 October 25

Dynamical Phase Transitions in Quantum Reservoir Computing.
Conference on Complex Systems CCS 2021, Lyon, France.
 Martínez-Peña, Rodrigo ; Giorgi, Gian Luca; Nokkala, Johannes; Cornelles Soriano, Miguel; Zambrini, Roberta
 October 25 - 29

Equilibrium selection in coordination games: the role of local effects.
Conference on Complex Systems CCS 2021, Lyon, France.
 Raducha, Tomasz; San Miguel, Maxi
 October 25 - 29

Vulnerabilities of democratic electoral systems.
Conference on Complex Systems, CCS 2021, Lyon, France.
 Raducha, Tomasz
 October 25 - 29

Ordering Dynamics and the Path to Consensus in Multi-State Voter Models.
Conference on Complex Systems, CCS 2021, Lyon, France.
 Ramirez, Lucia S.; San Miguel, Maxi; Galla, Tobias
 October 25 – 29

Impact of Urban Structure on Infectious Disease Spreading.
Conference on Complex Systems, CCS 2021, Lyon, France.
 Aguilar, J.; Bassolas, A.; Ghoshal, G.; Hazarie,S.; Kirkley, A.; Mazzoli, M.; Meloni, S.; Mimar, S.; Nicosia, V.; Ramasco, J.J.; Sadilek, A.
 October 25 – 29

Persistent individual bias in the voter model with quenched disorder.
Conference on Complex Systems, CCS 2021, Lyon, France.
 Baron, Joseph William
 October 25 – 29

Biased voter model: How persuasive a small group can be?

Conference on Complex Systems, CCS 2021, Lyon, France.
Czaplicka, Agnieszka;
Charalambous, Christos; Toral, Raul; San Miguel, Maxi
October 25 - 29

Ecological patterns of information ecosystems.

Conference on Complex Systems, CCS 2021, Lyon, France.
Meloni, Sandro
October 27

Capturing the diversity of multilingual societies.

Conference on Complex Systems, CCS 2021, Lyon, France.
Louf, Thomas; Sanchez, David;
Ramasco, Jose J.
October 29

Bilayer graphene topological states scattering.

Graphene conference 2021 Grenoble, France.
Benchtaber, Nassima
October 26 – 29

Modelling spatial interactions among seagrasses using clonal network.

ECONET 2021: V Symposium on Ecological Networks 2021 Palma, Spain.
Llabrés, Eva; Mayol, N. Marbà;
Sintes, Tomas
November 8 - 10

Lagrangian flow networks, connectivity and betweenness of marine populations.

ECONET2021: V Symposium on Ecological Networks, Palma, Spain.
Hernandez-Garcia, Emilio
November 10 -12

Structural Predictors for Species Survival in Ecological Networks.

ECONET 2021: V Symposium on Ecological Networks 2021 Palma, Spain.
Calleja-Solanas, Violeta;
Hernández-García, Emilio; Meloni, Sandro
November 10

Ocean microbiome ecological dynamics model from longitudinal abundance data.

ECONET 2021: V Symposium on Ecological Networks 2021 Palma, Spain.
Sheykali, Somaye; Fernández-Gracia, Juan; Duarte, Carlos M.; Irigoien, Xabier; Eguíluz, Víctor M.
November 10

56 Gbaud PAM-4 100 km Transmission System with Photonic Processing Schemes.

International Symposium on Physics and Applications of Laser Dynamics 2021 (IS-PALD 2021) Tainan, Taiwan.
Estébanez, Irene; Li, Shi; Schwind, Janek; Fischer, Ingo; Pachnike, Stephan; Argyris, Apostolos
November 16 - 18

Equilibrium selection in coordination games: the role of local effects.

Complex networks 2021. The 10th International Conference on Complex Networks and their Applications Madrid, Spain.
Raducha, Tomasz; San Miguel, Maxi
November 30 – December 2

Dynamical models from microbial communities abundance data.

Complex networks 2021. The 10th International Conference on Complex Networks and their Applications Madrid, Spain.
Sheykali, Somaye; Fernández-Gracia, Juan; Duarte, Carlos M.; Irigoien, Xabier; Eguíluz, Víctor M.
November 30 - December 2

Mixed micro-resonator and delay based photonic neural networks.

Kick-off of the nanolab, University of Trento, Italy.
Donati, Giovanni
December 3

a.6.3 Poster presentations

Dynamical Phase Transitions in Quantum Reservoir Computing.

