ANNUAL REPORT 2022

EXCELENCIA MARÍA DE MAEZTU 2023 - 2027

IFISC

Universitat de les Illes Balears

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Institute for Cross-Disciplinary Physics and Complex Systems

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PRESENTATION AND RESEARCH LINES

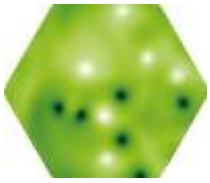
IFISC (Institute for Cross-Disciplinary Physics and Complex Systems) is a joint research institute of the University of the Balearic Islands (**UIB**) and the Spanish National Research Council (**CSIC**) created in 2007 building upon the former Cross-Disciplinary Physics Department of the Mediterranean 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. Recently, research has also moved towards new topics in quantum machine learning.

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. In addition, the award has been renewed for the 2023-2026 period.

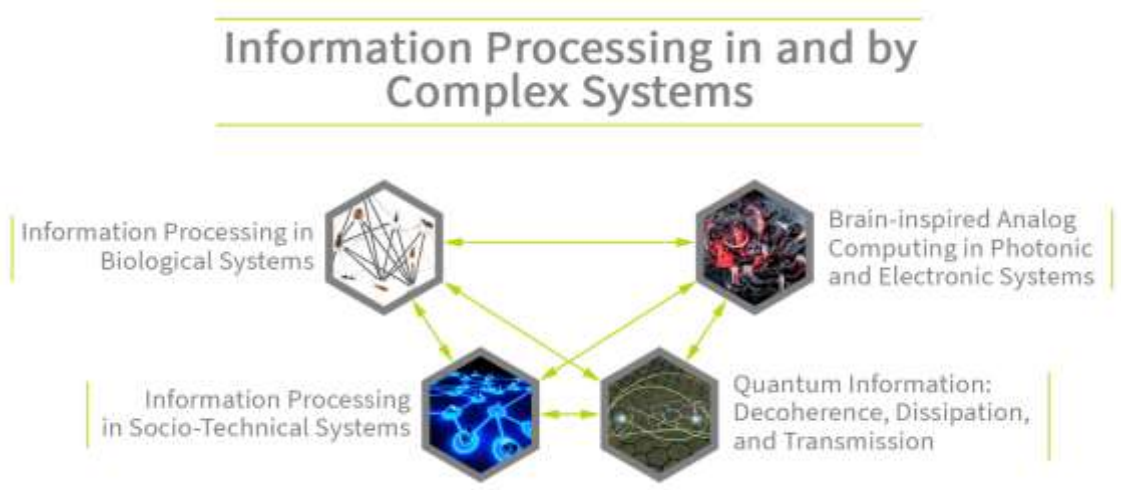
According to the Ministry, being awarded as "Severo Ochoa" or "María de Maeztu" represents "the recognition and accreditation of the best centers and units that stand out for their international impact and the relevance of their results obtained in the last four years". Moreover, it targets "the financing 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 "Maria de Maeztu" (MdM) 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. **IFISC was the first unit of excellence in the Balearic Islands to receive the Maria de Maeztu award.**

The research project associated to the MdM award granted in 2018 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 2018-2022 Maria 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 2018-2022 within the MdM program are:

POSTDOCTORAL RESEARCHERS:

Pere Mujal

Sungguen Ryu

Lucia S. Ramirez

Giula Ruzzene

Andrea Tabi

Christos Charalambous

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 TECHNICIANS: **Eduard Solivellas and Esteve Seguí**

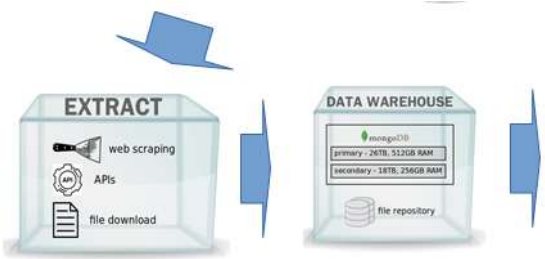
1.3. IFISC SERVICE UNIT: DataAnalytics@IFISC

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.



- Urban mobility
- Tourism
- Sociodemographics
- Air transportation networks
- Epidemic spread
- Opinion dynamics & elections
- Language use
- Biomedics
- Population mobility in ecology

1.4 IFISC STRUCTURE CHART

1.5 2022 REPRESENTATIVE RESEARCH RESULTS

Here are some research results published during 2022. They are representative of the different research lines and thus illustrate the range of topics studied at IFISC.

The Shape of Memory in Temporal Networks

O. Williams, L. Lacasa, A.P. Millán, V. Latora

Nature Communications 13, 499

The outcome of dynamical processes running on networks –such as epidemic spreading, diffusion or synchronization—are impacted by the fact that the network of interactions changes over time. For instance, it has been observed that an evolving topology can slow down or speed up propagation of information throughout the network, depending on the specific evolution of the network substrate over which the dynamical process takes place. Understanding the dynamics of the network is thus of capital importance, not only per se, but also to gain understanding on how dynamical processes running on networks are impacted by an intrinsic network dynamics.

Within this context, how to best define, detect and characterize network memory, i.e. the dependence of a network's structure on its past, is currently a matter of debate. In this work we show that the memory of a temporal network is inherently multidimensional as it cannot be reduced to a scalar quantity, i.e. memory has a shape. We introduce a mathematical framework for defining and efficiently estimating the microscopic shape of memory, which characterises how the activity of each link intertwines with the activities of all other links.

We first validate our methodology on a range of synthetic generative models, where we provide rigorous results on their memories.Then, we show that simple spreading processes can have qualitately different outcomes when the memory shape of the network is different, even if all these temporal networks have the same 'scalar memory', reinforcing the fact that memory is multidimensional and that such novel structure needs to be taken into account to properly account for the effects that intrinsic network dynamics have on processes running on top of the network. At this point we unveil a new phenomenon that we call virtual loops, these are memory resonances that emerge as part of the memory shape: long microscopic memories, not originally planted in the models, that emerge out of the network interaction dynamics and are felt by dynamical processes running on top. We study in detail this new phenomenon, and quantify its prevalence in large networks: we find that these are unstable resonances that tend to vanish as the network backbone increases in complexity, a phenomenon that we call virtual loop decoherence.

Finally, we study the memory shape of real-world temporal networks spanning social, technological and biological systems, finding that these networks display heterogeneous memory shapes. In particular, online and offline social networks are markedly different, with the latter showing richer memory and memory scales. Our theory provides a novel methodology for exploring the dynamically rich structure of complex systems and our findings certify that there is indeed "more room at the bottom" in terms of the structure of memory in networks.

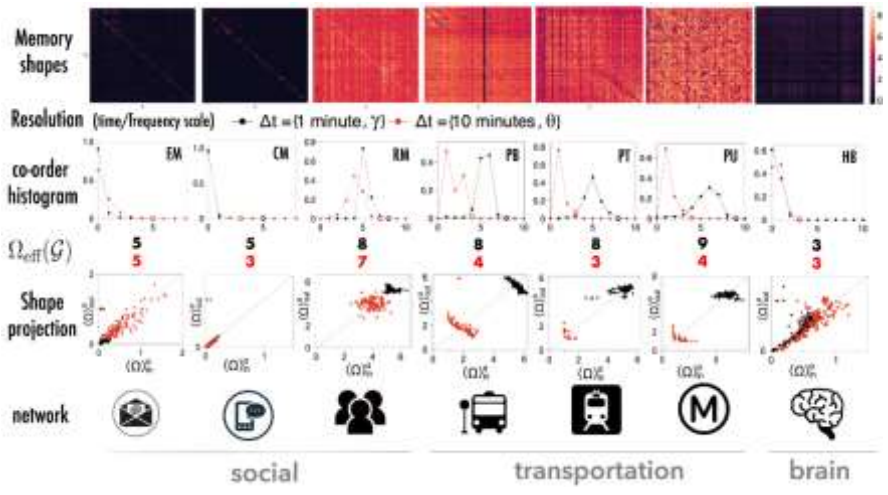


Figure: Examples of memory shapes and different metrics extracted from them for a range of empirical temporal networks.

Eigenvalues of random matrices with generalised correlations: a path integral approach

Joseph W. Baron, Thomas Jun Jewell, Christopher Ryder, Tobias Galla
Physical Review Letters 128, 120601 (1-6)

Determining the factors that contribute to the stability of a dynamical system with many interacting components is a fundamental problem. The theory of large random matrices demonstrates that we can ascertain the stability of such a system given only statistical information about its microscopic interactions. As such, random matrix theory (RMT) has found myriad applications outside its original field of conception, that of nuclear and atomic physics, and has become a rich and active area in its own right. Among the diverse range of fields where RMT enjoys a centrally important role are spin glasses, complex ecosystems, and neural networks.

Over time the remit of RMT has systematically been expanded to encompass an evermore complete collection of random matrix ensembles. For example, it has been shown that Wigner's semi-circle law can be generalised for asymmetric matrices, which have eigenvalues that are uniformly distributed in an ellipse in the complex plane.Allowing for a uniform non-zero mean for each of the matrix elements gives rise to an additional outlier eigenvalue. More elaborate block-structured matrices and matrices with element-specific variability have also been investigated. Despite these developments, typically only correlations between matrix elements that are diagonally opposite each other (i.e., a_{ij} and a_{ji}) are included in RMT calculations. This is a rather artificial restriction.

In this Letter, we study the eigenvalue spectrum of an ensemble of random matrices with correlations between any pair of elements. To this end, we introduce an analytical method that maps the resolvent of the random matrix onto the response functions of a linear dynamical system. The response functions are then evaluated using a path-integral formalism combined with diagrammatic expansion, which we are able to resum. This enables us to make deductions about the eigenvalue spectrum. Our central result is a simple, closed-form expression for the leading eigenvalue of a large random matrix with generalised correlations. This formula demonstrates that correlations between matrix elements that are not diagonally opposite, which are routinely neglected, can have a significant impact on stability.

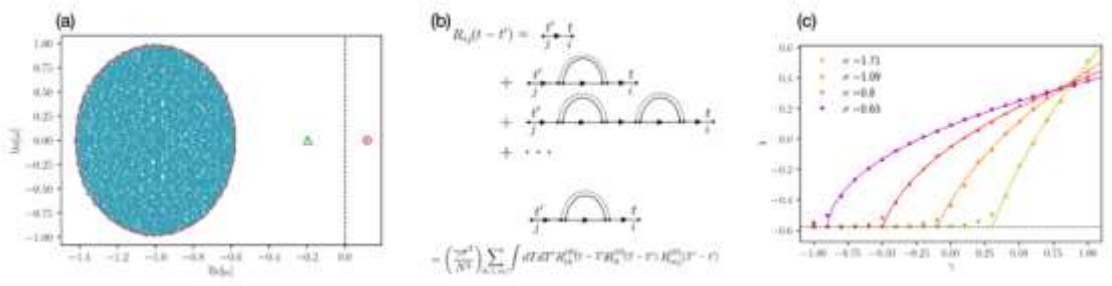


Figure 1. (a) Sample spectrum of a random matrix with generalised correlations; (b) Illustration of the diagrammatic approach; (c) Theoretical predictions for outlier eigenvalue (lines) agree with simulations (markers).

Topological triple phase transition in non-Hermitian Floquet quasicrystals.

S. Weidemann, M. Kremer, S. Longhi, A. Szameit
Nature 601, 354–359.

Phase transitions, in which the properties of matter change abruptly, are familiar in our daily life. However, phase transitions in which two properties change at the same time are rarer. An example is provided by superconductors: when they are cooled towards absolute zero, they lose their electrical resistance completely and simultaneously change their magnetic properties. Even more elusive are phase transitions that link three different properties. With cutting-edge optical technologies, a collaborative team from the University of Rostock and IFISC have observed in the lab a type of such an elusive triple phase transition, in which three independent characteristics of a material jointly undergo an abrupt change. Such results have been published in the prestigious Nature journal.

The researchers demonstrated that in a certain class of solids with quasi-periodic order, known as quasicrystals, three fundamental properties are linked to one another unexpectedly and a triple phase transition can take place: topology, conductivity and exchange of energy between the quasicrystal and its environment change abruptly. To experimentally observe such phase transitions, a synthetic quasicrystal made of laser light was realized, in which the paths of light in kilometer-long optical fibers are intertwined (Fig.1). The resulting complex dynamics faithfully mirror the motion of electrons in quasicrystals.

The discovery of such a triple phase transition and the possible unification of topology, conductivity and energy exchange, represents a breakthrough in the fundamental science of propagation of all types of waves, ranging from light to sound and even electrons.

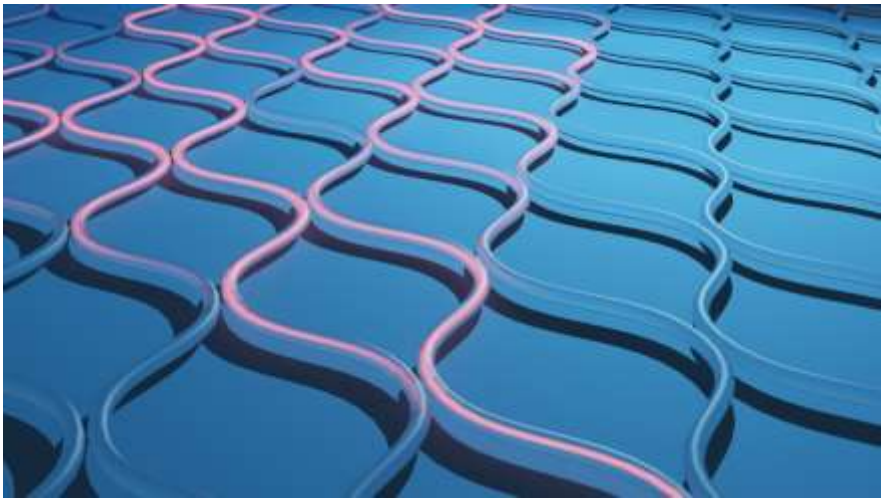


Fig.1. Schematic of a synthetic photonic quasicrystal made with laser light. Light pulses propagate in optical fibers whose special arrangement intertwin different light paths, so that the laser light mimics the quantum motion of electrons in a quasi-crystal.

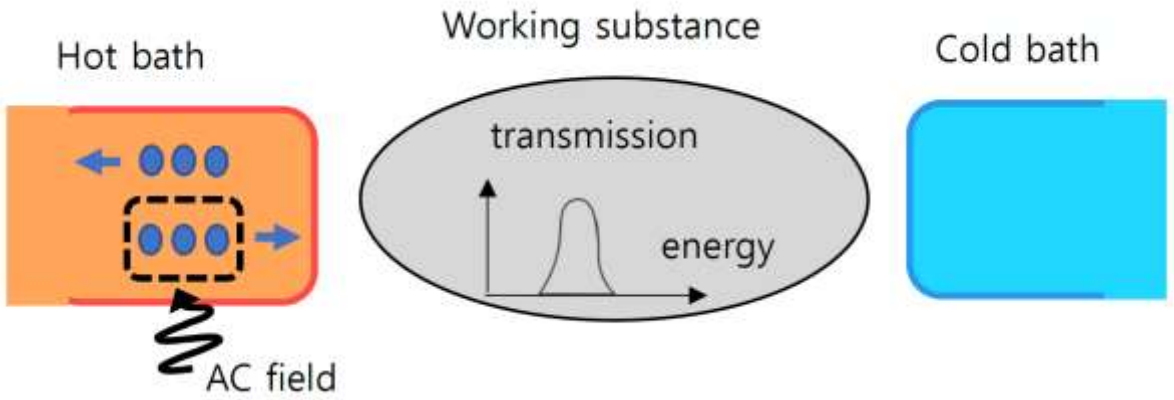
Beating Carnot Efficiency with Periodically Driven Chiral Conductors

Sungguen Ryu, Rosa López, Llorenç Serra, and David Sánchez
Nature Communications 13, 2512.

One of the implications of the second law of thermodynamics is that the power generated by a thermal machine cannot exceed the Carnot efficiency limit in the classical regime. However, this upper limit can in principle be exceeded if we assume that quantum coherence is also a resource for entropy production. Therefore, understanding how the entropy resource can be controlled in different scenarios is key to achieving higher efficiency in quantum coherent engines and refrigerators.

We posited a quantum engine consisting of an arbitrary energy-dependent transmission tunneling scatterer coupled to hot and cold electronic reservoirs in the presence of an external AC (alternate current) bias voltage. A crucial point is to understand that most AC voltage sources inject net energy into the motor, thus reducing the power developed. Remarkably, we figure out how to cancel this detrimental effect using chiral conductors such as those created with topological matter. Once the external AC field is selectively applied to the electrons depending on their propagation direction in the chiral conductor, the net input energy completely vanishes. This enables high efficiencies of the quantum engine even beyond the Carnot limit, in contrast to non-chiral cases.

However, this does not mean that the second law of thermodynamics is being violated, since with the proper definition entropy production is always positive. This proper entropy production yields a new upper bound of the efficiency that, unlike the Carnot value, is not universal and depends on the details of the AC voltage. This implies that there is, in principle, huge room to tailor large efficiencies in AC driven quantum chiral conductors.



High-Performance Reservoir Computing with Fluctuations in Linear Networks

J. Nokkala, R. Martínez-Peña, R. Zambrini, M. C. Soriano

IEEE Transactions on Neural Networks and Learning Systems 33, 2664-2675

Oscillator networks are a type of system that has shown promise in the field of machine learning. They consist of a collection of interconnected oscillators that are able to store and process information. These networks can be used to perform complex computational tasks, such as time series prediction, channel equalization, or nonlinear system identification. In particular, they are well-suited for reservoir computing, which is a machine learning approach that involves feeding input data into a complex system and then using the output of the system to make predictions. Oscillator networks can also be easily adapted to work with noisy data, making them a good choice for real-world applications.

In this work, we have investigated how to use the fluctuations of a network of linearly interacting quantum harmonic oscillators (QHON) for reservoir computing. This scheme is illustrated in Fig. 1 (left). We focused on a linear readout and compared the results to a standard approach known as Echo State Network (ESN). We identified non-linear memory in the system correlations, displaying also dependence on the inputs at different delays. The results showed that the model of interacting harmonic oscillators was robust to additive noise in input and reservoir observables, and that the ability to finely control reservoir memory is crucial in realistic noisy conditions. The memory of the model can be easily controlled via the input encoding and the observables used by the linear readout, which can facilitate solving the task with smaller reservoirs. As shown in Fig. 1 (right), these oscillator networks can achieve performance comparable to traditional machine learning methods, while also being potentially more energy-efficient.

This work highlights the appealing experimental prospects of reservoir computing based on fluctuations, particularly in optical platforms. Overall, oscillator networks represent an exciting and rapidly developing area of research in machine learning, with the potential to transform the way we process and analyze data.

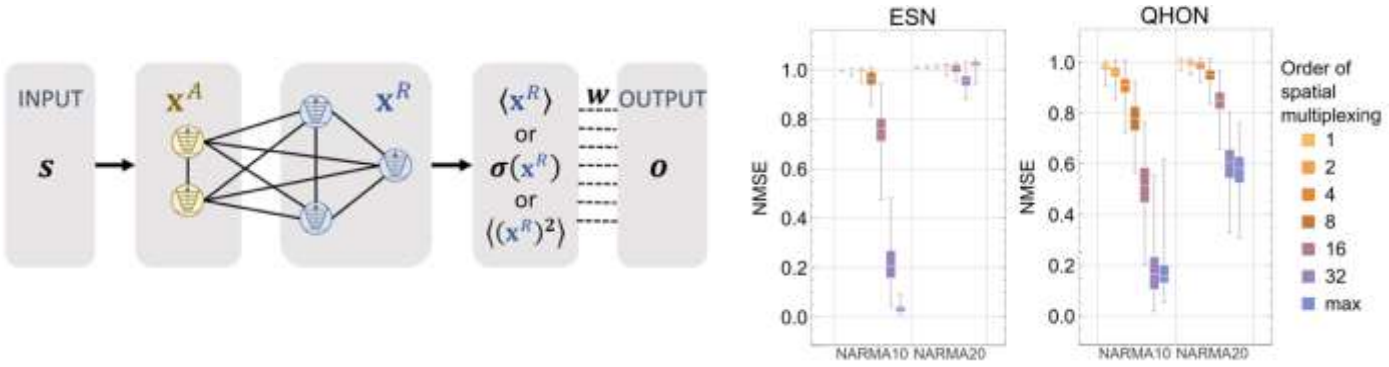


Figure 1: (Left) Reservoir computing scheme. A sequence s is injected into a network of harmonic oscillators by periodically resetting the states of a subset of oscillators. Each element in the output sequence o is a trained linear combination of either the first or second moments or covariances of the reservoir operators xR before each state reset. (Right) Comparison of ESN and oscillator network performance in a nonlinear system identification task (NARMA) for different orders of spatial multiplexing and a single component network of the largest size (max = 128). NMSE stands for Normalized Mean Square Error.