24th Annual Conference on Quantum Information Processing, Munich, Germany.
Martínez-Peña, Rodrigo; Giorgi, Gian Luca ; Nokkala, Johannes; Cornelles Soriano, Miguel; Zambrini, Roberta
February 1 - 5

Risk of establishment of Pierce's disease in main wine-producer regions worldwide.

3rd European Conference on Xylella fastidiosa.
Giménez Romero, Alex ;Galván, Javier ;Montesinos, Marina ;Bauzá, Joan ;Godefroid, Martin ;Fereres, Alberto ;Ramasco, Jose ;Matias, Manuel ;Moralejo, Eduardo
April 26 - 30

Transition to self-aggregation with enhanced variability for increasing CO₂ concentration in radiative-convective equilibrium with a slab ocean.

Workshop on Spatial Organisation of Convection, Clouds and Precipitation.
Drotos, Gabor; Becker, Tobias; Mauritsen, Thorsten; Stevens, Bjorn
May 6

Dynamical Phase Transitions in Quantum Reservoir Computing.

Quantum Information (ICE-6), Spain.
Martínez-Peña, Rodrigo; Giorgi, Gian Luca; Nokkala, Johannes; Cornelles Soriano, Miguel; Zambrini, Roberta
May 10 - 14

Generation of fast physical periodic patterns with high intra-pattern diversity using semiconductor lasers with optical feedback.

Conference on Lasers and Electro-Optics CLEO/Europe-EQEC 2021 Munich, Germany.
Argyris, Apostolos; Schwind, Janek; Ingo Fischer
June 21 – 25

Collective Phenomena on Superconducting Qubits: Synchronization, Subradiance, and Entanglement Generation.
Collective Effects and Non-Equilibrium Quantum Dynamics (Bad Honnef), Germany.
 Cattaneo, Marco; Giorgi, Gian Luca; Maniscalco, Sabrina; Paraoanu, Sorin; Zambrini, Roberta
 June 29

Inhibitory Gatin in Dentate Gyrus.
International congress of experimental and computational neuroscience, CNS2020. Melbourne, Australia.
 Estarellas Martin, Cristian; Mirasso, Claudio; Canals, Santiago.
 July 18 - 22

56 Gbaud PAM-4 100 km Transmission System with Photonic Processing Schemes.
AI for Optical Networks & Neuromorphic Photonics for AI Acceleration Summer School Fraunhofer Heinrich-Hertz-Institut (HHI), Berlin, Germany
 Estébanez, Irene
 September 6 - 9

Biased voter model: How persuasive a small group can be?.
5th European Conference on Social Networks, Naples, Italy
 Czaplicka, Agnieszka; Charalambous, Christos; Toral, Raúl; San Miguel, Maxi
 September 6 - 10

Thermodynamics of Gambling Demons.
Third EPS Conference "Statistical Physics of Complex Systems", ICTP/SISSA Trieste, Italy.
 Manzano, Gonzalo; Subero, Diego; Maillet, Olivier; Fazio, Rosario; Pekola, Jukka P.; Roldán, Édgar
 September 8 - 10

Information transmission in delay-coupled neural circuits in the presence of a relay population.
SENC Meeting 2021, Lleida, Spain.
 Sánchez-Claras, Jaime; Pariz, Aref; Valizadeh, Alireza; Canals, Santiago; Mirasso, Claudio.
 November 3

Inferring leader-follower behavior from presence data.
ECONET 2021: V Symposium on Ecological Networks. Palma, Spain.
 Fernández-Gracia, Juan; Rodríguez, Jorge P.; Eguíluz, Víctor M.
 November 10 – 12

Population dynamics and competition in seagrass meadows in a global warming scenario.
ECONET 2021: V Symposium on Ecological Networks. Palma, Spain.
 Sintes, Tomas; Llabrés, Eva; Ruiz-Reynés, Daniel; Gomila, Damià; Hernández-García, Emilio; Marbà, Nuria; Duarte, Carlos M.
 November 10 – 12

Dynamical Phase Transitions in Quantum Reservoir Computing.
2nd European Quantum Technologies Virtual Conference (EQTC). Ireland.
 Martínez-Peña, Rodrigo; Giorgi, Gian Luca; Nokkala, Johannes; Cornelles Soriano, Miguel; Zambrini, Roberta
 November 29 – December 2

Topologic implications in information routing in *Caenorhabditis elegans*.
The 10th International Conference on Complex Networks and their Applications, Madrid, Spain.
 Medina Hernández, Jorge; M. Eguíluz, Víctor; Mirasso, Claudio
 November 30