Optical dendrites for spatio-temporal computing with few-mode fibers

S. Ortín, M.C. Soriano, I. Fischer, C.R. Mirasso, A. Argyris
Optical Materials Express 5, 453506

Multimode fibers have been traditionally used in short-range communication systems and optical imaging. Recently, their potential for unconventional optical computing has been recognized due to their ability to perform complex spatial and spatio-temporal transformations. This article highlights this potential and demonstrates the analogy between light propagation in few-mode fibers and electric signals in dendrites of biological neurons.

In the proposed system, a few-mode fiber-based optical dendritic unit (FMF-ODU) is used as a linear computing element to implement an ultra-fast spatio-temporal coincidence detector. The few-mode fiber considered in this study has a small core diameter of 14 µm, supporting eight linearly polarized spatial modes. To excite multiple propagation modes with similar power, the input optical beam needs to be misaligned with respect to the fiber axis. The temporal mixing of an input signal occurs as it travels through the different spatial fiber modes. Modes with the same group velocity contribute to the same dendritic branch.

The operation of the proposed FMF-ODU scheme is evaluated via header recognition and bit counting tasks, demonstrating its potential for optical computing applications. The input is a sequence of binary digits, represented by the presence or absence of a 25 ps Gaussian optical pulse. After 4.5 meters of propagation in the few-mode fiber, the signal is photo-detected by an n x n square photodetection array. The photodetector output of n^2 features is used for pattern classification using logistic regression. Our study shows that a 2x2 photodetection array allows for error-free symbol classification for the 4-bit header recognition task and the "1" counter task.

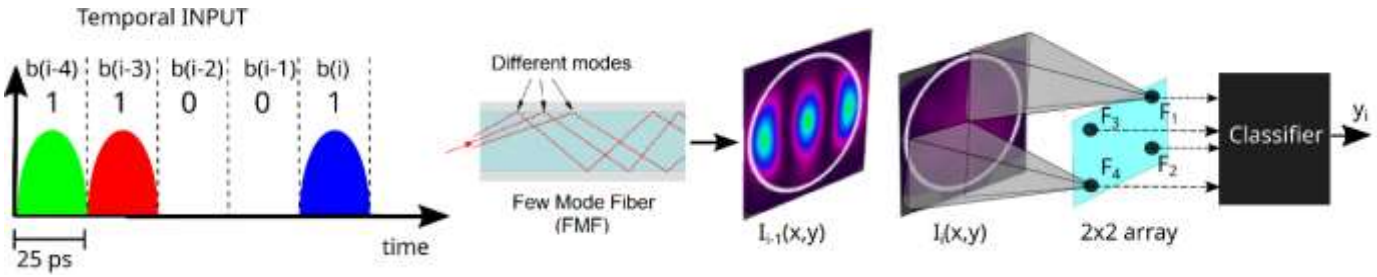


Figure 2: Schematic of the FMF-ODU computational concept. The input is a sequence of binary digits, represented by the presence or absence of a 25 ps Gaussian optical pulse. After fiber propagation, we obtain the output intensity pattern distribution I(x,y) in the spatial domain of each input bit. When photodetecting the optical intensity with a 2x2 photodetection array, four output features are available to the classifier to predict the corresponding output.

Spatial effects in parasite-induced marine diseases of immobile hosts

À. Giménez-Romero, F. Vazquez, C. López, and M. A. Matías
Royal Society Open Science 9, 212023

One of the main threats of Global Change in marine ecosystems is the appearance of emerging epidemics caused by the invasion of pathogens not present so far in the ecosystem. One such epidemic has caused the virtual extinction of the noble pen shell, *Pinna nobilis,* in the Mediterranean basin by the invading parasite *Haplosporidium pinnae*, except in particular spots with very high or low salinity.

In a previous study (Ecol. Model. 459, 109705 (2021) we described the main factors characterizing the disease from experimental data of pen shells kept in tanks using a compartmental model, that assumes that the medium is well mixed. The goal of the present study is to analyze the effect of a spatial distribution of pen shells and how parasites move along the medium. The study is built on an Individual-based model that describes the stochastic spread of parasites in the system, and their infection of the pen shells. One of the results is the characterization of the transition between an epidemic event that is localized on a part of system and eventually becomes extinct (disease-free phase), and a global epidemic one that propagates over the whole system (propagation phase). This transition depends on the tradeoff between local parameters influencing the basic reproductive number and the spatial mobility of the parasite, which determines its typical traveling distance before becoming deactivated. Thus, a highly infective epidemic may become confined if it is balanced by a parasite with a low mobility and/or short lifetime.

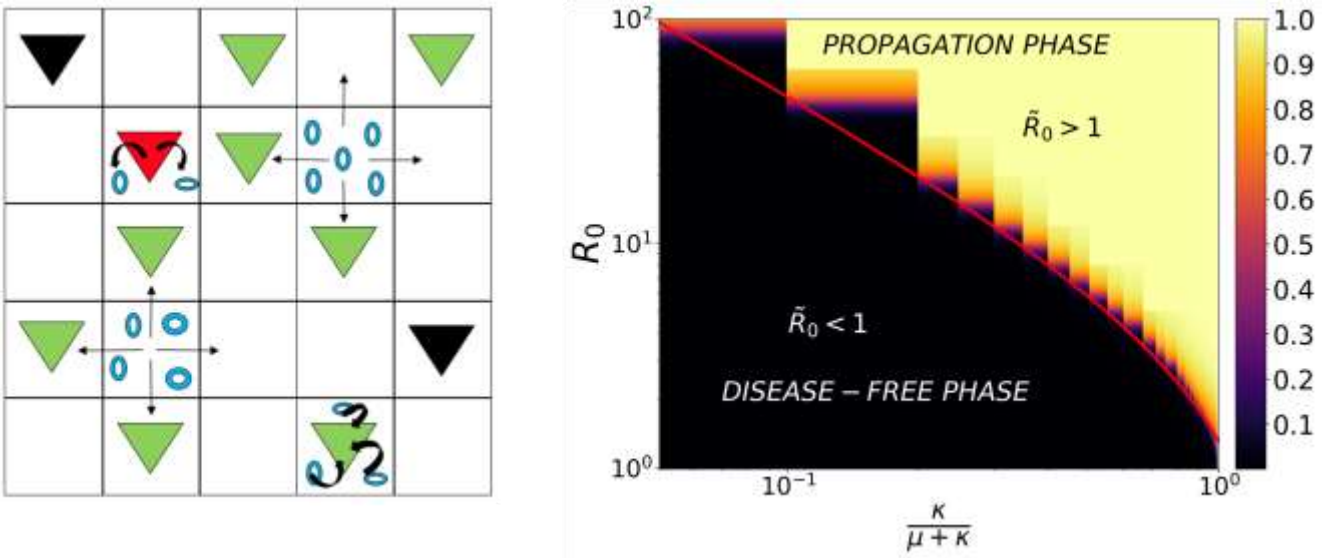


Fig. 1. Left: sketch of the parasite transmitted disease, with 3 host states: healthy (green), infected (red) and removed (dead in black). Right: Phase diagram of the confined (disease-free) and propagation phases as a function of the mean-field R0 parameter vs. the term regulating propagation, that depends on mobility κ and mortality μ.

We also studied the speed at which the disease propagates over the system and several limits in which the problem can be described by the well known SIR model, with effective interactions between the hosts that do not require an explicit description of the parasites.

We hope to apply the study to experimental data of pen shells spread in space as soon as they become available, what can be difficult because right now noble pen shells are a highly protected species.

Global predictions for the risk of establishment of Pierce's disease of grapevines

À. Giménez-Romero, J. Galván, M. Montesinos, J. Bauzà, M. Godefroid, A. Fereres, J. J. Ramasco, M. A. Matías, and E. Moralejo

Communications Biology 5, 1389

This study shows that one can model the influence of climatic variables on the risk of establishment of the vector transmitted bacterium *Xylella fastidiosa* (Xf), that causes Pierce's Disease (PD) on grapevines. The bacterium Xf is transmitted by xylem sap-feeding insects, and the meadow spittlebug, *Philaenus spumarius* (Ps) is its major vector in Europe. A mechanistic model that includes transmission is devised, based in the fact that PD is a thermal-sensitive disease, while the effect of cold-temperature exposures in the recovery of Xf-infected grapevines is a well-established phenomenon. Our model has 3 different components: i) the effect of temperature on the growth of Xf; ii) the effect of cold temperatures on winter curing; iii) the climatic suitability of the vector (Ps). The model is calibrated with the response of 36 grapevine varieties to the pathogen. Furthermore, a projection of the risk to 2050 was performed. The model describes correctly the distribution of PD in areas of North America, where it is endemic and where there are multiple transmitting vectors. Including the 3 different pieces of information of the model in Europe, that is where climatic suitability of the main vector Ps is available, the model confirms that the areas at risk are mainly islands, including the island of Mallorca where PD has recently been established. Outside these regions the risk is in general low, except in some coastal areas, where the risk is moderate. However, some areas, like Northern Portugal and areas in France present an increasing risk of establishment of the disease in 2050 due to the effects of global change, while some contraction of epidemic-risk zones is observed in some Mediterranean islands and Apulia (Italy) as the climate becomes hotter and dryer.

Overall the study downplays the risk of establishment of the bacterium in areas that were thought to be at risk and highlights the importance of considering climate variability, vector distribution, and an invasive criterion as factors to obtain better PD risk maps.

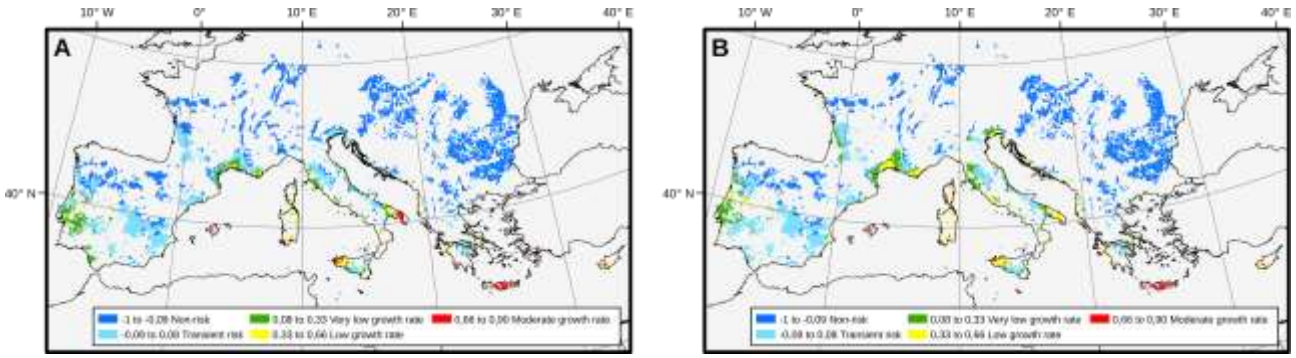


Fig. 1 Risk of establishment of PD in Europe determined for vineyards (from the Corine Land Cover database): A corresponds to 2020; B to a prediction for 2050. Blue colours represent non-risk zones and transient risk zones for chronic PD.

Inequalities in COVID-19 inequalities research: Who had the capacity to respond?

Benach, Joan; Cash-Gibson, Lucinda; Rojas-Gualdrón, Diego F; Padilla-Pozo, Álvaro; Fernández-Gracia, Juan; M Eguíluz, Víctor and COVID-SHINE group

Plos One 17, e0266132

The COVID-19 pandemic has highlighted a growing awareness of the need to understand and address the deepening social and health inequalities caused by the virus. This study examines global scientific production on COVID-19 inequalities from 2020 to 2021, including the distribution of research by country income groups and world regions, and the inter-country collaborations involved. It is hoped that the results will provide insight into the research capacity among countries, the scientific knowledge gaps, and the need for research networks to be strengthened.
Our bibliometric and network analyses of the COVID-19 inequalities research field (2020-2021) have revealed a highly collaborative research field, yet significant inequalities still exist within the scientific production and international research collaborations. High-income countries (HIC) have a research productivity rate 33 times higher than that of low-income countries (LIC), and the US and UK are the two highest country producers of this research, together producing 48% of the total scientific production. As for the international research collaborations, the US is at the center of all the clusters, followed by the UK, and a new Latin American research cluster has emerged made up of four countries. These findings provide a useful overview of the likely global dynamic and patterns within this potentially new scientific field, and can serve as a basis from which to pose further research questions and conduct assessments of local COVID-19 inequalities research capacities. Investment in health inequalities research capacities must be both a local and global priority to ensure better preparedness for future crises, and more effective strategies to tackle health inequalities.

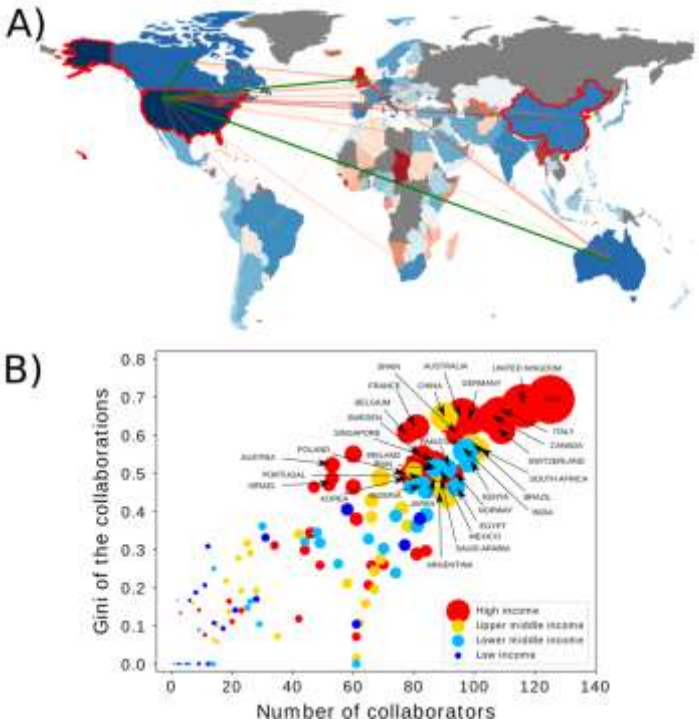
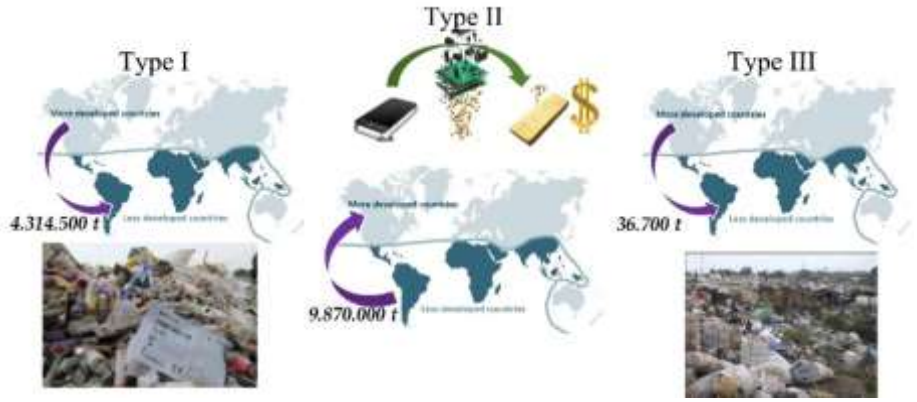


Fig. 1. A) Degree of collaboration between countries in the research field of COVID-19 inequalities. The countries are represented in different colors, with red representing the least collaborative and blue the most. The connections between countries are color-coded, from yellow to red, with green representing the highest-producing research cluster.. B) The Gini coefficient of international collaborations. The size of the symbols indicates the number of articles for each participating country and the color indicates the country's income group. Here, only the 30 countries with the highest Gini coefficient and most collaborations are labeled.

The world-wide waste web.

Martínez, J. H., Romero, S., Ramasco, J. J., & Estrada, E.
Nature Communications, 13(1), 1615.



Approximately 7 to 10 billion metric tons of waste are produced every year in the world, from which 300 to 500 metric tons is hazardous waste. Consequently, some countries ship some of their waste to other countries and they receive payment in compensation. In an ideal situation this trade would imply benefits for both parts. On one hand, an exporter receives funds that can be useful for its economic development, while on the other side, the importers can extract valuable materials from such waste. All this legal trade of hazardous waste implies the existence of a large and dense network of importers and exporters of 108 categories of wastes according to the international classification made by the Basel Convention. This is the “Worldwide waste web” or 4W.

In this work we gain a better perspective of the 4W by developing a mathematical model to study the trade of different hazardous waste grouped in 7 classes which include the 108 categories before mentioned. The study collected data from the Basel Convention for the trade of hazardous waste between all countries in the world during the period 2001-2019. In this period more than 1.4 million metric tons of hazardous waste was reported by countries adhering to the Basel Convention. The mathematical model developed to study this trade on the 4W consists of a fractional logistic model, where the Caputo fractional derivatives are used to account for the “memory” effect played by the fact that waste can be congesting a given country while it is waiting to be exported to a second one. Using this model and the 4W for each of the years in the period studied we estimate the time of the year in which a given country would get congested of a given class of waste. Such congestion can be produced either by importing more than the processing capacity that the country has, or by accumulating excessive amounts of one class of waste before exporting it.

We then combine the risk of congestion that a country has with the information about the environmental protection index of the corresponding country. In this way we elaborate a diagram of the risk of improper handling and disposal of wastes by every country. In this way we found 28 countries high risk of improper handling and disposal of wastes (HRIHDW). These are countries that could display poor handling of such hazardous materials creating situations that are likely to lead to environmental and public health problems. We identified a series of chemical fingerprints which can be traced back from hazardous wastes to the environment or the organisms of animals and people. We found evidence that such fingerprints are already present in the environment and human populations in those 28 countries at HRIHDW.

Echo chambers and information transmission biases in homophilic and heterophilic networks

Fernando Diaz-Diaz, Maxi San Miguel, and Sandro Meloni
Scientific Reports 12, 9350.

Information transmission in the context of Information and Communication Technologies is a great opportunity to create a better-informed society, but in practice, these technologies are also promoting phenomena such as the viral spreading of fake news, echo chambers and perception biases like false consensus or majority illusions and social polarization. The real social impact of echo chambers and their causal link with misinformation cascades are debated topics, but data-driven and computational approaches confirm that the structural properties of social networks are tied to the emergence of echo chambers. In particular, the homophily of the network –that is, the tendency of nodes to be connected to other nodes of the same group— seems to be a key ingredient to generate echo chambers and perception biases in what have been defined "information transmission biases" (IT biases).

Often, the spreading of information is assumed to follow the same laws as the spreading of diseases. Because of this, epidemic models (also called Simple Contagion models) have been used for discussing the transmission of information. However, spreading of information, adoption of innovations, etc. are examples of social contagion phenomena in which individuals often require multiple exposures to a given piece of information to adopt it. These social mechanisms are included in models of Complex Contagion in which adoption requires a threshold number of neighboring agents that have already adopted it. However, there is also empirical evidence that many processes of information transmission involve both Simple and Complex Contagion, with some agents adopting in a single interaction and others requiring multiple exposures. As a consequence, different models of Hybrid Contagion combining Simple and Complex Contagion have been proposed.

In this work, we have explored how information transmission (IT) in homophilic networks can be modeled, focusing on alterations of information transmission such as the emergence of echo chambers. To achieve this, we have analyzed Simple, Complex and Hybrid Contagion models and proposed a decomposition of information transmission that allowed a straightforward quantification of the presence of biases. Our results show that Hybrid Contagion leads to three IT biases: one concerning emissivity, one receptivity, and echo chambers. Importantly, the echo chamber bias, which is not present in neither Simple nor Complex Contagion, arises for a wide range of homophily parameters. On a more general note, we point out three important factors when analyzing information transmission. Firstly, that homophily play a key role in how well information is transmitted and which biases appear. Secondly, the quantity of transmitted information is not necessarily correlated with lack of biases: our analysis showed that models with low average information transition can be free from biases, whereas models with high mean information transmission can show strong biases. Thirdly, biases in information transmission are not limited to echo chambers. Other biases (such as different levels of emissivity) can play a comparable role and affect the transmission of knowledge in our society.

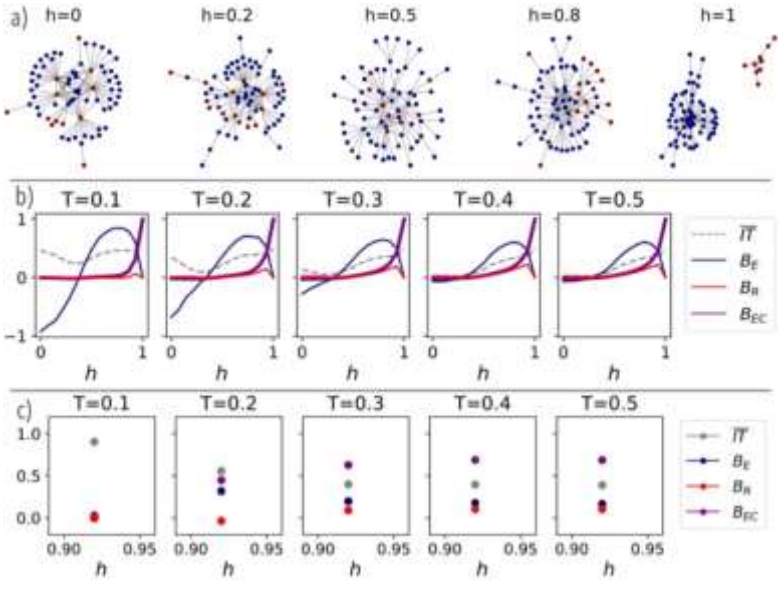


Figure. (panel a) Homophily networks. Examples of networks generated with the BAh model, for different values of the homophily parameter h. Blue nodes indicate a majority group, while red nodes indicate a minority group. **(panel b) Information transmission biases for the hybrid-contagion model. Information transmission** biases: IT, B_E, B_R and B_{EC} as a function of the homophily parameter *h*. Nodes dynamics follows Hybrid Contagion: information is transmitted following simple contagion for nodes belonging to the same group as of the source that generated the information, while it follows complex contagion for nodes belonging to the other group. Each subpanel represents a different threshold *T* for the complex contagion. **(panel c) Real network.** Information transmission biases for Hybrid Contagion dynamics in a network of scientific citations between papers of the APS, for different thresholds *T*.

Air delay propagation patterns in Europe from 2015 to 2018: an information processing perspective

Luisina Pastorino and Massimiliano Zanin
J. Phys. Complex. 3, 015001

The characterisation of delay propagation is one of the major topics of research in air transport management; yet, mechanisms underlying such propagation are still poorly understood, and all mitigation policies are broad in scope—i.e. policies tend to penalise all delays, irrespective of their role in the global dynamics. The reasons for this can be traced back to the limitations inherent these simulation-based studies, including limited availability of real data, the intrinsic uncertainty of the system's dynamics, and the difficulty of validating synthetic models. A better understanding of air transport architectural interactions may come from the study of how the system processes information: one airport receiving (possibly delayed) flights and dispatching them to other airports is not just managing the movement of the aircraft, but is also *receiving*, *processing* and *retransmitting* information about the system.

We here propose a large-scale analysis of the structure and evolution of the delay propagation network in Europe. We detect instances of delay propagation across the 50 largest European airports during four years, from 2015 to 2018, using the celebrated Granger Causality metric; and represent and characterize the resulting structures through complex network representations.

Results indicate that the monthly propagation networks have a highly variable structure. Such variability is mainly affecting the global (or macro-scale) structure of the network; nevertheless, the micro-scale structure is notably much more consistent. A representation of one of such networks, corresponding to March 2015, is presented in Fig. 1a. The delay propagation network is dominated by triangular structures and by large airports, which have a higher probability of starting a delay propagation – see Fig. 1b. From a more general perspective, this may point towards the presence of two opposing forces: a structural one, according to which some airports have a stable propagation role, resulting from their connectivity, traffic volume, procedures, equipment, etc; and the appearance of random events throughout the system. While the former pushes the propagation network towards a fixed state, the latter events can appear at any location and time, thus effectively acting like a random rewiring.

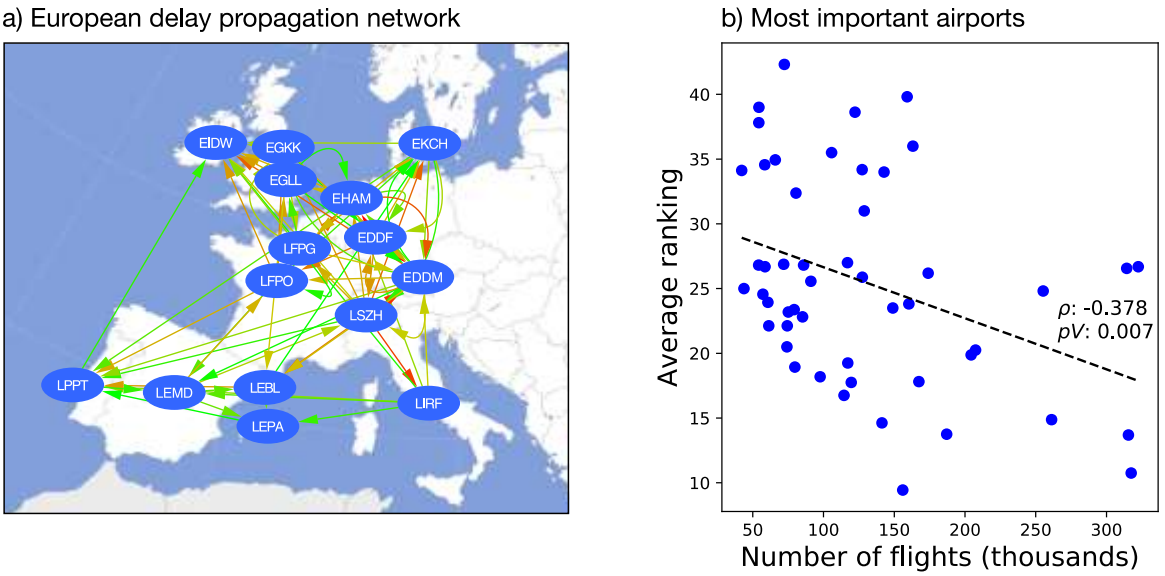


Fig. 1. Some key results for the European air transport network. a) Plot of the network of delay propagation between the top-15 European airports. The colour of links indicates the strength of the causality relationship as measured through the *p*-value of the GC test, from weak (green) to strong (red). b) Ranking of airports according to their out-degree (i.e. amount of propagated delays) as a function of the volume of traffic there operating.

1 PRESENTATION AND RESEARCH LINES

2

PERSONNEL

2 PERSONNEL

2.1 PERMANENT SCIENTIFIC STAFF

APOSTOLOS ARGYRIS	Associate Professor UIB, formal ascription pending
PERE COLET	CSIC Research Professor
MIGUEL C. SORIANO	Associate Professor UIB, formal ascription pending
ERNESTO ESTRADA	CSIC Research Professor
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
CRISTOBAL LÓPEZ	University Full Professor UIB
ROSA LÓPEZ	University Full Professor UIB
VÍCTOR M. EGUÍLUZ	CSIC Senior Researcher
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, Emeritus since October
JOSE J. RAMASCO	CSIC Tenured Scientist
DAVID SÁNCHEZ	University Full Professor UIB
LLORENÇ SERRA	University Full Professor UIB, IFISC Academic Secretary
TOMÀS 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	Apostolos Argyris	Pere Colet	Victor M. Eguiluz	Ernesto Estrada	Ingo Fischer	Tobias Galla	Damia Gomila	Emilio Hernández-Garcia	Lucas Lacasa	Cristobal López	Rosa López	Manuel Matias	Sandro Meloni	Claudio Mirasso	José J. Ramasco	David Sánchez	Maxi San Miguel	LLorenç Serra	Tomás Sintes	Miguel C. Soriano	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	x	x
2) Transport and Information in Quantum Systems											x					x		x		x		x
3) Nonlinear Photonics	x	x			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	
6) Collective phenomena in Social and Socio-technical Systems		x	x	x		x	x		x				x		x	x	x				x	

2 PERSONNEL

2.2 TENURE TRACK AND SENIOR RESEARCH FELLOWS

GIAN LUCA GIORGI	*Beatriz Galindo* fellow
MASSIMILIANO ZANIN	ERC Starting Grant
CARLOS J. MELIAN	*Maria Zambrano* fellow
MICHAEL MOSKALETS	*CSIC-Ukraine collaboration* contract

2.3 SCIENTIFIC ASSOCIATES

JUAN CARLOS GONZÁLEZ-AVELLA
STEFANO LONGHI
HORACIO WIO
KONSTANTIN KLEMM

2.4 POSTDOCTORAL RESEARCH ASSOCIATES

LLUIS AROLA	Project DYNDEEP
JOSEPH BARON	Project PACCS
CHRISTOS CHARALAMBOUS	*Maria de Maeztu*, Balearic Government from June
JYOTI P. DEKA	Project ADOPD
JUAN FERNANDEZ GRACIA	Balearic Government
EVA LLABRÉS	Balearic Government, *Vicenç Mut* fellow
GONZALO MANZANO	*Juan de la Cierva* 'Incorporación'
JOHANN MARTINEZ	Project FACE

PERE MUJAL	*Maria de Maeztu*
CHARLES N. DE SANTANA	La Caixa/UPF
FELIPE E. OLIVARES	Project ARTIC
SILVIA ORTIN	NeuroAging PTI+
LUCIA S. RAMIREZ	*Maria de Maeztu*
GIULIA RUZZENE	Project VPP4ISLANDS
SUNGGUEN RYU	KAIST Univ. Korea
ANDREA TABI	*Maria de Maeztu*
FATIMA Z.E. VELASQUEZ	Project FACE

2.4 PHD STUDENTS

DAVID ABELLA	Balearic Government Project NouLloguer
JAVIER AGUILAR	*Maria de Maeztu* and Balearic Government
HIRA ALI	*SOIB Research and Innovation*
JOSE A. ALMANZA	*SOIB Research and Innovation*
ALEJANDRO ALMODOVAR	*Maria de Maeztu*
MIGUEL ALVAREZ	FPI *Maria de Maeztu*
BEATRIZ ARREGUI	FPI *Maria de Maeztu*
NASSIMA BENCHTABER	FPI Project TQM@NANO
HELENA BORDINI	Univ. Federal de Alagoas, Brasil
KATIELE V. BRITO	Univ. Federal de Alagoas, Brasil
GORKA BUENVARON	*The Red Sea Functional Biodiversity* contract
ALBERT CABOT	FPI fellow Balearic Government
ANNALISA CALIGIURI	FPI *Maria de Maeztu*
VIOLETA CALLEJA	FPI fellow Balearic Government
MARCO CATTANEO	*Maria de Maeztu*
DIMITRIOS CHALKIADAKIS	*SOIB Research and Innovation*
PARIDE CRISAFULLI	Fundacio La Caixa
MAR CUEVAS	CAASE Project
GRAÇA R. M. DE ALMEIDA	Univ. Federal de Alagoas, Brasil
JUAN I. DE GREGORIO	*Maria de Maeztu*
REBECA DE LA FUENTE	FPI Project LAOP
FERNANDO DIAZ	FPI *Maria de Maeztu*
DANIELE DI MICELI	Project MAGMA
GIOVANNI DONATI	*Maria de Maeztu*
NOEMIE EHSTAND	*Marie Curie* Network CAFE
CRISTIAN ESTARELLAS	Project DECAPH
IRENE ESTÉBANEZ	*Maria de Maeztu*

MAR FERRI	*Maria de Maeztu*
JAVIER GALVAN	FPI *Maria de Maeztu*
JORGE GARCÍA BENI	FPI Balearic Government
ALEX GIMENEZ	*Maria de Maeztu*
MIRKO GOLDMANN	*Marie Curie* Network Postdigital
ADRIA LABAY	Associated to the *Beatriz Galindo* Program
GUILLEM LLODRA	Project “Aprendizaje Automático Cuántico”
ERJIAN LIU	Beijing Jiaotong University, China
THOMAS LOUF	*Maria de Maeztu*
MAGDALENA F. MARCINIAK	Lodz University of Technology, Poland
MARIA MARTINEZ BARBEITO	*Maria de Maeztu*
RODRIGO MARTÍNEZ PEÑA	FPI *Maria de Maeztu*
JORGE MEDINA	FPI *Maria de Maeztu*
MANUEL MIRANDA	FPI Project OPERADORES
JESUS A. MORENO	FPI Project PACCS
PABLO MORENO	FPI Project SUMAECO
LUISINA PASTORINO	Project ARTIC
PABLO ROSILLO	*SOIB Research and Innovation* contract
JAIME SANCHEZ CLAROS	FPI Balearic Government
ANTONIO SANNIA	Project QUARESC
MORITZ PFLÜGER	Project ADOPD
LUCAS R. TALANDIER	*Marie Curie* Network Postdigital
FANG ZHAO	Beijing Jiaotong University, China

2.5 TECHNICAL AND ADMINISTRATIVE SUPPORT

ROBERTO J. ALCARAZ	Computing Lab Data Engineer Project FACE
MIQUEL ARTIGUES	Computing Lab Data Engineer Project FACE
INMA CARBONELL	Accountant
ADRIAN GARCÍA	Communication and Dissemination
JOSEP MATEU	Administration Unit Head, IFISC Manager
SIMONA OBREJA	Project Manager
MARTA OZONAS	IFISC Administration
ALBERTO J. SANCHEZ	Accounting Administration
ESTEVE SEGUÍ	Computing Lab Technician
FRANCESC SERRA	Lab Technician Project CLIMB-OUT
AKSHAY TIWARI	*SOIB Research and Innovation* contract
RUBEN TOLOSA	Computing Lab Technician
ANTONIA TUGORES	Data Engineer

2.6 VISITORS

LONG-TERM VISITORS (more than one month)

BENJAMÍN CARRERAS	University of Alaska, USA (March – April)
ANA RUIZ VARONA	Univ. San Jorge, Zaragoza (March)
JORGE P. RODRIGUEZ	IMEDEA, Spain (Nov.-Dec.)
LONG NGUYEN	Aston Univ., Birmingham, UK (Feb-March)
ELGER VLIEG	IBM Research, Switzerland (June-July)
TIGERS JONUZI	Univ. Politecnica Valencia, Spain (July)
BYUNGJOON MIN	Chungbuk National Univ. Rep. of Korea (July)

SHORT-TERM VISITORS (Less than one month)

FRANCESCO PLASTINA	Univ. of Calabria, Italy (March)
PAOLO BARTESAGHI	Univ. of Milan, Italy (March)
CAMILO CELA LOPEZ	Univ. Complutense, Madrid (May)
KUN WOO KIM	Univ. of Korea (February)
MASSIMILIANO LUCA	Fondazione Bruno Kessler, Trento, Italy (April)
KERSTIN LENK	Technical Univ. Graz, Austria (May)
RAMON AGUADO	ICMM, CSIC, Madrid (June)
VALENTINA PARIGI	Sorbonne Univ. Paris, France (June)
CELINE ROZENBLAT	Univ. Lausanne, Switzerland (June)
JUAN JOSE IBAÑEZ	Institute Mila I Fontanals CSIC (September)
FIONA PICHON	Institute Mila I Fontanals CSIC (September)
GIANMICHELE BLASI	Univ. de Geneve, Switzerland (September)
RICCARDO GALLOTTI	Fondazione Bruno Kessler, Trento, Italy (October)
ROELAND VAN DE VIJSEL	Wageningen Univ., The Netherlands (December)

2.7 MASTER AND COLLABORATION STUDENTS

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

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

2022-2023 IFISC Master

CAMILO CELA
SAMUELE CIARDELLA
KALOYAN DANOVSKI
MIQUEL DURAN
MARC DURAN
JUAN A. GARCÍA
PEDRO JIMENEZ
ALVARO LUQUE
DAVID ORTIZ
IVONNE P. ROJAS
ZITA SZABO
DANIEL VISA

Collaboration students

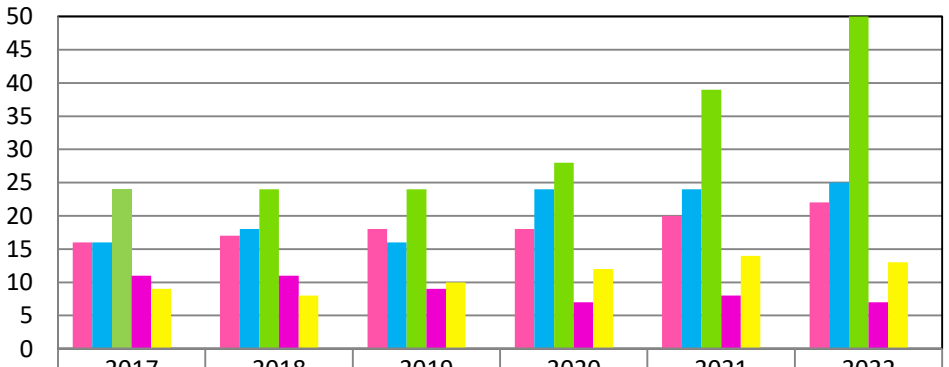
LUCA CASAGRANDE	ERASMUS+ Univ. of Pisa, Italy (April - July)

2.8 HUMAN RESOURCES OVERVIEW

HUMAN RESOURCES IFISC 2022

	Total	Male	Female
Permanent staff	22	20	2
Tenure track & senior fellows	4	4	0
Postdoctoral fellows	17	11	6
PhD students	50	33	17
Long-term visitors	7	6	1
Support personnel	13	9	4
Total	113	83	30

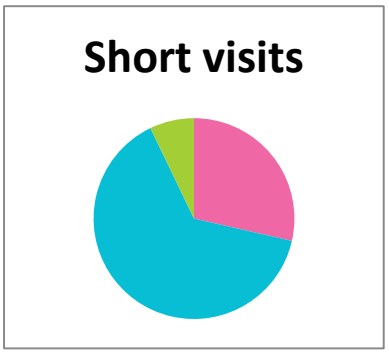
PERSONNEL IFISC 2017-2022

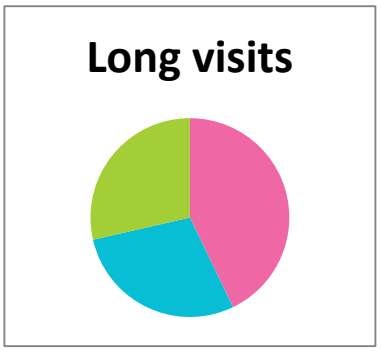


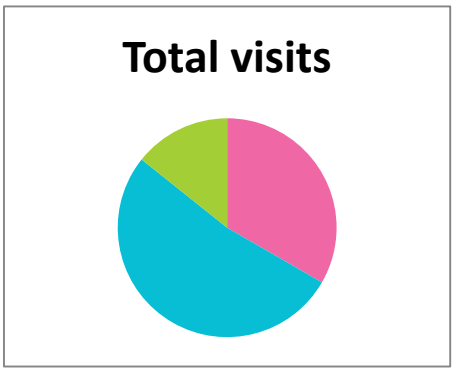
	2017	2018	2019	2020	2021	2022
PERMANENT STAFF	16	17	18	18	20	22
POSTDOCS, SENIORS & ASSOCIATED	16	18	16	24	24	25
PhD STUDENTS	24	24	24	28	39	50
LONG TERM VISITORS	11	11	9	7	8	7
SUPPORT PERSONNEL	9	8	10	12	14	13
TOTAL	76	78	77	89	105	117

VISITING SCIENTISTS AT IFISC 2017-2022

		Short visits	Long visits	**Total visits**
	SPAIN	4	3	7
	EUROPE	9	2	11
	REST OF THE WORLD	1	2	3
	TOTAL	14	7	21