Ordering dynamics in multi-state voter models.
10th International Conference on Complex Networks and Their Applications, Madrid, Spain.
 Ramirez, Lucía; San Miguel, Maxi; Galla, Tobias
 November 30 – December 2

a.6.4 Seminars and talks in other research centers

Reducing the stress on intensive care by optimally load balancing patients in the era of COVID-19.
UBICS Complex Systems and Covid colloquia Seminar, University of Barcelona, Spain.
 Lacasa, Lucas
 January 1

Characterizing physical and ecological connectivity by Lagrangian flow networks: Dispersion, mixing and marine provinces (webinar).
ICBM - Institut für Chemie und Biologie des Meeres, Carl von Ossietzky Universität, Oldenburg, Germany.
 Hernandez-Garcia, Emilio
 January 21

Dynamical Phase Transitions in Quantum Reservoir Computing.
Namur Institute of Complex Systems, Belgium.
 Martínez-Peña, Rodrigo
 February 4

Conductance oscillations in 2D strips with chiral or localized Majorana modes.
Electronics and Nanoscale Engineering Division, University of Glasgow, UK.
 Serra, Llorenç
 March 19

Networks in Virology. Learning from SARS-CoV-2.
BIFI, Universidad de Zaragoza, Spain.
 Estrada, Ernesto
 April 16

Time-Delay reservoir computing.
University of Trento, Italy.
 Donati Giovanni
 May 28

Ecology of Online Social Systems.
Institute of Biocomputation and physics of Complex Systems, University of Zaragoza, Spain.
 Meloni, Sandro
 June 4

Quantum reservoir computing with complex networks.
DIPC Donostia International Physics Center, Spain.
 Zambrini, Roberta
 June 17

What can we learn from simple models of social behavior.
Latin American alliance or capacity building in Advanced Physics. Bucaramanga, Colombia.
 San Miguel, Maxi
 September 20

Network-theory tools to characterize physical and ecological connectivity in fluid flows.
Physics Department of PUC-Rio, Rio de Janeiro, Brazil.
 Hernandez-Garcia, Emilio
 September 30

Silicon microring resonators for time-delay reservoir computing.
University of Trento, Italy.
 Donati Giovanni
 October 8

Sensing complex systems: time series, networks, and their interface.
Universidad Politécnica de Madrid Applied Mathematics Colloquium. Spain.
 Lacasa, Lucas
 October 15

Complex network approaches for the study of atmospheric blocking events and El Niño–Southern Oscillation.
LSCE (Laboratoire des Sciences du Climat et de l'Environnement, Paris), France.
 Ehstand, Noémie; Donner, Reik V.; López, Cristóbal; Hernández-García, Emilio
 October 20

Nobel Prize in Physics 2021: Giorgio Parisi's Work, A Few Aspects.
Univ. Navarra, Pamplona, Spain.
 Wio, Horacio S.
 November 15

Understanding the effects of disordered interactions using dynamic mean field theory.
NORDITA, Stockholm, Sweden.
 Baron, Joseph W.
 November 15

Seminars during the Life Data Epidemiology Course.
University of Padova, Italy
 Meloni, Sandro
 November 18

Disordered systems in theoretical ecology and game theory.
École Polytechnique, Paris, France.
 Galla, Tobias
 December 3

Układy zlozone, fizyka i sieci społeczne.
A lecture in polish given during the annual board meeting of the Polish Physical Society, Poland.
 Raducha, Tomasz
 December 18

a.7. Other Activities

a.7.1. Master Thesis

Evolutionary Game Theory with payoff fluctuations: Bet-Hedging
 Calvo Ibáñez, Ruben (supervisor: Galla, Tobias)
 October 27

Statistical physics in a three-state extended voter model
 Lázaro Sánchez, Teresa (supervisors: Galla, Tobias; Klemm, Konstantin)
 October 22

Spontaneous synchronization in spin systems
 Rodrigo Bort, Lucía (supervisors: Zambrini, Roberta; Giorgi, Gian Luca)
 October 22

A normal form for excitable vegetation dynamics
 Carles Martorell (advisor: Gomila, Damià)
 October 20

Understanding migrations in Central America and Mexico using geolocated data
 Rodriguez Gomez, Miguel (advisor: Ramasco, Jose J.)
 October 8

A compartmental model for vector transmitted diseases: an application to *Xylella fastidiosa*
 Flaquer Galmés, Rosa (advisor: Matias, Manuel A.)
 September 30

Cell migration in cancer metastasis
 Pedrosa Garcia-Moreno, Marta; (advisors: Sintes, Tomás; Janssen, Liesbeth; Storm, Cornelis)
 September 8

Detecting zealots in the Noisy Voter Model using Bayesian inference
 Alvarez-Sánchez, Miguel (supervisors: Galla, Tobias; San Miguel, Maxi)
 July 21

Effects of Control Limitations on the Power Grid Fluctuations
 Sadurní Parera, Marc (advisors:
 Gomila, Damià; Colet, Pere)
 July 16

Information processing in homophilic and heterophilic social networks: simple vs. complex contagion
 Díaz Díaz, Fernando (supervisors:
 San Miguel, Maxi; Meloni, Sandro)
 July 6

Influence of Measurements on Continuous Variable Quantum Reservoir Computing
 García Bení, Jorge (advisors: C.
 Soriano, Miguel; Zambrini, Roberta)
 January 26

a.7. 2. Research stays in other centers

Instituto de Neurociencias, Alicante, Spain.
Research stay in Dr. Santiago Canals' lab.
 Sanchez Claros, Jaime
 March 1 – September 30

University of Padova, Italy.
Visit at Liph lab, Department of Physics.
 Calleja-Solanas, Violeta
 September 19 – December 23

IBM (Zurich), Switzerland.
Secondment in the framework of Post-digital project.
 Talandier, Lucas
 October 1 – December 31

Rijksuniversiteit Groningen, Germany.
Research stay at the MINDS group led by Dr. Herbert Jaeger.
 Goldmann, Mirko
 November 1 – January 31, 2022

University of Padova, Italy.
Visit at Liph lab, Department of Physics.
 Meloni, Sandro
 November 15 - 19

KAUST, Saudi Arabia.
Research stay at Red Sea Research Center,
 Álvarez, Miguel; Giménez-Romero, Àlex; Llabrés, Eva; Matias, Manuel A.; Sintes, T
 December 2 - 9

a.8. Press and Media

The titles are linked to the document or media clip

a.8.1 Press and digital Media

Un estudi internacional amb participació de la UIB proposa un model computacional d'evolució lingüística
Diari de Balears
 January 22

Definim la «temperatura» de les llengües
El Diari de la UIB
 January 22

El conseller Martí March ha visitat avui els centres de recerca IFISC i IUNICS
Govern Illes Balears
 January 22

March sigue en el Ifisc y el Iunics su ronda de visitas a los institutos de investigación de Baleares
Europa Press
20minutos
NoticiasDe
Gente Digital
La Vanguardia
 January 22

El rastreig digital funciona: L'aplicació Radar COVID detecta el doble de contactes estrets
Tarragona Digital
 January 27

'Radar Covid' detecta el doble de contactos que el rastreo manual, según un estudio
20minutos
El Diario
 January 27

Evidència experimental de l'aplicació Radar COVID
El Diari de la UIB
 January 28

Investigadores validan la utilidad de la aplicación Radar COVID para rastrear contactos
Última Hora
 January 29

Sistemes como el “Radar COVID19” ofrecen el doble de resultado que el rastreo manual pero precisan de campañas de concienciación
Salud Ediciones
 January 29

El fracàs de l'app Radar Covid: detecta pocs contactes perquè no es fa servir prou
 Notícies TV3
 January 30

El ruido provocado por el ser humano altera la vida en los océanos
CSIC
 February 4

La contaminación acústica perturba la vida en los océanos
Agencia SINC
Economía Avanzad@
TecnoXplora
El Mercurio Digital
La Voz de Galicia
Estrella Digital
Siglo XXI
 February 4

El ruido humano altera la vida en los océanos
Catalunya Vanguardista
Asturias Mundial
Solidaridad Digital
EFE Verde
IB3 Notícies
La Voz de Asturias
Industrias Pesqueras
Acción Verde
ECNoticias
 February 5