2 PERSONNEL

3

RESEARCH PROJECTS AND FUNDING

3 RESEARCH PROJECTS AND FUNDING

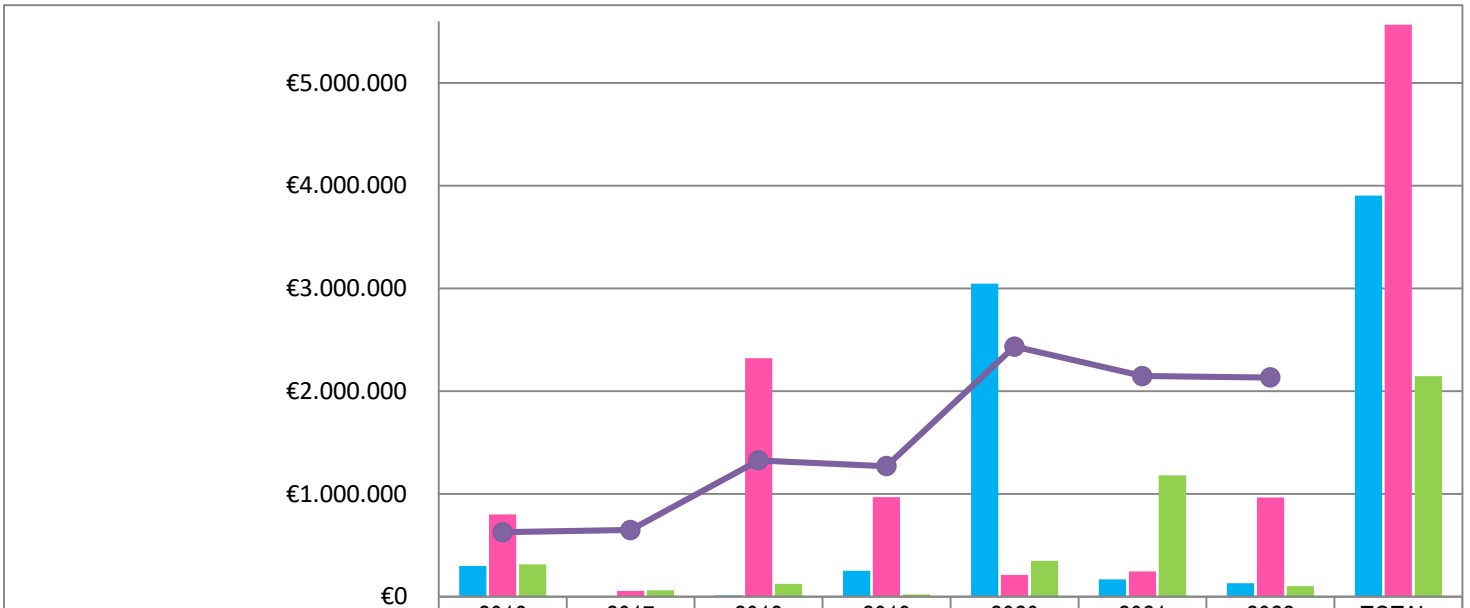
DURING 2022 IFISC HAS RECEIVED FUNDING VIA THE ACTIVE RESEARCH PROJECTS LISTED IN THE FOLLOWING PAGES. IN BRIEF:

- European Commission Framework Program projects: **8**
- Spanish National Plan: **13**
- Collaboration Networks: **7**

Grand total budget of active projects in 2022: **8.527.611 € (including 2.000 k€ MdM)**
Average yearly project funding in 2016-22: **1.659.887 €**
Average EC funding in 2016-22: **30,93 % of total**

BUDGET FIGURES FOR THE PERIOD 2016-2022 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 budged granted in that year and in the two previous years):

BUDGET IFISC´S RESEARCH PROJECTS 2016-2022 (IN €)



	2016	2017	2018	2019	2020	2021	2022	TOTAL
European Commission	€298.121	€0	€12.000	€250.904	€3.045.987	€169.007	€128.799	€3.904.818
Spanish National Plan for Science	€799.084	€54.450	€2.320.000	€969.227	€212.120	€246.865	€966.145	€5.567.891
Other Funding	€312.740	€60.500	€122.573	€20.000	€347.136	€1.181.210	€102.344	€2.146.503
Total	€1.409.945	€114.950	€2.454.573	€1.240.131	€3.605.243	€1.597.082	€1.197.288	€11.619.212
Annualized total	€625.961	€648.528	€1.326.489	€1.269.885	€2.433.316	€2.147.485	€2.133.204	

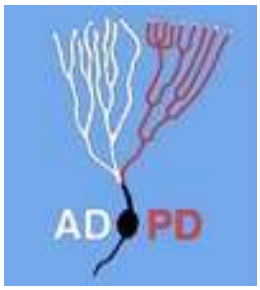
3.1 RESEARCH FUNDED BY THE EUROPEAN COMMISSION

CAFE

Climate Advanced Forecasting of sub-seasonal Extremes. Marie Sklodowska-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 Skolodowska-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 €

Climb-Out

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

DYNDEEP

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

MAGMA

Magnetic topological insulators for robust majorana bound states. International collaboration Project AEI-PCI-ERA. (2022-2025) Principal Investigator: Llorenç Serra. Budget: 128.799,96 €

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 €

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 Laplacianoss en grafos y redes con repulsores/atractores 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 €

SEDIMENT

Seagrass diversity in the Mediterranean basin in a global change scenario: a machine learning approach from satellite images. [TED2021-131836B-I00] (2022-2024) Ecological Transition project. Principal Investigators: Tomas Sintes, Manuel Matías. Budget: 193.200 €

APASOS

A Physics approach to sociotechnical systems: from theory to data analysis [PID2021-122256NB-C21/C22] (2022-2025) Principal Investigators: Tobias Galla, Sandro Meloni, Maxi San Miguel and Raul Toral. Budget: UIB: 193.600 € and CSIC: 181.500 €

CYCLE

Complex DYnamics of CoastaL Ecosystems: Resilience to Climate Change. Modelling and Simulations. [PID2021-123723OB-C22] (2022-2025) Principal Investigators: Tomas Sintes and Damia Gomila. Budget: 124.630 €

LAMARCA

Lagrangian transport of marlne litter and microplastics in coastal waters: structures of transport and connectivity patterns [PID2021-123352OB-C32] Principal Investigators: Emilio Hernández-García, Cristóbal López and Enrico Ser Giacomi (2022-2026) Budget: 102.850 €

UpMEMO

Updating the brain's memory base: computational perspective [PID2021-128158NB-C22] Principal Investigator: Claudio Mirasso (2022-2025) Budget: 340.365 €

i-LINKB20072

Quantum fluctuations and dissipation: towards highly efficient and precise nano engines [LINKB20072] Thematic Research Network. Principal Investigator: Rosa López (2022-2023) Budget: 23.600 €

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. Balearic 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 €

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 €

CAFECONMIEL

Corpus Automático y Fenómenos de Contacto en Mallorca: Inteligencia, Entrenamiento y Lengua. Balearic Government. IFISC Principal Investigator: David Sánchez (2021-2024) Budget: 47.510 €

MACTOPE

Materia Cuántica Topológica: Precisión y Energía. [PDR2020/12] Balearic Government. 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 €

UCRAN20029

Floquet quantum information processing devices. Accion Complementaria CSIC. Principal Investigator: David Sánchez (2022-2024) Budget: 102.344 €

3.4 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 (PTI+). 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)

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

BBVA DATA & ANALYTICS

HUAWEI

Google

cuebiq

ib-salut servei de salut de les Illes Balears

Fundación SICOMORO

3 RESEARCH PROJECTS AND FUNDING

4

IFISC SEMINARS

4 IFISC SEMINARS

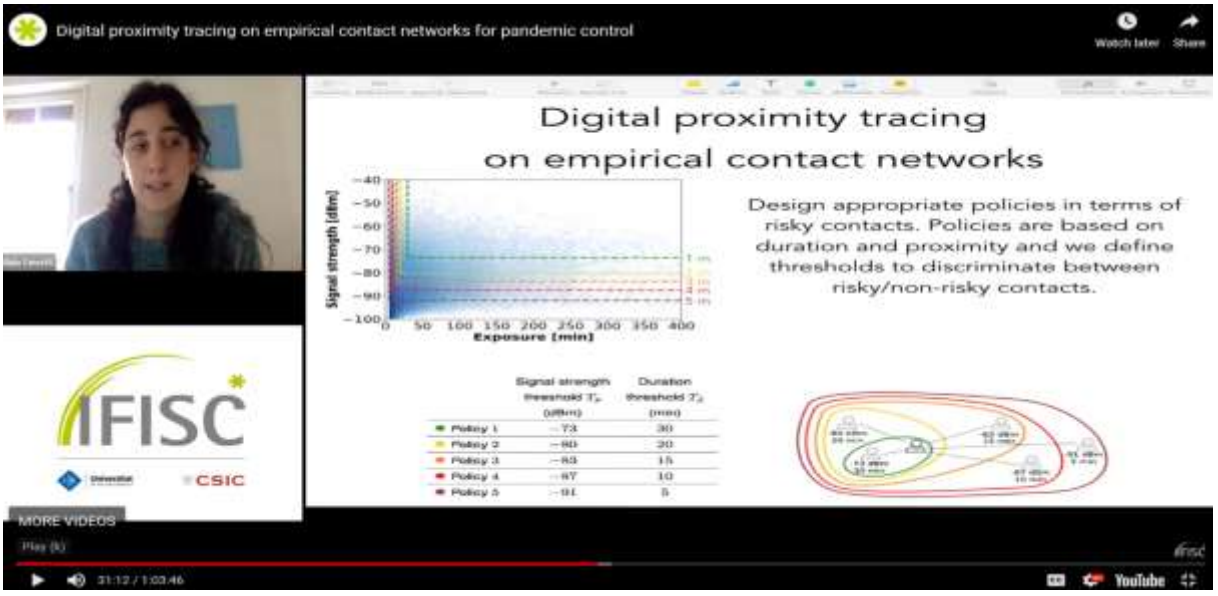
Coordinators:

Tobias Galla

Sandro Meloni

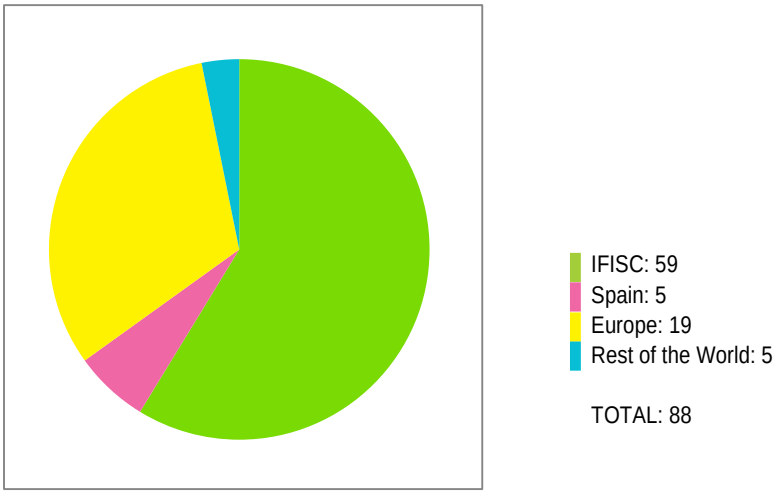
A total of 88 seminars, including weekly regular seminars and talks, were given at IFISC in 2022. The full list of seminars can be found at the website: **http://ifisc.uib-csic.es/en/events/seminars/** as well as in the Appendix of this report.

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/**

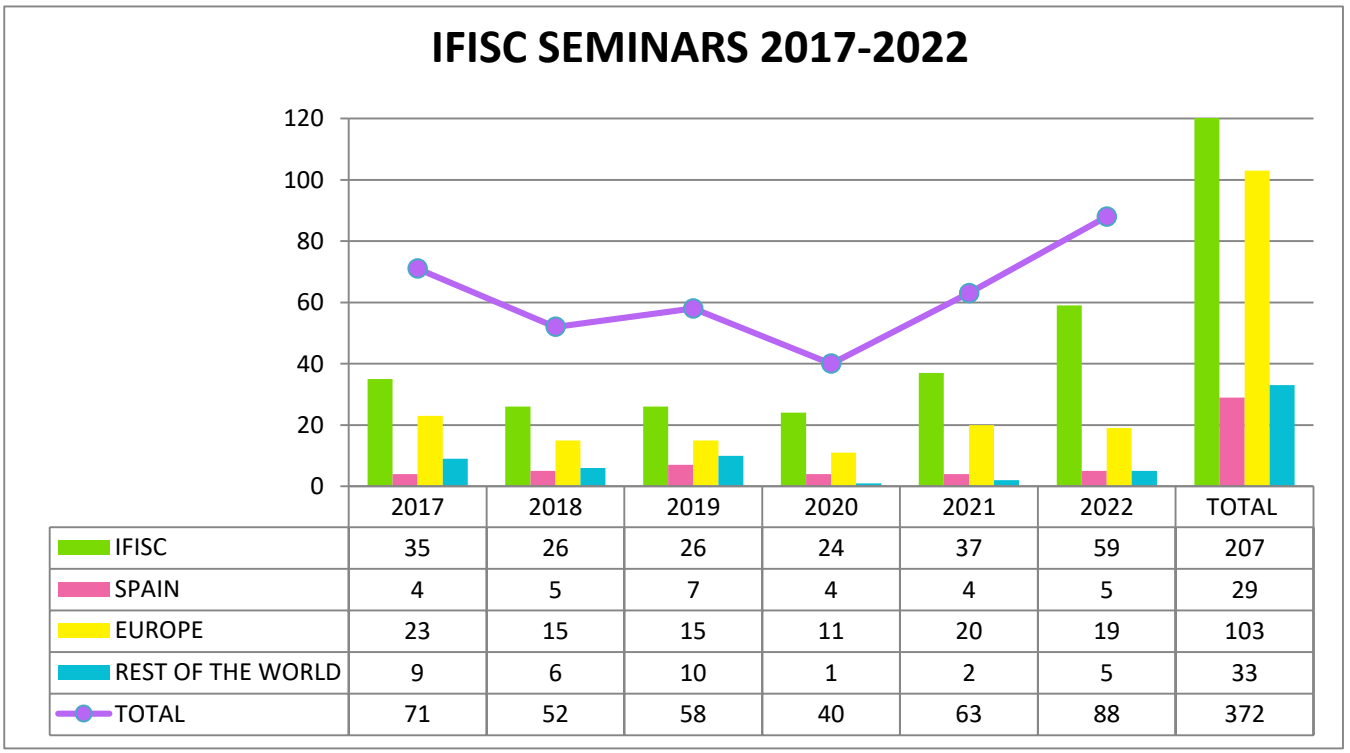


The following graphs show the distribution of seminars by geographical provenance of the speaker for 2022 and for the previous years:

PROVENANCE OF SPEAKERS AT IFISC SEMINARS 2022



IFISC SEMINARS 2017-2022



	2017	2018	2019	2020	2021	2022	TOTAL
IFISC	35	26	26	24	37	59	207
SPAIN	4	5	7	4	4	5	29
EUROPE	23	15	15	11	20	19	103
REST OF THE WORLD	9	6	10	1	2	5	33
TOTAL	71	52	58	40	63	88	372

5

PUBLICATIONS

5 PUBLICATIONS

IFISC RESEARCH RESULTS HAVE BEEN REPORTED IN THE FOLLOWING PUBLICATIONS DURING 2022:

- Papers in indexed journals: **100**
- Other publications: **3**

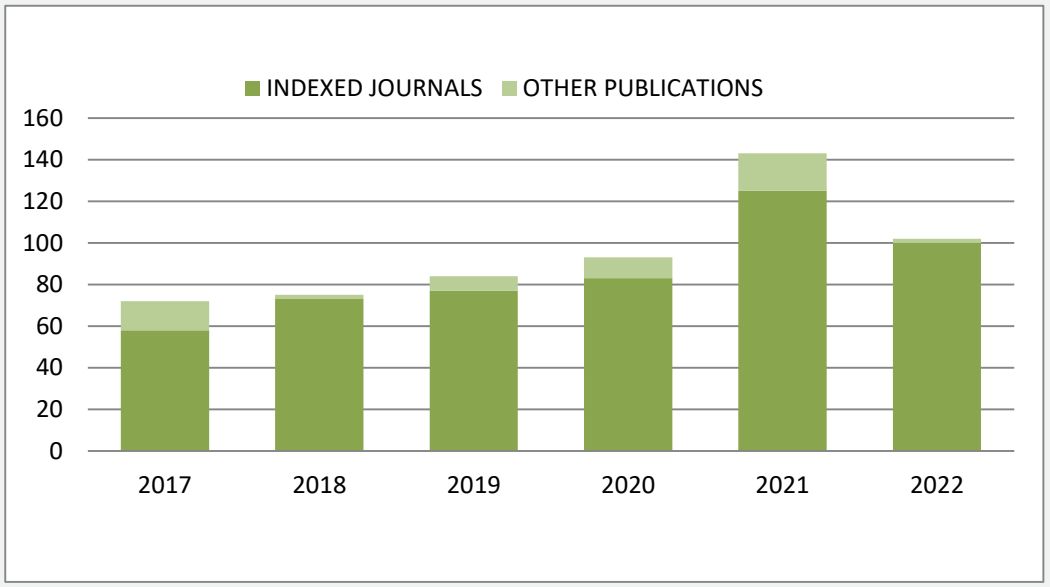
The following tables place these numbers in the context of the publication activity during the past years, specifying the main journals in which IFISC papers are published. It is a strategic commitment of IFISC to target cross-disciplinary research areas lying outside the domain of traditional physics. 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 2022 IFISC has published 2 papers in Nature, 5 papers in Nature Communications, 1 paper in Physical Review X, and 4 in Physical Review Letters.

- Non Physics Journals: **20**
- High Impact Journals: **12**

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 2017-2022



	2017	2018	2019	2020	2021	2022	TOTAL
INDEXED JOURNALS	58	73	77	83	125	100	516
OTHER PUBLICATIONS	14	2	7	10	18	3	54
TOTAL	72	75	84	93	143	103	570

JOURNALS WITH THE LARGEST NUMBER OF PUBLICATIONS

IFISC PUBLICATIONS	2017	2018	2019	2020	2021	2022	TOTAL
Physics journals							
Physical Review E	4	10	8	3	9	10	44
Physical Review B	4	5	2	5	7	4	27
Chaos	5	4	4	8	5	1	27
New Journal of Physics	3	4	3	2	5	3	20
Optics Letters	1	0	0	7	5	4	17
Physical Review Letters	1	3	1	2	4	4	15
Physical Review A	3	0	1	2	2	3	11
Multidisciplinary journals							
Scientific Reports	11	3	9	5	8	8	44
Nature Communications	0	0	2	2	4	5	13
Plos One	1	4	0	3	0	3	11
IEEE journals	1	0	2	4	3	4	14
Other non-physics journals	7	13	21	11	40	20	112

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, eLife, PLoS Computational Biology, PLoS Genetics, Ecological Complexity, Ecological Modelling, Ecography, Biomolecules, NPJ Systems Biology and Applications, Frontiers in Systems Neuroscience, Frontiers in Medicine, Computer Methods and Programs in Biomedicine, Environmental Microbiology, The ISME Journal, Biological Conservation, Viruses, Methods in Ecology and Evolution, Theoretical Population Biology, Journal of Theoretical Biology, Briefings in Bioinformatics, Ecological Applications, Oikos, Communications Biology, BMC Health Services Research, Computational and Structural Biotechnology Journal, Statistics in Medicine, Neuroimage, JAMA Network Open, Human Brain Mapping, Brain Topography, and Brain Sciences.

Earth sciences:

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

Sociotechnical and Social systems:

Palgrave Communications, Journal of Economic Interaction and Coordination, Transportation Research, International Journal of Electrical Power and Energy Systems, Games and Economic Behaviour, and Cybergeo.

Data science, Neural Computation and Machine learning:

Mathematical models and Methods in the Applied Sciences, Frontiers in Neuroinformatics, Neuroinformatics, Neural Networks, EPJ Data Science, Cognitive Computation, Nature Machine Intelligence, Neurocomputing, IEEE Transactions on Neural Networks and Learning Systems, Research Synthesis Methods, , and Applied Network Science.

6

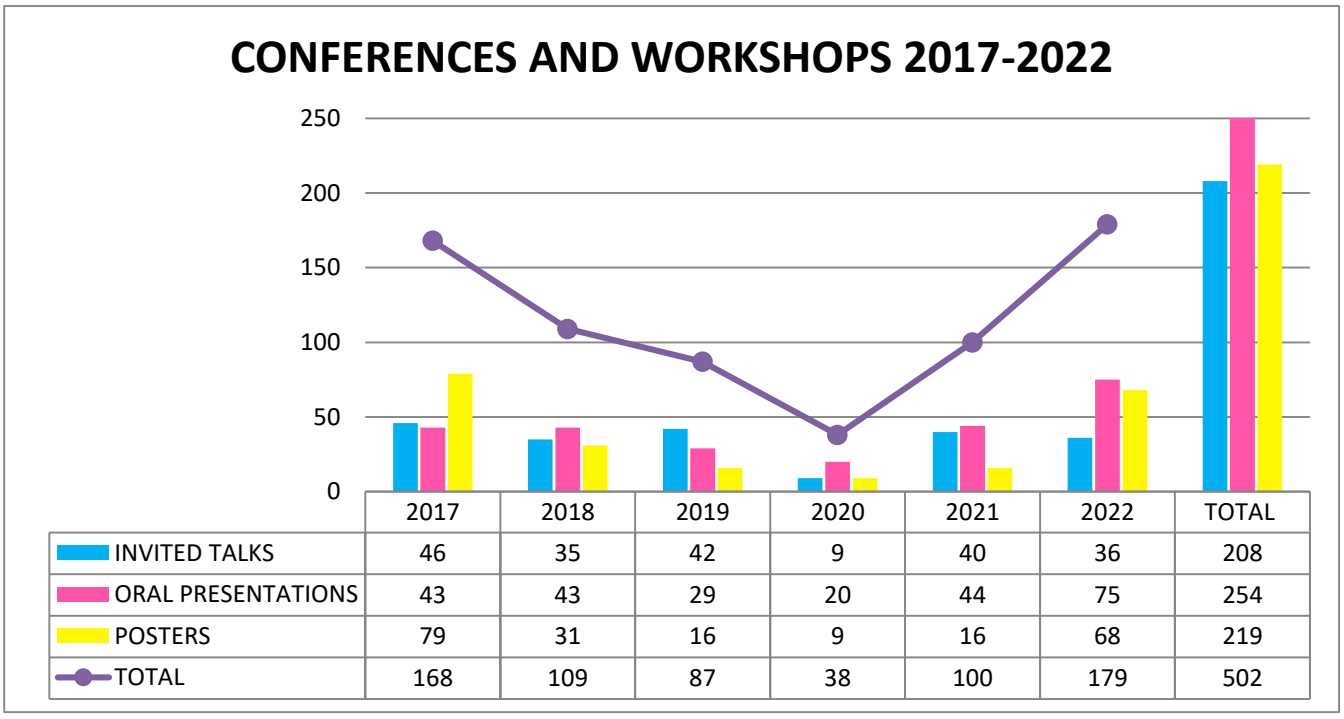
CONFERENCES AND WORKSHOPS

6 CONFERENCES AND WORKSHOPS

6.1 PRESENTATIONS AT SCIENTIFIC CONFERENCES 2022

- Invited talks: **36**
- Oral presentations: **75**
- Posters: **68**
- Total in 2022: **179**

Full listing in the Appendix of this Report.



	2017	2018	2019	2020	2021	2022	TOTAL
INVITED TALKS	46	35	42	9	40	36	208
ORAL PRESENTATIONS	43	43	29	20	44	75	254
POSTERS	79	31	16	9	16	68	219
TOTAL	168	109	87	38	100	179	502

6.2 ORGANIZATION OF CONFERENCES AND WORKSHOPS

- **Colet, Pere**

Member of the Scientific Commitee and the local Organizing Commitee of the X GEFENOL Summer School on Statistical Physics of Complex Systems.

Member of the Scientific Commitee and the Local Organizing Commitee of the II Summer School on Complex Socio-Technical Systems (Palma, Spain).

Member of the Organizing Commitee of the Conference in Complex Systems CCS2022 (Palma).

- **Toral, Raul**

Member of the local Organizing Commitee of the X GEFENOL Summer School on Statistical Physics of Complex Systems.

- **Galla, Tobias**

Member of the local Organizing Commitee of the X GEFENOL Summer School on Statistical Physics of Complex Systems.

- **Ramasco, Jose J.**

Member of the Scientific Commitee and the Local Organizing Commitee of the II Summer School on Complex Socio-Technical Systems (Palma, Spain).

Chair of the Steering Committee and organizer of the 2022 edition of the Conference on Complex Systems, CCS2022, Palma de Mallorca, Spain.

- **Cornelles Soriano, Miguel**

Program Committee Member of the Emerging Topics in Artificial Intelligence conference, SPIE.

Elected member of the Quantum Optics and Nonlinear Optics Committee (Sociedad Española de Optica, SEDOPTICA).

Organizing committee (part of the XXXVIII Bienal de la RSEF, Murcia). Quantum and Nonlinear Optics Symposium.

- **Zambrini, Roberta**

Organizer of the Satellite Event on Quantum Information and Computation in the Conference of Complex Systems, CCS2022.

- **Sintes, Tomas**

Member of the scientific committee of the XXIII Congreso de Física Estadística (Fises'22).

- **Hernández-García, Emilio**

Member of Program Committee of the CCS2022: conference on Complex Systems 2022. Palma de Mallorca.

Member of de Scientific Committee of Weather and Climate Extremes and their Predictability. Barcelona.

- **San Miguel, Maxi**

Advisory and Organizing Committee of the Conference in Complex Systems, CCS2022, Palma de Mallorca.

- **Sánchez, David**

Organizer of a Satellite event of the Conference in Complex Systems, CCS2022, Palma de Mallorca, Spain.

6 CONFERENCES AND WORKSHOPS

7

OTHER ACTIVITIES

7 OTHER ACTIVITIES

7.1 PhD PROGRAM

IFISC participates in the PhD Program in Physics of the University of the Balearic Islands. During 2022, 48 PhD students developed their research project at IFISC, and 1 PhD thesis was completed and successfully defended:

Lagrangian transport of sinking particles. From theoretical characterization to oceanic applications
de la Fuente, Rebeca (Supervisors: Cristobal Lopez and Emilio Hernandez-Garcia)
May 30

7.2 SURF@IFISC

The Summer Undergraduate Research Fellowships program is part of one of the IFISC commitments. For the 2022 program we received 54 applications from 32 universities and 13 countries. The following six were selected:

Sebastian Castedo, from the University of Manchester, UK

Adrian Nadal Rosa, from the University of Valencia, Spain

Alberto Gallego Pozo, from the Carlos III University of Madrid, Spain

Pablo Cabrales Miró-Granada, from the Autonoma University of Madrid, Spain

Antonio Alberto Carpes Martínez, from the Complutense University of Madrid, Spain

Carlota Prieto Jiménez, from the Complutense University of Madrid, 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 2021-2022 academic course 11 students of 5 different nationalities and 8 different universities are registered in the master.
In the year 2022, 22 master thesis were defended. They are listed in the Appendix of this Report.

This is the 2021-2022 Master syllabus:

Structural module courses (39 credits):

Complex networks (3 credits)	E. Estrada, S. Meloni
Cooperative and critical phenomena (6 credits)	T. Sintes, E. Hernández-García
Dynamical systems and chaos (6 credits)	P. Colet, M. Matías
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, G.L. Giorgi, G. Manzano

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)	G. Manzano, G.L. 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 2022

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**

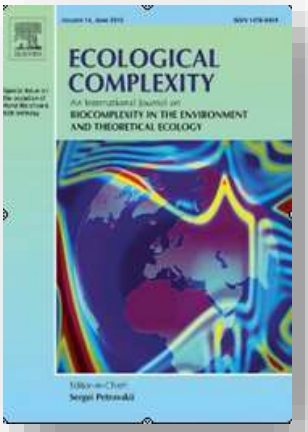
David Sánchez, Llorenç Serra

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



Frontiers in Physics.
Apostolos Argyris

Complex Networks.
Estrada, Ernesto (editor in chief)

Proceeding of the Royal Society A: Mathematical, Physical and Engineering Sciences.
Estrada, Ernesto (associate editor)
Giorgi, Gian Luca

MATCH: Communications in Mathematical and in Computer Chemistry.
Estrada, Ernesto (associate editor)

Chaos: An Interdisciplinary Journal of Nonlinear Science.
Fischer, Ingo (advisory board)

Ecological Complexity.
Hernandez-Garcia, Emilio (advisory board)

Frontiers in Physics, Interdisciplinary Physics Section.
Wio, Horacio S. (advisory board)

European Physical Journal B, Entropy, Physica A.
Wio, Horacio

Frontiers in Complex Systems
San Miguel, Maxi (editor in chief)

Complexity
San Miguel, Maxi

Journal of Physics Complexity.
Maxi San Miguel

PLoS ONE.
Meloni, Sandro
Ramasco, Jose

European Physical Journal Special Topics.
Colet, Pere

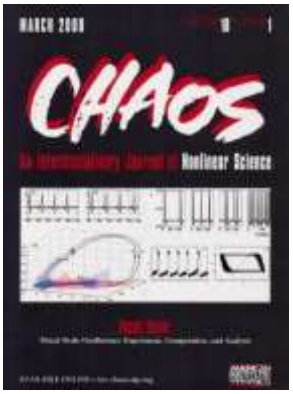
Scientific Reports.
Ramasco, J.J.

Entropy.
San Miguel, Maxi (complexity section)
Lopez, Cristobal
Sánchez, David

Nanophotonics. Special Issue "Neural network learning for photonic circuit design".
Soriano, Miguel Cornelles

Chaos, Solitons and Fractals.
Toral, Raul

Physical Review Letters.
Zambrini, Roberta (divisional associate editor)



7.6 SCIENTIFIC COMMITTEES

- **Colet, Pere**

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

- **Ramasco, Jose J.**

Elected member of the council of the Complex Systems Society.

President of COMSOTEC, Spanish Association for the Study of SocioTechnical Systems.

Coordinator PTI Mobility 2030 of CSIC.

- **Cornelles Soriano, Miguel**

Elected Member of IEEE Task Force on Reservoir Computing.

Elected member of the Quantum Optics and Nonlinear Optics Committee (SEDOPTICA).

- **Fischer, Ingo**

Elected Member of IEEE Task Force on Reservoir Computing.

- **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.

- **Zambrini, Roberta**

Gestora AEI. Area Physics; Subarea Physics and applications.

Responsible and moderator of the Quantum Thermodynamics website.

Member and reviewer of the Barcelona Supercomputing Center's Access Commitee.

- **Martínez-Barbeito, María**

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

- **San Miguel, Maxi**

Chair of the International Scientific Advisory Board of the Internet Interdisciplinary Institute (IN3) of the Open University of Catalunya (UOC).

- **Estrada, Ernesto**

Elected as Fellow of the Institute of Mathematics and its Applications (IMA) of the U. K.

- **Tugores, Antonia**

Member of Authentication and Authorization Infrastructure Architecture (AAI) Task Force of the European Open Science Cloud, EOSC.

7.7 RESEARCH STAYS IN OTHER CENTERS

During 2022 IFISC Researchers visited 11 external research centers.

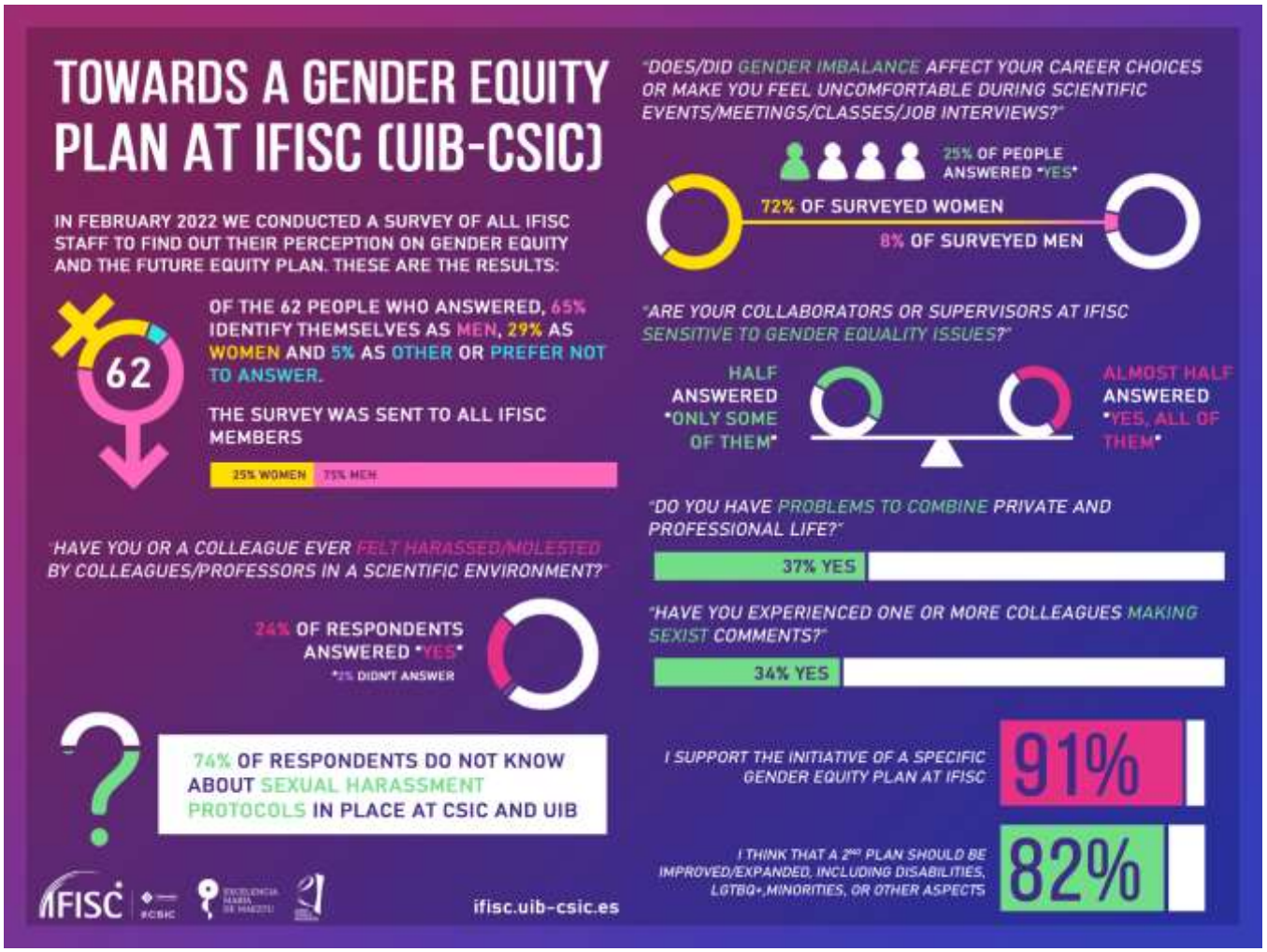
These visits are listed in the Appendix to this Report.

7. 8 'WOMEN IN SCIENCE' ACTIVITIES

Participation of IFISC in the 11F: International Day of Women and Girls in Science 2022.

In 2015 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.

At IFISC, a team of students, postdocs, permanent researchers, administration personnel and technicians, has started to work on an IFISC gender equity plan. To this end, a survey was distributed to all IFISC members in order to gather opinions, experiences and suggestions that can help in the preparation of the plan. A 92% of the inquired people support this initiative.



The survey provides a good measure of the state of gender-related aspects at the present time and to identify pressing issues before the preparation of the IFISC gender equity plan. By comparing the responses to current and future surveys, one can monitor if the actions that will be included in the equity plan have any measurable consequences. The survey was prepared inspired by the **Gender Equality in Academia and Research (GEAR)** tool, which provides universities and research organisations with practical advice and tools.

The equity team at IFISC is committed to implement measures to improve the working conditions of all IFISC personnel, with special attention to underrepresented groups. The answers to the survey indicate that there is a clear need to raise awareness about equity issues across the institute.

IFISC presented these results within the 11F 2022 program organized by the 11F Balears Platform, whose objective 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.

7 OTHER ACTIVITIES

8

OUTREACH ACTIVITIES

8 OUTREACH ACTIVITIES

8.1 POSTER WEEK

https://ifisc.uib-csic.es/en/research/ifisc-poster-party-2022/

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 a 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.

8.2 LA RESISTÈNCIA CIENTÍFICA

La Resistencia Científica was a late night science show organized by IFISC and the Delegation of the CSIC in the Balearic Islands on the occasion of Researchers' Night 2022. This show brought together the centers of the Consejo Superior de Investigaciones Científicas (CSIC) in the Balearic archipelago to talk about the science that was done in these islands with a touch of humor.

The event was supported by the Direcció General de Política Universitària i Recerca and "la Caixa" Foundation, and four free shows were held from 26 to 29 September in the Lluís Domènech i Montaner auditorium of the Caixaforum in Palma.

In addition, there was live music by the group REFRACTAL, and the stage decoration was made by the associations Noctiluca and Mar Inquieto and the artists Nivola Uyà and África Juan with materials they had collected from the garbage collection in the different coastal areas of Mallorca.

The first session, dedicated to the research being done at IFISC, included an interview with researcher David Sanchez, who discussed his latest work in nanoscience and linguistics. In addition, PhD students Pablo Rosillo and Manuel Miranda helped with the organization and logistics.

The sessions were broadcast in streaming and are available **on the YouTube channel of the CSIC Delegation in the Balearic Islands**.


LA RESISTÈNCIA
CIENTÍFICA
El show de ciència que es resisteix a ser avorrit
Ho organitza:
IFISC
CSIC
Amb el suport de:
Fundación "la Caixa"

8.3 EUROPEAN RESEARCHER'S NIGHT

The European Researchers' Night is a science outreach project promoted by the European Commission as part of the Marie Sktodowska-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 researchers participated in the online scientific dissemination activities organized by the CAFE Climate Extremes Project.

- Round Table: Nuevos métodos en meteorología y climatología, by Marcelo Barreiro (Universidad de la Republica (Uruguay), Ileana Bladé (Universitat de Barcelona), Emilio Hernández-García (IFISC, UIB-CSIC), and Cristina Masoller (UPC), moderated by Daniel Ramos, (CRM)

- Señales tempranas de alarma en los ecosistemas y el clima, talk by Noemie Ehstand (IFISC, UIB-CSIC)

CCS 2022: Complejidad para Comprender la Sociedad

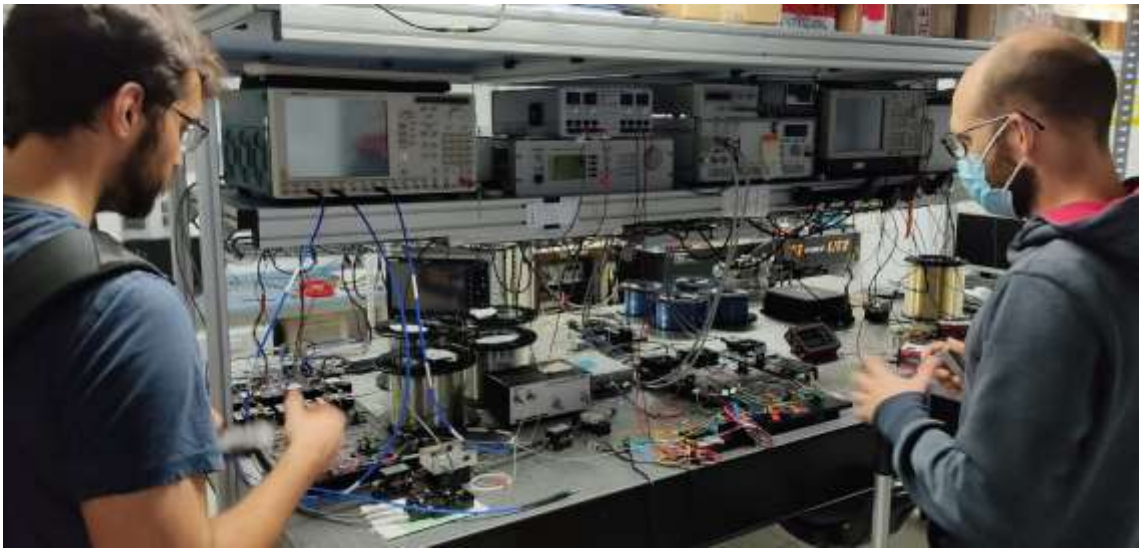
A dissemination session open to general public was held on October 21, in Auditorium's Sala Mozart at 7 p.m. in the context of the Conference on Complex Systems CCS 2022. The session, aimed to approach science to society, is entitled "Complejidad para Comprender la Sociedad", and includes "World Wide Waste Web: Red de comercio internacional de basuras" by Ernesto Estrada (IFISC); "Leyes de Movilidad Humana: desde el individuo a emisiones vehículos en ciudades" by Marta González (UC Berkeley and Lawrence Berkeley National Laboratory) and "Aquellos maravillosos años: los círculos de Dunbar y las amistades en el instituto" by Anxo Sánchez (Universidad Carlos III).