Las mujeres ocupan sólo el 26,5% de las plazas en grados de ciencia de la UIB
Europa Press
Noticias De
Diari de Balears
Gente Digital
20minutos
La Vanguardia
 February 11

| | | |
|---|--|--|
| Ruido submarino: otra amenaza para la vida en los océanos | Investigadores del IFISC analizan la importancia de los retrasos en el flujo de información cerebral | The 5 most popular scientific papers of February 2021 in the Nature Index journals |
| <i>Sport</i> <i>El Periódico</i> <i>La Opinión A Coruña</i> <i>Faro de Vigo</i> <i>Opinión de Zamora</i> <i>La Opinión de Murcia</i> <i>TICbeat</i> <i>Aquí en Elche</i> February 6 | <i>CSIC Illes Balears</i> April 16 | <i>Nature Index</i> May 6 |
| La contaminación acústica perturba la vida en los océanos | Investigadors de la UIB analitzen la importància dels retards en els fluxos d'informació cerebral | La nueva Ley de Ciencia fijará un incremento gradual hasta llegar a un 2% del presupuesto autonómico dedicado a I+D+i |
| <i>Hipertextual</i> <i>Telecinco</i> February 9 | <i>Diari de Balears</i> April 19 | <i>Noticias Mallorca</i> <i>20 minutos</i> <i>La Vanguardia</i> <i>CSIC</i> May 14 |
| Test de las tarjetas Nvidia | El Govern creará en Mallorca un centro de Inteligencia Artificial con fondos europeos | Models matemàtics inspirats en l'ecologia per comprendre les xarxes socials |
| <i>SIE</i> February 23 | <i>Diario de Ibiza</i> <i>Diario de Mallorca</i> April 19 | <i>Universitat Oberta de Catalunya</i> May 14 |
| Dos investigadoras del CSIC en las Illes Balears participan en la coordinación del Libro Blanco de Desafíos Científicos 2030 | Analizando la comunicación online como sistemas ecológicos | Spain's IFISC Tackles COVID-19, Climate Change with GIGABYTE Servers |
| <i>CSIC Illes Balears</i> March 9 | <i>CSIC Illes Balears</i> <i>El diari de la UIB</i> <i>Noticanarias</i> April 26 | <i>GIGABYTE</i> May 31 |
| ¿Cómo se hunden los microplásticos en el Mar Mediterráneo? | La importància de les aplicaciones de seguimiento de la COVID-19 | Midiendo los cuellos de botella en el océano |
| <i>El Diari de la UIB</i> <i>CSIC Illes Balears</i> March 10 | <i>El diari de la UIB</i> April 29 | <i>El Diari de la UIB</i> September 1 |
| Trayectorias de éxito llevan a los titulados a diferentes lugares de Europa | Un estudio con participación del IFISC destaca la importancia de las aplicaciones de seguimiento de la COVID-19 | Xarxes Neuronals Profundes amb només una neurona |
| <i>El Norte de Castilla</i> March 10 | <i>CSIC Illes Balears</i> April 29 | <i>El Diari de la UIB</i> <i>Salud Ediciones</i> September 14 |
| El IFISC analiza el hundimiento de los microplásticos desde la superficie hasta el fondo marino | El IFISC destaca la eficacia del rastreo digital de contactos en los contagios de COVID19 en el trabajo, la comunidad y los transportes | La Noche de la investigación vuelve para acercar la ciencia a la ciudadanía |
| <i>Última Hora</i> March 11 | <i>Salud Ediciones</i> April 30 | <i>Noticias Mallorca</i> <i>NoticiasDe</i> <i>Mallorca Actual</i> <i>EFE Servicios</i> <i>Gente Digital</i> <i>Europa Press</i> <i>La Vanguardia</i> <i>Diari de Balears</i> <i>20 minutos</i> <i>Ara Balears</i> <i>IB3</i> September 22 |
| Los Premios Nacionales de Movilidad evalúan las candidaturas de su 1ª edición | Científicos de todo el mundo se reúnen para compartir sus avances sobre la Xylella fastidiosa | Un trabajo del CSIC estudia cómo cambia la economía cuando esta puede ser manipulada |
| <i>Logística Profesional</i> <i>FuturEnergy</i> April 7 | <i>Guía Verde</i> April 30 | <i>CSIC</i> <i>El Diari de la UIB</i> <i>CNB</i> September 22 |
| Investigadors de l'IFISC analitzen la importància dels retards en el flux d'informació cerebral | La importància de les aplicaciones de seguimiento de la COVID-19 | |
| <i>El diari de la UIB</i> <i>Salut i Força</i> April 16 | <i>Ibeconomía</i> May 4 | |

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| Cómo cambia la economía cuando esta puede ser manipulada <i>REDIB Informa</i> September 24 | Disease outbreak simulations reveal influence of “seeding” by multiple infected people <i>Science Magazine</i> October 14 | In the quantum realm, not even time flows as you might expect <i>Eurekalert</i> <i>Phys</i> <i>Science Daily</i> <i>SciTech Daily</i> <i>University of Bristol</i> <i>Remonews</i> <i>IFLS</i> November 26 |
| La energía fotovoltaica necesita más potencia para no sufrir apagones <i>Última Hora</i> <i>Periódico de Ibiza y Formentera</i> September 28 | Les simulacions de brots de malalties revelen la influència de la «semeja» de múltiples persones infectades <i>El Diari de la UIB</i> October 15 | ¿En qué dirección fluye el tiempo en un mundo cuántico? <i>Digital Trends</i> November 26 |
| Energía solar puede aumentar hasta 30 % sin riesgo de apagones, según IFISC <i>Investing</i> <i>EFE</i> <i>El Periódico de la Energía</i> <i>Economía de Mallorca</i> September 28 | Simulaciones de brotes de enfermedades revelan que la ‘siembra’, con la llegada continua de infectados, aumenta la incidencia <i>Salut i Força</i> October 16 | En la mecànica quàntica el temps no flueix com caldría esperar <i>El Diari de la UIB</i> November 29 |
| Investigadores del IFISC evalúan el riesgo de apagones en sistemas con alta penetración de renovables <i>Smart Grid Info</i> September 29 | Los límites matemáticos de la amistad, la enemistad y el Big Data <i>ABC</i> <i>La Voz Digital</i> October 25 | En el mundo cuántico el tiempo no fluye como se podría esperar <i>Madridmasd</i> <i>El Debate</i> <i>EFE</i> <i>El Obrero</i> <i>El Tiempo</i> <i>Madrid Press</i> November 29 |
| Un estudio del IFISC evalúa el impacto de la sustitución de centrales convencionales <i>Especial Energía, Última Hora</i> September 30 | La transición ecológica <i>Última Hora</i> October 29 | Científica recibe el premio Giambiagi a la mejor tesis doctoral en Física <i>Noticias Universidad Nacional de San Luis</i> December 1 |
| Un mundo nuevo allí abajo <i>The Conversation</i> <i>Yahoo! Noticias</i> <i>El Diari de la UIB</i> <i>El Obrero</i> October 4 | Estas son las personas ganadoras de los Concursos Contra el Cambio Climático <i>Delegación CSIC Illes Balears</i> November 2 L'IFISC i l'IMEDEA organitzen el V Simposi sobre Xarxes Ecològiques <i>El Diari de la UIB</i> <i>Delegación CSIC Illes Balears</i> November 9 | Demuestran que un sistema cuántico puede evolucionar, al mismo tiempo, hacia el pasado y el futuro <i>ABC</i> <i>La Voz Digital</i> December 2 |
| Los sistemas complejos explican el clima y los fenómenos emergentes a gran escala <i>CSIC</i> <i>Noroeste Madrid</i> <i>MeteoRed</i> October 8 | La nueva Ley de la Ciencia garantizará al menos un 2% de inversión anual en I+D+I <i>Diario de Mallorca</i> <i>CAIB</i> <i>Periódico de Ibiza</i> <i>Diario de Ibiza</i> <i>Europa Press</i> November 10 | Los sistemas cuánticos evolucionan al pasado y al futuro <i>Ambientum</i> December 3 |
| El Govern comparte con representantes de la comunidad científica el contenido de la futura Ley de la Ciencia <i>La Vanguardia</i> <i>Noticias Mallorca</i> <i>Europa Press</i> <i>20minutos</i> <i>Gente Digital</i> October 13 | Augmentar la potència de sortida dels làsers trencant-ne la simetria <i>El Diari de la UIB</i> November 11 | Redes Complejas y dónde encontrarlas <i>Fundación Sicómoro</i> December 15 |
| Redes matemáticas para entender conflictos sociales <i>Materia, El País</i> October 14 | | |

a.8.2 Radio and TV

Temperatura lingüística

De Far a Far, Radioilla Formentera
January 28

11F: Interview to Rosa López

Balears Fa Ciència, IB3 Ràdio
February 6

11F: Interview to Roberta

Zambrini
IB3 Televisió
February 11

Interview to Emilio Hernández

Balears Fa Ciència, IB3 Ràdio
June 12

La comunitat científica de les Illes es prepara per celebrar aquest divendres la Nit de la Recerca

IB3 Televisió
Septembre 22

Nobel de Física: Los Sistemas

Complejos
Radio Francia
October 5

Collaboration in the podcast:

"Voces, CSIC Baleares"