Visit of the Escola Global students

Y9 and y10 students of the "Institut Escola Global de Parc Bit" visited IFISC in two sessions (February 8 and February 11) to learn about the SuMaECO project from Damià Gomila. They were also given a presentation of IFISC and research in Complex Systems.

Visit of the scientific communicator Jordi Pereyra (Ciencia de Sofá)

Taking advantage of the fact that he was in Mallorca to present his latest book, the well-known popularizer Jordi Pereyra, author of the project Ciencia de Sofá with more than 540,000 subscribers on YouTube, visited IFISC and its photonics laboratory.



Divulgació, Sistemes Complexos i l'IFISC at IES Madina Mayurqa

On April 12, technician Adrián García gave an introductory talk on complex systems and the research carried out at IFISC at the IES Madina Mayurqa high school.

Ciència per a Tothom: Escape room, L'enigma del canvi global

Ciència per a Tothom is a science fair held on the university campus organized by the UIB. The fair has stands of the different departments of the UIB and is especially oriented to students of schools and institutes.

In the 2022 edition, IFISC participated jointly with the CSIC Delegation in the Balearic Islands organizing the Escape Room activity: Escape room, L'enigma del canvi global. The activity consisted of an Escape Room in which the situation of finding different clues to access the computer of a scientist studying global change was presented. The clues were related to global change issues: epidemics, ecology, environment, climate change.... In addition, students were explained how scientists work, publishing their results in peer-reviewed journals and attending conferences to present their results.

Stay of a student from the Lycée Français

In June, a student from the Lycée Français in the 4th year of ESO spent 4 days at IFISC. During those days the student learned how to program a Monte Carlo method, learned what complex systems are, played with the experimental devices of IFISC, talked with PhD students, etc.

8.5 OUTREACH MATERIALS

The Youtube 'IFISC outreach' playlist (https://bit.ly/3enKSYz) contains many outreach videos on topics related to IFISC research lines. Also in 2022, some outreach articles were published in different media:

- Premio Nobel de Física 2021: Otorgado por “Contribuciones revolucionarias en la comprensión de los sistemas físicos complejos” by Ramasco, José Javier; Gutiérrez, José Manuel; San Miguel, Maxi in Revista Española de Física 35 (2022)

- Hacia la soberanía digital para sostener la sociedad futura by Zambrini, R; Rius, G. in CSIC Investiga 4: Sociedad Digital 4, 3-3 (2022)

8.6 VOCES, CSIC BALEARS

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, IGME, IEO-COB and ICTS SOCIB), it aims to increase the visibility of the science carried out in the region.

In 2022, 14 interviews were published through the science outreach podcast platform Podcastidae. Of these interviews, 3 were with IFISC researchers:

- **Física cuántica, termoelectricidad y nanoconductores #20 | VOCES, CSIC BALEARS | Rosa López**
- **Divulgación, actividades y risas #22 | VOCES, CSIC BALEARS | Adrián García y Carolina Morán**
- **Quantum Reservoir Computing, redes cuánticas y divulgación #26 | VOCES, CSIC BALEARS | Roberta Zambrini**

The podcasts have been downloaded a total of 2.114 times. The audience comes mainly from Spain (80%) followed by Uruguay (3%) and USA (2%). Within Spain, 30% of listeners come from the Balearic Islands, followed by Madrid (15%), Catalonia (13%) and Andalusia (6%).

8.7 PRESS & MEDIA

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

IFISC research has also received attention from newspapers and other media. During 2022, IFISC activities produced 140 press releases and appearances in written and digital press (national and international), and 9 clips on radio and TV. See the full lists in the Appendix.

COPE

CIENCIA MEDIOAMBIENTE

Identifican la red mundial de residuos y los países en riesgo de congestión

Anualmente se producen más 7.000 millones de toneladas de basuras, de las que una parte no se quedan en su lugar de origen, sino que viaja a otros países para ser procesada, creando una red mundial de basuras que ha sido estudiada para identificar a los 28 países con alto riesgo de congestión.

MEDIO AMBIENTE

El IFISC desarrolla un modelo para entender las epidemias marinas

Un modelo planteado por el Institut de Física Interdisciplinar i Sistemes Complexos desarrolla un modelo epidemiológico para entender epizootias marinas. Los investigadores analizan los efectos espaciales en este tipo de epidemias y concluyen que a mayor movilidad de los parásitos que transmiten el patógeno, más severos son los brotes epidemiológicos. Los autores validaron el modelo con datos de la epidemia de nacras (en la imagen) transmitida por un parásito que ha diezmado la población de este molusco en el Mediterráneo. **R.L.**

SOCIAL MEDIA IMPACT SUMMARY

TWITTER @IFISC_mallorca

Total Followers 2.953 (12% increase of number of followers in 2022)

http://www.facebook.com/ifisc

Facebook fans: 1.086 (3% increase of fan number in 2022)

62% men / 38% women

Mostly located in Spain, Brazil and Mexico

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

Visualizations: 34.672 in 2022 of a total of 267.213

YouTube subscribers: 1.954 (23% increase of subscribers in 2022)

83% men / 17% 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: 679

APPENDIX

a.4. IFISC seminars and talks 2022

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

December 19
IFISC Projects Presentations
IFISC Principal Investigators, IFISC

December 15
A method for detecting and quantifying information transmission biases in complex networks
Fernando Diaz, IFISC

December 14
Learning force fields from stochastic trajectories
Anna Frishman, Technion Israel, Department of Physics, Israel

December 13
Integrated optical output layer for a reservoir computer based on frequency multiplexing
Tigers Jonuzi, VLC Photonics, Valencia, Spain

December 12
Functional networks of weather events propagation between airports
Raúl López Martín, IFISC

December 7
Time evolution of signed networks sparkling with conflicts
Paride Crisafulli, IFISC

November 30
Ecological dynamics in cancer-immune interactions
Guim Aguadé Gorgorió, L'Institut des Sciences de l'Evolution de Montpellier, Université de Montpellier, France

November 23
Complexity Economics of Global Change
Roger Cremades, Wageningen University, Wageningen, The Netherlands

November 22
Benchmarking the Role of Particle Statistics in Quantum Reservoir Computing
Guillem Llodrà, IFISC

November 16
A Lagrangian view on the seascape: theory and applications
Enrico Ser-Giacomi, MIT - IFISC

November 2
Learn one size to infer all: Exploiting symmetries in dynamical systems using scalable neural networks
Mirko Goldmann, IFISC

October 26
How not to construct functional brain networks
Onerva Korhonen, Aalto University, Finland

October 24
Analysis and the Action Curve of Agent Zero: Theory and Simulation
Benjamin Maxwell Fried, IFISC

October 24
Time delay reservoir computing with short-external-cavity laser dynamics and phase encoding
Lucas Talandier, IFISC

October 20
Network-based measure of the finite size Lyapunov exponent
Joan Antich Navarro, IFISC

October 14
Network analysis of marine megafauna movement
Lina Estefanía Navarro Alvarado, IFISC

October 14
Partisan Voter Model: Noise-Induced Transitions
Jaume Llabrés Rubio, IFISC

October 10
Multilayer analysis of online social interactions
José María Ramos Fernández, IFISC

October 5
Synchronization in complex networks under uncertainty
Lluís Arola Fernández , IFISC

October 5
Epidemiological approach to tau propagation in Alzheimer's disease
Gorka Buenvarón Campo, IFISC

October 4
The effects of coherence in quantum absorption refrigerators
Jose Antonio Almanza, IFISC

October 4
Deep learning applied to the analysis of dissolved carbon dioxide in coastal areas of the Balearic Sea
Akshay Tiwari, IFISC

September 30
Sampling rare trajectories in complex systems
Sara Oliver Bonafoux, IFISC

September 28
European Researchers' Night: Round Table: Nuevos métodos en meteorología y climatología
Emilio Hernández-García, IFISC

September 28
European Researchers' Night: Señales tempranas de alarma en los ecosistemas y el clima
Noémie Ehstand, IFISC

September 28
Hybrid normal-superconducting Aharonov-Bohm quantum thermal device
Gianmichele Blasi, University of Geneva, Switzerland

September 27
Trivial versus topological confinement in bilayer graphene quantum dots and rings
Nassima Benchtaber, IFISC

September 23
In search of anticipated synchronization in the dentate gyrus
Dimitrios Chalkiadakis, IFISC

September 23
Modeling preferences in language contact
Pablo Rosillo, IFISC

September 22
Creativity as a random walk search on a semantic network
Nicoleta Kyosovska, IFISC

September 21
The Knowledge Acquisition process from a Complex System perspective
Fátima Velásquez-Rojas, IFISC

September 20
New simple model for pattern formation in coral reefs
Miguel Álvarez-Alegría, IFISC

September 14
Regional Interaction Networks at the origin of the Neolithic in the Near East
Juan José Ibáñez and Fiona Pichon, Institución Milá y Fontanals de investigación en Humanidades (IMF), CSIC (Barcelona), Spain

September 7
Air transport through the (statistical physics) looking glass
Massimiliano Zanin, IFISC

September 2
Generating functional analysis of Lotka-Volterra equations with Hebbian couplings
Enrique Rozas García, IFISC

September 1
Photonic Reservoir Computing
Miguel C. Soriano, IFISC

August 31
Modelling and synchronization of neuronal populations.
Claudio Mirasso, IFISC

August 30
Pattern Formation in Posidonia Meadows
Damià Gomila, IFISC

July 28
Effects of passive dendritic arborization on neuronal response in extended integrate and fire models
Jacopo Giorgi, IFISC

July 27
Precipitation sources and moisture transport in atmospheric rivers from a Lagrangian perspective
Alfredo Crespo, IFISC

July 26
Characterization of hypergraphs in ecological networks
Daniel Cebrian Lacasa, IFISC

July 22
Non-trivial interplay between immunity and human mobility shapes SARS-CoV-2 spreading
Beatriz Arregui García, IFISC

July 20
Type-I excitable media: a theoretical framework for space extended excitable systems
Pablo Moreno Spiegelberg, IFISC

July 19
Modelling parasite-produced marine diseases of immobile hosts
Alex Giménez Romero, IFISC

July 18
Towards a mechanistic understanding of the assembly and disassembly of ecological networks
Miguel Lurgi, Swansea University (UK)

July 13
Competition and cooperation in contagion processes on complex networks
Byungjoon Min, Chungbuk National University, Korea

July 12
Quantum associative memory with a single driven-dissipative non-linear oscillator
Adrià Labay Mora, IFISC

July 7
Periodically Refreshed Baths: a numerical technique and a thermodynamic cycle
Archak Purkayastha, Aarhus University, Denmark

June 30
Coevolution in Coordination Games
Miguel Angel Gonzalez, IFISC

June 29
Resilience and transitions of global complex urban systems
Céline Rozenblat, University of Lausanne (UNIL), Switzerland

June 28
Identifiability and prediction in ecological interaction network models
Leonardo Aguirre, Eawag, ETH-Domain, Switzerland

June 28
Convex optimization for non-equilibrium steady states on a hybrid quantum processor
Jonathan W. Z. Lau, CQT Singapur

June 22
The role of non-conservative interactions in non-equilibrium stochastic systems
Sarah Loos, DAMTP Cambridge, and ICTP Trieste, Italy

June 16
Hubs-biased advection-diffusion on undirected graphs.
Manuel Miranda Barrado, IFISC

June 15
Eco-evolutionary dynamics on networks: From diversification to coexistence in complex ecosystems
Carlos Melian, Eawag, ETH-Domain, Switzerland and IFISC

June 14
Analysis of the European air route network: properties, evolution and resilience
Pau Esteve, IFISC

June 10
The process of doing a PhD - lessons learned from being a student and a supervisor
Tobias Galla, IFISC

June 8
Beating Carnot efficiency with periodically driven chiral conductors
Sungguen Ryu, IFISC

June 7
Quantifying mobility responses to COVID-19 containment strategies in Spain
Mar Cuevas Blanco, IFISC

June 2
Yu-Shiba-Rusinov subgap excitations in hybrid superconductor/semiconductor nanowires containing quantum dots
Ramón Aguado , Instituto de Ciencia de Materiales de Madrid, CSIC

May 30
Exploring selective breeding as a strategy to increase thermal resilience of reef-building corals
Manuel Aranda, KAUST, Arabia Saudita

May 30
Lagrangian transport of sinking particles. From theoretical characterization to oceanic applications
Rebeca de la Fuente, IFISC

May 26
Generalized diffusion in graphs/networks
Fernando Díaz Díaz, IFISC

May 25
Understanding the origin and maintenance of biodiversity through eco-evolutionary feedbacks
Catalina Chaparro, EAWAG, ETH domain, Switzerland

May 4
Lucy Mensing: Forgotten Pioneer of Quantum Mechanics
Gernot Münster , Westfälische Wilhelms-Universität Münster (Germany)

April 27
Towards Geographically-Transferable Deep Learning Models for Human Mobility
Massimiliano Luca, Faculty of Computer Science, Free University of Bolzano - MobS Lab, Fondazione Bruno Kessler, Trento, Italy.

April 26
Multicompartmental model of CA3 and CA1 hippocampal regions for studying rythms
Jaime Sánchez Claros, IFISC

April 13
Understanding the effects of COVID-19 on Financial Market Structures: A study of the USA & Brazil
Ola Megahed Ali, IFISC

April 12
Divulgació, Sistemes Complexos i l'IFISC
Adrián García Candel, IFISC

April 8
Seagrass spatiotemporal dynamics with a time-dependent mortality
Jorge Mampel, IFISC

April 6
When machine learning deciphers the 'language' of atmospheric air masses
Davide Faranda, LSCE-CEA Saclay-IPSL-UVSQ-Université Paris Saclay, France

April 5
An introduction to Conceptors
Mirko Goldmann, IFISC

March 23
Using random matrix theory to determine the stability of the generalised Lotka-Volterra equations
Joseph Baron, IFISC

March 21
Implementing a photonic reservoir computer based on diffractively coupled VCSELs: Characterization and basic benchmark performance
Moritz Pflüger, IFISC

March 16
Non-complex" approaches to understand clinically-relevant "complex" cancer clinical traits
Diego M. Marzese, Cancer Epigenetics Laboratory Fundació Institut d'Investigació Sanitària Illes Balears, Spain

March 2
Benchmarking experimental quantum computation: rigorous noise analysis in the simulation of dissipative collective effects
Marco Cattaneo, IFISC and University of Helsinki, Finland

February 23
Excursions through network theory
Ernesto Estrada, IFISC

February 22
How can the structure of ecosystems predict species' survival?
Violeta Calleja Solanas, IFISC

February 22
Single silicon microring resonator for time delay reservoir computing: from theory to experimental challenges
Giovanni Donati, IFISC and University of Trento, Italy

February 16
Floquet topological metal, avoiding the Anderson localization
Kun Woo Kim, Chung-Ang University, South Korea

February 15
An improved estimator of Shannon entropy with applications to systems with memory
Juan de Gregorio, IFISC

February 9
Higher-Order Kuramoto dynamics on Simplicial Complexes
Joaquin J. Torres, Universidad de Granada

February 3
Liquid-Hexatic-Solid phases in active and passive Brownian particles driven by stochastic birth-death events
Alejandro Almodóvar Del Pozo, IFISC

February 2
Digital proximity tracing on empirical contact networks for pandemic control
Giulia Cencetti, FBK Foundation, Trento, Italy

February 1
Data analysis of frequency fluctuations in the Balearic grid before and after coal closure
María Martínez-Barbeito, IFISC

January 26
Discrete and continuum methods to investigate pattern formation in growing cell populations
Fiona Macfarlane, University of St. Andrews, UK.

January 21
Noisy voter models with time-varying influencers.
Annalisa Caligiuri, IFISC

January 19
Quantitative comparisons between models and data to provide new insights in cell and developmental biology
Ruth Baker, University of Oxford, UK.

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

Spin-orbit microlaser emitting in a four-dimensional Hilbert space
Zhang, Z.; Zhao, H.; Wu, S.; Wu, T.; Qiao, X. ; Gao, Z. ; Agarwal, R. ; Longhi, S.; Litchinitser, N.M. ; Ge, L.; Feng, L.
Nature 612, 246–251

Topological triple phase transition in non-Hermitian Floquet quasicrystals
Weidemann, Sebastian; Kremer, Mark; Longhi, Stefano; Szameit, Alexander
Nature 601, 354–359

High-order dynamic localization and tunable temporal cloaking in ac-electric-field driven synthetic lattices
Wang , Shulin; Qin, Chengzhi; Liu, Weiwei ; Zhou, Feng; Ye, Han ; Zhao , Lange ; Dong, Jianji; Zhang, Xinliang; Longhi, Stefano ; Lu, Peixiang
Nature Communications 13, 7653 (1-11)

Beating Carnot efficiency with periodically driven chiral conductors
Ryu, Sungguen; López, Rosa; Serra, Llorenç; Sanchez, David
Nature Communications 13, 2512 (1-6)

The world-wide waste web
Martínez, Johann H; Romero, Sergi; Ramasco, Jose J.; Estrada, Ernesto
Nature Communications 13, 1615 (1-13)

Reply to: On the difficulty of achieving differential privacy in practice: user-level guarantees in aggregate location data
Bassolas, A; Barbosa-Filho,H; Dickinson, B; Dotiwalla, X; Eastham, P; Gallotti, R; Gourab Ghoshal, Bryant Gipson, Surendra A. Hazarie, Henry Kautz, Onur Kucuktunc, Allison Lieber, Adam Sadilek & Jose J. Ramasco
Nature Communications 13, 30 (1-2)

The shape of memory in temporal networks
Williams, Oliver; Lacasa, Lucas; Millán, Ana; Latora, Vito
Nature Communications 13, 499 (1-8)

Photonic neuromorphic technologies in optical communications
Argyris, Apostolos
Nanophotonics 11, 5, 897-916

Aharonov-Bohm caging and inverse Anderson transition in ultracold atoms
Li, Hang; Dong, Zhaoli; Longhi, Stefano; Liang, Qian ; Xie, Dizhou; Yan, Bo
Physical Review Letters 129, 220403 (1-6)

Partition of Two Interacting Electrons by a Potential Barrier
Ryu, Sungguen; Sim, H.-S.
Physical Review Letters 129, 166801 (1-7)

Self-healing of non-Hermitian topological skin modes
Longhi, Stefano
Physical Review Letters 128, 157601 (1-6)

Eigenvalues of random matrices with generalised correlations: a path integral approach
Baron, Joseph William; Jewell, Thomas Jun; Ryder, Christopher; Galla, Tobias
Physical Review Letters 128, 120601 (1-6)

Role of Eckhaus instability and pattern cracking in ultraslow dynamics of Kerr combs
Gomila, D.; Parra-Rivas, P.; Colet, P.; Coillet, A.; Lin, G.; Daugey, T.; Diallo, S.; Merolla, J.-M.; Chembo, Y.K.
Physical Review A 106, 053518 (1-7)

Topological aspects in nonlinear optical frequency conversion
Longhi, Stefano
Physical Review A 106, 053503 (1-13)

Dynamics of a dispersively coupled transmon qubit in the presence of a noise source embedded in the control line
Vaaranta, Antti; Cattaneo, Marco; Lake, Russell
Physical Review A 106, 042605 (1-19)

Non-Hermitian invisibility in tight-binding lattices
Longhi, Stefano; Pinotti, Ermanno
Physical Review B 106, 094205 (1-11)

Nonlocal quantum heat engines made of hybrid superconducting devices
Tabatabaei, S. M.; Sánchez, D.; Levy Yeyati, A.; Sánchez, R.
Physical Review B 106, 115419 (1-13)

Conductance of electrostatic wire junctions in bilayer graphene
Ryu, Sungguen; López, Rosa; Serra, Llorenç
Physical Review B , 035424 (1-8)

Non-Hermitian skin effect and self-acceleration
Longhi; Stefano
Physical Review B 105, 245143 (1-13)

Structured interactions as a stabilizing mechanism for competitive ecological communities
Calleja-Solanas, Violeta; Khalil, Nagi; Gómez-Gardeñes, Jesús; Hernández-García, Emilio; Meloni, Sandro
Physical Review E 106, 064307 (1-12)

Local and global ordering dynamics in multistate voter models
Ramirez, Lucía; San Miguel, Maxi; Galla, Tobias
Physical Review E 106, 054307 (1-17)

Liquid-Hexatic-Solid phases in active and passive Brownian particles determined by stochastic birth and death events
Almodovar, Alejandro; Galla, Tobias; López, Cristóbal
Physical Review E 106, 054130 (1-9)

Vector-borne diseases with non-stationary vector populations: the case of growing and decaying populations
Giménez-Romero, Àlex; Flaquer-Galmés, Rosa; Matias, Manuel A.
Physical Review E 106, 054402 (1-11)

Learn one size to infer all: Exploiting translational symmetries in delay-dynamical and spatiotemporal systems using scalable neural networks
Goldmann, Mirko; Mirasso, Claudio R.; Fischer, Ingo; Soriano, Miguel C.
Physical Review E 106, 044211 (1-9)

Bifurcation structure of traveling pulses in Type-I excitable media
Moreno-Spiegelberg, Pablo; Arinyo-i-Prats, Andreu; Ruiz-Reynés, Daniel; Matias, Manuel A.; Gomila, Damià
Physical Review E 106, 034206 (1-15)

Collective effects on the performance and stability of quantum heat engines
Souza, Leonardo S.; Manzano, Gonzalo; Fazio, Rosario;Iemini,Fernando
Physical Review E 106, 014143 (1-20)

Sampling rare trajectories using stochastic bridges
Aguilar,Javier;Baron,Joseph;Galla, Tobias;Toral,Raul
Physical Review E 105, 064138 (1-7)

Permutation Jensen-Shannon distance: A versatile and fast symbolic tool for complex time-series analysis
Luciano Zunino, Felipe Olivares, Haroldo V. Ribeiro, and Osvaldo A. Rosso
Physical Review E 105, 045310 (1-21)

Survival and extreme statistics of work, heat and entropy production in steady-state heat engines
Manzano, Gonzalo; Roldán, Édgar
Physical Review E 105, 024112 (1-9)

Non-Abelian Quantum Transport and Thermosqueezing Effects
Manzano, Gonzalo; Parrondo, Juan M. R.; Landi, Gabriel T.
Physical Review X Quantum 3, 010304

Correlations of network trajectories
Lacasa, Lucas; Rrodriguez, Jorge P.; Eguiluz, Victor M.
Physical Review Research 4, L042008 (1-7)

Inferring work by quantum superposing forward and time-reversal evolutions
Rubino, Giulia; Manzano, Gonzalo; Rozema, Lee A.; Walther, Philip; Parrondo, Juan M. R.; Brukner, Časlav
Physical Review Research 4, 013208 (1-12)

Quantum synchronisation and clustering in chiral networks
Lorenzo, Salvatore; Militello, Benedetto; Napoli, Anna; Zambrini, Roberta; Palma, G.Massimo
New Journal of Physics 24, 023030

Communicability in time-varying networks with memory
Ernesto Estrada
New Journal of Physics 24, 063017 (1-16)

Quantum Consensus Dynamics by Entangling Maxwell Demon
Ryu,Sungguen;López,Rosa;Toral,Raúl
New Journal of Physics 24, 033028 (1-18)

The study of aggression and affiliation motifs in bottlenose dolphins' social networks
Pérez-Manrique, Ana; Fernández-Gracia, Juan; Gomila, Antoni; Ramasco, Jose J.
Scientific Reports 12, 19672

Aging effects in Schelling Segregation model
Abella, David; San Miguel, Maxi; Ramasco, José J.
Scientific Reports 12, 19376

pH trends and seasonal cycle in the coastal Balearic Sea reconstructed through machine learning
Flecha, Susana; Giménez-Romero, Àlex; Tintoré, Joaquín; Pérez, Fiz F.; Alou-Font, Eva; Matías, Manuel A.; Hendriks, Iris E.
Scientific Reports 12, 12956 (1-11)

Echo chambers and information transmission biases in homophilic and heterophilic networks
Diaz-Diaz, Fernando; San Miguel, Maxi; Meloni, Sandro;
Scientific Reports 12, 9350

Rapid evolution of SARS-CoV-2 challenges human defenses
Duarte, Carlos M; Ketcheson, David I; Eguíluz, Víctor M; Agustí, Susana; Fernández-Gracia, Juan; Jamil, Tahira; Laiolo, Elisa; Gojobori, Takashi; Alam, Intikhab
Scientific Reports 12, 6457 (1-8)

Impact of urban structure on infectious disease spreading
Aguilar,Javier;Bassolas,Aleix;Ghoshal, Gourab;Hazarie, Surendra;Kirkley,Alec;Mazzoli,Matia;Meloni,Sandro;Mimar,Sayat;Nicosia,Vincenzo;Ramasco, Jose Javier;Sadilek, Adam;
Scientific Reports 12, 3816

Coordination and equilibrium selection in games: the role of local effects
Raducha, Tomasz; San Miguel, Maxi
Scientific Reports 12, 3373

Telling functional networks apart using ranked network features stability
Zanin, Massimiliano; Güntekin, Bahar; Aktürk, Tuba; Yıldırım, Ebru; Yener, Görsev; Kiyi, Ilayda; Hünerli-Gündüz, Duygu; Sequeira, Henrique; Papo, David
Scientific Reports 12, 2562

Effects of the COVID-19 pandemic in higher education: A data driven analysis for the knowledge acquisition process
Velásquez-Rojas, Fátima; Fajardo, Jesus E; Zacharías, Daniela; Laguna, María Fabiana
PLoS ONE 17, 1-20

Some recent advances in urban system science: models and data
Arcaute, Elsa; Ramasco, Jose J.
PloS ONE 17, e0272863

Inequalities in COVID-19 inequalities research: Who had the capacity to respond?
Benach, Joan; Cash-Gibson, Lucinda; Rojas-Gualdrón, Diego F; Padilla-Pozo, Álvaro; Fernández-Gracia, Juan; M Eguíluz, Víctor and COVID-SHINE group
Plos One 17, e0266132

Non-Hermitian Bloch-Zener phase transitions
Longhi; Stefano
Optics Letters 47, 6345-6348

Invisible non-Hermitian potentials in discrete-time photonic quantum walks
Longhi; Stefano
Optics Letters 47, 4091-4094

Non-Hermitian topological mobility edges and transport in photonic quantum walks
Longhi, Stefano
Optics Letters 47, 2951-2954

Non-Hermitian laser arrays with tunable phase locking
Longhi, Stefano
Optics Letters 47, 2040-2043

A brief journey through collision models for multipartite open quantum dynamics
Cattaneo, Marco; Giorgi, Gian Luca; Zambrini, Roberta; Maniscalco, Sabrina
Open Systems & Information Dynamics 29, 2250015

Global risk predictions for Pierce's disease of grapevines
Giménez-Romero, Àlex; Galván, Javier; Montesinos, Marina; Bauzà, Joan; Godefroid, Martin; Fereres, Alberto; Ramasco, José J.; Matias, Manuel A.; Moralejo, Eduardo
Communications Biology 5, 1389 (1-13)

Visibility graphs of animal foraging trajectories
Paiva Leticia; Alves, Sidiney; Lacasa, Lucas; DeSouza, Og; Miramontes, Octavio
Journal of Physics: Complexity 3, 04LT03

Benchmarking the Role of Particle Statistics in Quantum Reservoir Computing
Llodrà, Guillem; Charalambous, Christos; Giorgi, Gian Luca; Zambrini, Roberta
Advanced Quantum Technologies 2022, 2200100 (1-10)

Emergence of explosive synchronization bombs in networks of oscillators
Arola-Fernández, Lluís; Faci-Lázaro, Sergio; Skardal, Per Sebastian; Boghiu, Emanuel-Cristian; Gómez-Gardeñes ,Jesús; Arenas,Alex
Communication Physics 5, 264

Does big data help answer big questions? The case of airport catchment areas & competition
Adler, N; Brudner, A; Gallotti, R; Privitera, F; Ramasco, J J
Transportation Research Part B 166, 444-467

Network Meta-Analysis: A Statistical Physics Perspective
Davies, Annabel L; Galla, Tobias
Journal of Statistical Mechanics: Theory and Experiment 2022, 11R001 (1-79)

EvoDynamics.jl: a framework for modeling eco-evolutionary dynamics
Vahdati, Ali R.; Melián, Carlos J.
The Journal of Open Source Software 7, 4775

Non-Hermitian Hartman Effect
Longhi; Stefano
Annalen der Physik 534, 2200250 (1-12)

Learning unseen coexisting attractors
Gauthier, Daniel J.; Fischer, Ingo; Röhm, André
Chaos 32, 113107 (1-9)

Analyzing international events through the lens of statistical physics: The case of Ukraine
Zanin, Massimiliano; Martínez, Johann H.
Chaos: An Interdisciplinary Journal of Nonlinear Science 32, 051103 (1-8)

An improved estimator of Shannon entropy with applications to systems with memory
De Gregorio, Juan; Sánchez, David; Toral, Raúl
Chaos, Solitons and Fractals 165, 112797 (1-9)

The nonequilibrium potential today: A short review
H.S. Wio, J.I. Deza, A.D. Sánchez, R. García-García, R. Gallego, J.A. Revelli, R.R. Deza
Chaos, Solitons and Fractals 165, 112778 (1-11)

Biased-voter model: how persuasive a small group can be?
Czaplicka,Agnieszka;Charalambous,Christos;Toral,Raul;San Miguel,Maxi
Chaos, Solitons and Fractals 161, 112363

Time and space generalized diffusion equation on graph/networks
Estrada, Ernesto; Diaz-Diaz, Fernando
Chaos, Solitons and Fractals 156, 111791 (1-9)

Designing non-Hermitian real spectra through electrostatics
Yang, Russell; Tan, Jun Wei; Tai, Tommy; Koh, Jin Ming ; Li, Linhu ; Longhi, Stefano ; Lee, Ching Hua
Science Bulletin 67, 1865-1873

Analytical and numerical treatment of continuous ageing in the voter model
Baron, Joseph W;Peralta, Antonio F. ;Galla, Tobias.;Toral, Raul
Entropy 24, 1331

Degree-Biased Advection-Diffusion on undirected graphs/networks
Miranda, M.; Estrada, E.
Mathematical Modelling of Natural Phenomena 17, 30

Spatial effects in parasite induced marine diseases of immobile hosts
Giménez-Romero, Àlex; Vázquez, Federico; López, Cristóbal; Matías, Manuel A.
Royal Society Open Science 9, 212023 (1-14)

The Potential Impact of Climate Change on the Efficiency and Reliability of Solar, Hydro, and Wind Energy Sources
Bhatt, Uma S.; Carreras, Benjamin A.; Reynolds-Barredo, José Miguel; Newman, David E.; Colet, Pere; Gomila, Damià
Land 11, 1275

Can Deep Learning distinguish chaos from noise? Numerical experiments and general considerations
Zanin, Massimiliano
Communications in Nonlinear Science and Numerical Simulation 114, 106708

Haros graphs: an exotic representation of real numbers
Calero-Sanz, Jorge; Luque, Bartolo; Lacasa, Lucas
Journal of Complex Networks 10, cnac043

Corrupted bifractal features in finite uncorrelated power-law distributed data
Olivares, Felipe; Zanin, Massimiliano
Physica A: Statistical Mechanics and its Applications 603, 1-11

Algorithmic hospital catchment area estimation using label propagation
Challen, Robert J.; Griffith, Gareth J.; Lacasa, Lucas; Tsaneva-Atanasova, Krasimira
BMC Health Services Research 22, 828

Gait analysis under the lens of statistical physics
Zanin, Massimiliano; Olivares, Felipe; Pulido-Valdeolivas, Irene; Rausell, Estrella; Gomez-Andres, David
Computational and Structural Biotechnology Journal 20, 3257-3267

High-Performance Reservoir Computing With Fluctuations in Linear Networks
Nokkala, Johannes; Martínez-Peña, Rodrigo; Zambrini, Roberta; Soriano, Miguel C.
IEEE Transactions on Neural Networks and Learning Systems 33, 2664-2675

Information Processing Capacity of a Single-Node Reservoir Computer: An Experimental Evaluation
Vettelschoss, Benedikt; Röhm, André; Soriano, Miguel C.
IEEE Transactions on Neural Networks and Learning Systems 33, 2714-2725

Optimal Cost-Based Strengthening of Complex Networks
Rong, Qingnan; Zhang, Jun; Sun, Xiaoqian; Wandelt, Sebastian; Zanin, Massimiliano; Tian, Liang
IEEE Transactions on Network Science and Engineering 9, 1117 - 1127

Assessing Identifiability in Airport Delay Propagation Roles Through Deep Learning Classification
Ivanoska, Ilinka; Pastorino, Luisina; Zanin, Massimiliano
IEEE Access 10, 28520 - 28534

Quantum thermodynamics under continuous monitoring: a general framework
Manzano, Gonzalo; Zambrini, Roberta
AVS Quantum Science 4, 025302

Statistical–mechanical theory of topological indices
Ernesto Estrada
Physica A 602, 127612 (1-10)

Selective and tunable excitation of topological non-Hermitian quasi-edge modes
Longhi, Stefano
Proceedings of the Royal Society A 478, 20210927 (1-15)

20 years of ordinal patterns: Perspectives and challenges
Leyva Callejas, Inmaculada; Martinez, Johann; Masoller, Cristina; Rosso, Osvaldo A.; Zanin, Massimiliano
EPL 138, 31001 (1-7)

An integrated photorefractive analog matrix-vector multiplier for machine learning
Vlieg, Elger A.; Talandier, Lucas; Dangel, Roger; Horst, Folkert; Offrein, Bert J.
Applied Sciences 12, 4226 (1-11)

Optical dendrites for spatio-temporal computing with few-mode fibers
Ortín, Silvia; Soriano, Miguel C.; Fischer, Ingo; Mirasso, Claudio R.; Argyris, Apostolos
Optical Materials Express 12 (5), 1907-1919

Trivial and topological bound states in bilayer graphene quantum dots and rings
Benchtaber, Nassima; Sánchez, David; Serra, Llorenç
Physica Status Solidi B 2022, 2200023 (1-6)

Editorial: The Fluctuation-Dissipation Theorem Today
Gudowska-Nowak Ewa, OliveiraFernando A. and Wio Horacio Sergio
Frontiers in Physics 10, 859799 (3)

Network meta-analysis and random walks
Davies, Annabel L.; Papakonstantinou, Theodorus; Nikolakopoulou, Adriani; Rücker, Gerta; Galla, Tobias
Statistics in Medicine 41, 2091-2114

A mathematical model for inter-specific seagrass interactions: reproducing field observations for C. nodosa and C. prolifera
Eva Llabrés, Elvira Mayol, Núria Marbá, Tomás Sintes
Oikos 2022, e09296 (1-10)

From random failures to targeted attacks in network dismantling
Wandelt, Sebastian; Lin, Wei; Sun, Xiaoqian; Zanin, Massimiliano
Reliability Engineering & System Safety 218, 108146

Quantum Reservoir Computing for Speckle-Disorder Potentials
Mujal, Pere
Condensed Matter 7, 17 (1-9)

Secondary frequency control stabilising voltage dynamics
Tchawou Tchuisseu, Eder Batista; Dongmo, Eric Donald; Procházka, Pavel; Woafo, Paul; Colet, Pere; Schäfer, Benjamin
European Journal of Applied Mathematics , 1-17

Anomalous mobility edges in one-dimensional quasiperiodic models
Liu, Tong;, Xia, Xu; Longhi, Stefano; Sanchez-Palencia, Laurent
SciPost Physics 12, 027 (1-25)

Nonlinear Dynamics of a Single-Mode Semiconductor Laser with Long Delayed Optical Feedback: A Modern Experimental Characterization Approach
Porte, Xavier; Brunner, Daniel; Fischer, Ingo; Soriano, Miguel C.
Photonics 9, 47

Air delay propagation patterns in Europe from 2015 to 2018: an information processing perspective
Pastorino, Luisina; Zanin, Massimiliano
J. Phys. Complex. 3, 015001

56 GBaud PAM-4 100 km transmission system with photonic processing schemes
Estébanez, Irene; Li, Shi; Schwind, Janek; Fischer, Ingo; Pachnicke, Stephan; Argyris, Apostolos
Journal of Lightwave Technology 40, 1, 55-62

Microring resonators with external optical feedback for time delay reservoir computing
Donati, Giovanni; Mirasso, Claudio R.; Mancinelli, Mattia; Pavesi, Lorenzo; Argyris, Apostolos
Optics Express 30, 1, 522-537

Hubs-biased resistance distances on graphs and networks
Ernesto Estrada and Delio Mugnolo
Journal of Mathematical Analysis and Applications 507, 125728 (1-22)

Nonlinear photonic dynamical systems for unconventional computing
Brunner, Daniel; Larger, Laurent; Soriano, Miguel C.
Nonlinear Theory and Its Applications, IEICE 13, 26-35

A fast transform for brain connectivity difference evaluation
Zanin, M; Ivanoska, I.; Güntekin, B.; Yener, G.; Loncar-Turukalo, T.; Jkovljevic, N.; Sveljo, O.; Papo, D.
Neuroinformatics, 20, 285-299.

a.5.2. Other Publications

Hacia la soberanía digital para sostener la sociedad futura
Zambrini, R; Rius, G.
CSIC Investiga 4: Sociedad Digital 4, 3-3

Premio Nobel de Física 2021: Otorgado por "Contribuciones revolucionarias en la comprensión de los sistemas físicos complejos"
Ramasco, José Javier; Gutiérrez, José Manuel; San Miguel, Maxi
Revista Española de Física 35, 15-17

Noise effects on time delay reservoir computing using silicon microring resonators
Donati, Giovanni; (Argyris, Apostolos; Mancinelli, Mattia; Mirasso, Claudio Ruben; Pavesi, Lorenzo;)
Integrated Optics: Devices, Materials, and Technologies XXVI 12004, 219--226

a.6. Presentations at conferences and academic centers

a.6.1 Invited talks at conferences and workshops

Dynamical Phase Transitions in Quantum Reservoir Computing.
Openness as a resource: Accessing new quantum states with dissipation (Dresden, Germany).
Rodrigo Martínez-Peña, Gian Luca Giorgi, Johannes Nokkala, Miguel Cornelles Soriano and Roberta Zambrini
January 31

Time-Delay Identification Using Ordinal Quantifiers.
International Workshop on Ordinal Methods: Concepts, Applications, New Developments and Challenges (Dresden, Germany).
Soriano, Miguel Cornelles; Zunino, Luciano
February 28

New data sources for smart tourism.
Sustainable Destinations Summit, organized by the Fundació Mallorca Turisme of Consell de Mallorca in collaboration with the World Tourism Organization (UNWTO) in Palma de Mallorca, Spain.
Ramasco, JJ
April 07

What make a network complex?.
FisEs 2022, XXIII Congreso de Fisica Estadistica, Zaragoza.
Estrada, Ernesto; Lacasa, Lucas
May 12

Single-electron sources: from electron optics to thermodynamic machines.
11th school of Mesoscopic Physics, Asia Pacific Center for Theoretical Physics (Pohang, republic of Korea).
Ryu, Sungguen
May 19

Reservoir computing with qubit networks.
Conference Quantum Information in Spain ICE7, Granada, Spain .
Zambrini, Roberta
May 23

Homophily and Heterophily: Polarization, Eco-chambers and Information Transmission biases.
CSH External Faculty meeting, Complexity Sicience Hub, Viena, Austria.
San Miguel, Maxi
May 29

Competition of Species in niche space: new perspectives.
Eco-evolutionary Dynamics of Microbial Communities Across Scales, ICTP, Trieste.
Lopez, C
June 06

What makes a network complex?.
A journey in numerical linear algebra: a workshop in honor of Michele Benzi' s 60th birthday, Pisa, Italy.
Estrada, Ernesto; Lacasa, Lucas
June 10

Biased Advection operators on undirected graphs.
24th ILAS Conference, "Kemeny' s constant on networks and its application" Minisymposium Galway, Ireland.
Miranda, Manuel; Estrada, Ernesto
June 20

Generation of rare trajectories by walking backwards.
Symposium in remembrance of Lutz Schimansky-Geier. Berlin, Germany.
Toral,Raul
July 02

Symmetries in physical dilations of open quantum systems.
Quantum Hiking 2022 (Gran Paradiso National Park, Italy).
Cattaneo, Marco
July 05

Quantum Stochastic Thermodynamics.
The adjacent possible of stochastic thermodynamics, ICTP QLS Meeting (Trieste).
Manzano, Gonzalo
July 11

Patterns and fronts in underwater vegetation.
International Symposium on Nonlinear Dynamics and Complex Structures in the Geosciences. Oldenburg, Germany.
Hernandez-Garcia, Emilio
July 15

Dendritic-like computation using multimode optical fibers.
The 5th International Conference on Application of Optics and Photonics (AOP 2022), Guimaraes, Portugal.
Ortin, Silvia; Soriano, Miguel Cornelles; Fischer, Ingo; Mirasso, Claudio R.; Argyris, Apostolos
July 18

Photoassisted chiral transport beyond the Carnot limit.
Frontiers of Quantum and Mesoscopic Thermodynamics 2022 (FQMT'22), Praga (R. Checa).
Ryu, Sungguen; López, Rosa; Serra, Llorenç; Sanchez, David
August 01

Flow-Network Characterization of Transient Chaos in Open Systems.
Dynamics Days Europe 2022, Minisymposium on "Transient Chaos". Aberdeen, UK.
Hernandez-Garcia, E.
August 22

Inferring Untrained Dynamics of Complex Systems using Adapted Recurrent Neural Networks.
Dynamics Days Europe 2022, Minisymposium on "Adaptive dynamical networks". Aberdeen, UK.
Goldmann, Mirko; Mirasso, Claudio R.; Fischer, Ingo; Soriano, Miguel Cornelles
August 22

Quantum Reservoir Computing.
Lecture delivered at "Concepts and Applications of Quantum Information Summer School" in Vienna, Austria.
Giorgi, Gian Luca
August 29

Network bypasses sustain complexity.
Reconstructing network dynamics from data: Applications to neurosciences and beyond. Institute for Pure \& Applied Mathematics (IPAM); University of California, Los Angeles (UCLA).
Estrada, Ernesto; Lacasa, Lucas
August 29

Quantum Reservoir Computing with squeezed states.
Machine Learning Photonics, Lake Como School of Advanced Studies. Italy.
Zambrini, Roberta
August 29

Self-Organized Marine Vegetation Patterns and Traveling Pulses.
SIAM Conference on Nonlinear Waves and Coherent Structures (NWCS22). Bremen, Alemania.
Ruiz-Reynés, D.; Hernández-García, E.; Sintes, T.; Marbà, N.; Gomila, D.
August 30

Photonic Reservoir Computing.
X GEFENOL Summer School on Statistical Physics of Complex Systems (Palma de Mallorca, Spain).
Soriano, Miguel Cornelles
September 01

Quantum Complex Systems for Machine Learning.
Quantum characterization and control of quantum complex systems, Lake Como School of Advanced Studies.Italy.
Zambrini, Roberta
September 19

Mechanisms behind collective social phenomena.
Conferencia plenaria Reunion Asociación Fisica Argentina, RAFA 107, Bariloche, Argentina.
San Miguel, Maxi
September 27

Percolación inversa con múltiple ocupación de sitios.
107° Reunión de la Asociación Física Argentina Bariloche, Argentina .
Lucia Ramirez
September 27

Time-Series Quantum Reservoir Computing with Weak and Projective Measurements.
Conference Artificial Intelligence for Waves - AI4W Inria Research Center at Université Côte d' Azur, Valbonne, France.
Mujal, Pere; Martínez-Peña, Rodrigo; Giorgi, Gian Luca; Cornelles Soriano, Miguel; Zambrini, Roberta
October 10

Podscards from Network Theory.
CSS 2022 Warm Up. Young Researchers of the Complex Systems Society. Palma de Mallorca, Spain
Estrada, Ernesto
October 14

Topological transitions in the coupled dynamics of signed relations and node states.
Conference on Complex Systems CCS2022, Satellite on Signed relations and Structural Balance, Palma.
San Miguel, Maxi
October 17

Loss of Structural Balance in Stock Markets.
CSS 2022, Palma de Mallorca.
Estrada, Ernesto; Ferreira, Eva; Orbe, Susan; Ascorbebeitia , Jone, Alvarez-Pereira, Brais
October 17

WWWW: Red internacional de comercio de basuras.
CSS 2022, Palma de Mallorca, Spain.
Estrada, Ernesto
October 17

Coevolution dynamics of opinion and social network.
Workshop on Sociophysics: Social Phenomena from a Physics Perspective, International centre for Theoretical Physics, Sao Paolo, Brasil online.
San Miguel, Maxi
October 18

Quantum Reservoir Computing with qubits and continuous variables.
International School Of Solid State Physics 82nd Workshop: Unconventional computing: materials Science, informatics, hardware, software, Eice, Sicily.
Zambrini, Roberta
October 20

Non-Gaussian random matrices predict the stability of feasible Lotka-Volterra communities.
Modeling on Ecology and Evolution Workshop, Seoul, Korea.
Galla, Tobias
October 27

A quantum associative memory algorithm based on a single driven-dissipative nonlinear oscillator.
Workshop "Bridges Between Quantum and Classical Non-Equilibrium Physics", Stellenbosch (South Africa).
Giorgi, Gian Luca
November 07

Symmetries in physical dilations of open quantum systems.
New trends in mathematical physics (online, Moscow).
Cattaneo, Marco
November 08

a.6.2 Other talks at conferences and workshops

Noise effects on time delay reservoir computing using silicon microring resonators.
SPIE Photonics West, San Francisco, CA, U. S. A.
Donati, Giovanni; Argyris, Apostolos; Mirasso Claudio; Mancinelli, Mattia; Pavesi, Lorenzo
January 22

Impact of urban structure on infectious disease spreading.
NetSci-X 2022 hold in Oporto, Portugal.
Ramasco, JJ
February 08

Percolation based precursors for sudden shifts in the dynamics of coupled oscillators and applications to climate phenomena.
4rth CAFE Workshop, European Centre for Medium-Range Weather Forecasts, Reading. UK.
Ehstand, Noémie; Donner, Reik; López, Cristóbal; Hernández-García, Emilio
March 29

Survival and extreme statistics of work.
FISES'22. XXIII Congreso de Física Estadística (Zaragoza).
Manzano, Gonzalo
May 12

Inferring Generalized Lotka-Volterra parameters from longitudinal microbial data.
FisEs'22 XXIII Congreso de Física Estadística (Zaragoza, Spain).
Sheykhali, Somaye ;Fernández Gracia, Juan ;Melián, Carlos M. ;Rodríguez, Jorge P ;Irigoien, Xabier ;Duarte, Carlos M. ;Eguíluz, Víctor M.
May 12

Topological confinement and geometry dependence in bilayer graphene.
NanoSpain conference "NanoSpain 2022". Madrid, Spain.
Nassima Benchtaber
May 17

Using complex networks to predict abrupt changes in oscillatory systems.
European Geosciences Union 2022, Vienna, Austria.
Ehstand, Noémie; Donner, Reik; López, Cristóbal; Hernández-García, Emilio
May 23

Structural predictors of species' survival.
Young Modellers in Ecology Workshop (online).
Calleja-Solanas, Violeta; Sáiz, Hugo; Hernández-García, Emilio; Meloni, Sandro
May 23

Time and space generalized diffusion on graphs/networks.
Mathematics of Large Networks Summer School, Renyi Institute Budapest. Hungary.
Diaz-Diaz, Fernando; Estrada, Ernesto
May 30

Beating Carnot efficiency with periodic driven chiral conductors.
Third workshop on stochastic thermodynamics (WOST III), online.
Ryu, Sungguen; López, Rosa; Serra, Llorenç; Sanchez, David;
May 30

Scattering and confinement in bilayer graphene topological nanostructures.
EMRS-2022 Spring meeting (European Material Research Society). Online.
Serra, Llorenç
May 30

Global Risk Predictions for Pierce's Disease of Grapevines.
ISPVE, International Symposium of Plant Virus Epidemiology, CSIC, Spain.
Giménez-Romero, Àlex; Galván, Javier; Montesinos, Marina; Bauzà, Joan; Godefroid, Martin; Fereres, Alberto; Ramasco, José J.; Matias, Manuel A.; Moralejo, Eduardo
June 06

Corpus multiformato y contacto histórico de lenguas: el proyecto CAFECONMIEL.
VII Congreso Internacional de la red CHARTA (Granada).
Sanchez, D.
June 08

Quantum simulation of dissipative collective effects on noisy quantum computers.
New trends in complex quantum systems dynamics (San Sebastián, Spain) .
Cattaneo, Marco
June 20

Dynamical Phase Transitions in Quantum Reservoir Computing.
QUANTUMatter2022 (Barcelona).
Rodrigo Martínez-Peña, Gian Luca Giorgi, Johannes Nokkala, Miguel Cornelles Soriano and Roberta Zambrini
June 21

Non-Abelian Quantum Transport and Thermosqueezing Effects.
Quantum Thermodynamics Conference QTD 2022 (Belfast, UK).
Manzano, Gonzalo; Parrondo, Juan M.R.; Landi, G.T.
June 27

Inteligencia artificial y variación en documentos del proyecto CAFECONMIEL.
VI Congreso Internacional de Corpus Diacrónicos en Lenguas Iberorrománicas. Venezia, Italy.
Sanchez, David
July 05

Non-trivial interplay between immunity and human mobility shapes the SARS-CoV 2 variants spreading.
EpiMob - Satellite at NetSci 2022. Shanghai, China.
Beatriz Arregui García, José Javier Ramasco, Sandro Meloni
July 11

Photonic reservoir computing using quantum resources.
XXXVIII Bienal de la RSEF (Real Sociedad Española de Física), Murcia.
Garcia-Beni, Jorge; Giorgi, Gian Luca; Soriano, Miguel Cornelles; Zambrini, Roberta
July 11

Numerical sampling of rare trajectories using stochastic bridges.
XXXVIII Bienal de la RSEF (Real Sociedad Española de Física), Murcia.
Toral, Raul
July 11

Inferring Generalized Lotka-Volterra parameters from longitudinal microbial data.
XXXVIII Reunión Bienal de la Real Sociedad Española de Física (Murcia, Spain).
Sheykhali, Somaye ;Fernández Gracia, Juan ;Melián, Carlos M. ;Rodríguez, Jorge P. ;Irigoien, Xabier ;Duarte, Carlos M. ;Eguíluz, Víctor M.
July 11

Hardware-Friendly Deep Reservoir Computing.
1st International Workshop on Pervasive Artificial Intelligence (Hosted by the 2022 IEEE World Congress on Computational Intelligence), Padova, Italy.
Gallicchio, Claudio; Soriano, Miguel Cornelles
July 18

Beating Carnot efficiency using periodically driven chiral conductors.
29th International Conference on Low Temperature Physics (LT29), Sapporo (Japón).
Ryu, Sungguen; López, Rosa; Serra, Llorenç; Sanchez, David
August 18

Percolation framework to anticipate sudden shifts in irregular climate oscillations.
Dynamics Days Europe 2022, Aberdeen.
Ehstand, Noémie; Donner, Reik; López, Cristóbal; Hernández-García, Emilio
August 22

Ordering dynamics and path to consensus in multi-state voter models.
contributed talk to German Physical Society conference. Germany
Ramirez, Lucia; San Miguel, Maxi; Galla, Tobias
September 05

Local Balance Index of Signed Networks.
SIAM Workshop on Network Science (ONLINE).
Diaz-Diaz, Fernando; Bartesaghi, Paolo; Estrada, Ernesto
September 13

Multilingual societies from Twitter data: empirical analysis and theoretical modelling.
LLOD approaches for language data research and management (LLODREAM2022, Vilnius). Lituania.
Sanchez, D.
September 21

Modification of monolithic high contrast grating (MHCG) properties by varying its spatial parameters.
9th Workshop on Physics and Technology of Semiconductor Lasers. Cracovia, Poland.
M. Marciniak, A. Broda, M. Gębski, J. Muszalski, J.A. Lott, T. Czyszanowski
October 02

Air transport after COVID-19: recovering the mobility in Europe.
Joint Meeting JRC-NECTAR Cluster 4 \& 6, Seville, Spain.
Zanin, Massimiliano
October 05

Dinàmica de xarxes elèctriques amb gran penetració de renovables.
Trobada UIB \– Clúster per a la Transició Ecològica de les Illes Balears.
Gomila, Damià; Colet, Pere
October 07

Global Risk Predictions for Pierce's Disease of Grapevines.
Congreso de la Sociedad Española de Fitopatología (SEF).
Giménez-Romero, Àlex; Galván, Javier; Montesinos, Marina; Bauzà, Joan; Godefroid, Martin; Fereres, Alberto; Ramasco, Jose J.; Matías, Manuel A.; Moralejo, Eduardo
October 24

Monitored Quantum Reservoir Computing.
Conference Quantum Techniques in Machine Learning QTML 2022 Centro Congressi University of Naples Federico II, Naples, Italy.
Mujal, Pere; Martínez-Peña, Rodrigo; Giorgi, Gian Luca; Cornelles Soriano, Miguel; Zambrini, Roberta
November 07

Biased voter model: How persuasive a small group can be?.
Complex Networks 2022 (Palermo).
Christos Charalambous, Agniezcka Czaplicka, Raul Toral, Maxi San Miguel
November 08

Stochastic thermodynamics with martingales: extreme fluctuations and gambling demons.
(Post)Modern Thermodynamics (school + workshop), University of Luxembourg.
Manzano, Gonzalo
December 05

Talks given at VII COMSOTEC, March 30 – April 1st, Tarragona, Spain:

Ecological patterns of information ecosystems.
Meloni, Sandro

Aging effects in Schelling segregation model.
Abella, David; San Miguel, Maxi; Ramasco, José

Effects of high penetration of renewable energies in power grid frequency fluctuations.
Martínez-Barbeito, María; Gomila, Damià; Colet, Pere

Impact of urban structure on infectious disease spreading.
Ramasco, JJ

The biased voter model: How persuasive a small group can be.
Czaplicka, A.; Charamboulos, C.; Toral, R.; San Miguel, M.

Capturing the diversity of multilingual societies.
Louf, Thomas; Sanchez, David; Ramasco, Jose J

Talks given at the Conference on Complex Systems, CCS2022, October 17-20, Palma de Mallorca, Spain:

Time-Series Quantum Reservoir Computing with Weak and Projective Measurements.
Mujal, Pere; Martínez-Peña, Rodrigo; Giorgi, Gian Luca; Cornelles Soriano, Miguel; Zambirni, Roberta

Aging effects in Complex Contagion.
Abella, David; San Miguel, Maxi; Ramasco, Jose J.

Echo chambers and information transmission biases in social networks.
Diaz-Diaz, Fernando; Meloni, Sandro; San Miguel, Maxi.

Ordering dynamics in the Voter Model with Multiple Opinion States.
Ramirez, Lucía; San Miguel, Maxi; Galla, Tobias.

Multilayer structure enhances the optimal outcome of coordination games.
Raducha, Tomasz; San Miguel, Maxi

Coevolution of action and networks in coordination games.
Gonzalez-Casado, Miguel A.; Sanchez, Angel:; San Miguel, Maxi

Analytical studies of binary-state dynamics on complex networks: effect of fluctuations.
Toral, Raul

Frequency fluctuations in the Balearic grid with high penetration of solar PV and HVDC frequency control.
Martínez-Barbeito, María; Gomila, Damià; Colet, Pere

Long-range interactions and memory on networks: a generalized diffusion equation.
Diaz-Diaz, Fernando; Estrada, Ernesto

Marine Data Science: Animal Trajectory Classification.
Medina Hernández, Jorge; P. Rodríguez, Jorge; M.M. Sequeira, Ana; Lacasa, Lucas; M. Eguíluz, Víctor

A method to determine the memory of a discrete sequence based on the calculation of the Shannon entropy.
De Gregorio, Juan; Sánchez, David; Toral, Raúl

Noisy Voter Model with time-varying influencers.
Annalisa Caligiuri, Tobias Galla

Non-trivial interplay between immunity and human mobility shapes the SARS-CoV 2 variants spreading..
Beatriz Arregui García, José Javier Ramasco, Sandro Maloni

Collective effects on the performance and stability of quantum heat engines.
Manzano, Gonzalo

Stochatic thermodynamics with martingales: extreme fluctuations and gambling demons.
Manzano, Gonzalo

A simple model for pattern formation in coral reefs.
Álvarez-Alegría, Miguel; Matias, Manuel A.; Gomila, Damià

Global Risk Predictions for Pierce's Disease of Grapevines.
Giménez-Romero, Àlex; Galván, Javier; Montesinos, Marina; Bauzà, Joan; Godefroid, Martin; Fereres, Alberto; Ramasco, Jose J.; Matías, Manuel A.; Moralejo, Eduardo

Inferring Generalized Lotka-Volterra parameters from longitudinal microbial data.
Sheykhali, Somaye; Fernández Gracia, Juan; Melián, Carlos M.; Rodríguez, Jorge P.; Irigoien, Xabier; Duarte, Carlos M.; Eguíluz, Víctor M.

Algebraic shortcuts to the onset of network synchrony.
Arola-Fernández, Lluís; Burgio, Giulio; Steinegger, Benjamin; Arenas, Alex

Sampling rare trajectories using stochastic bridges.
J Aguilar, JW Baron, T Galla, R Toral

Unveiling hidden features of the Kitaev model through a complex-network analysis.
Giorgi, Gian Luca; Llodrà, Guillem; Zambrini, Roberta

Dynamics of seagrass meadows with two species.
Pablo Moreno Spiegelberg

Non-Gaussian random matrices determine the stability of Lotka-Volterra communities.
Galla, Tobias; Baron, Joseph W.

Quantifying the drivers behind collective attention in information ecosystems.
Calleja-Solanas, Violeta; Meloni, Sandron; Solé-Ribalta, Albert; Palazzi, María; Suweis, Samir; Pigani, Emanuele; Borge-Holthoefer, Javier

Housing and Transport: Analysing multidimensional inequalities from data and infrastructure in Madrid.
Moreno López, Jesús A.; Martín-Consuegra Ávila, Fernando; De Frutos García, Fernando; Ramasco Sukia, Jose J.

A generalized vectorial framework for mobility.
Erjian Liu, Mattia Mazzoli, Xiao-Yong Yan and Jose J. Ramasco

Effects of the COVID-19 pandemic in higher education: a particular case from the perspective of complex systems.
Velásquez-Rojas, Fátima; Fajardo, Jesús; Zacharías, Daniela; Laguna, María Fabiana

Blackout risk reduction by segmenting large power grids with variable impedance lines.
Gomila, Damià; Carreras, Benjamín A.; Reynolds-Barredo, José Miguel; Colet, Pere; Gomis-Bellmunt, Oriol

Linking network theory, dynamical systems and fluid flows: the Lagrangian betweenness.
Hernandez-Garcia, Emilio

Quantum associative memory with a single driven-dissipative non-linear oscillator.
Adrià Labay-Mora, Roberta Zambrini, Gian Luca Giorgi

An ordinal pattern analysis of lexical relations in major languages.
Sanchez, D.

Quantum Reservoir Computing for Speckle-Disorder Potentials.
Mujal, Pere

Quantum Reservoir Computing in a photonic gaussian platform.
García-Beni, Jorge; Giorgi, Gianluca; Cornelles Soriano, Miguel; Zambrini, Roberta

A model of node and link states for language competition.
Toral, Raul

American cultural regions mapped through the lexical analysis of social media.
Louf, Thomas; Gonçalves, Bruno; Ramasco, Jose J.; Sanchez, David; Grieve, Jack

a.6.3 Poster presentations

Information transmission in delay-coupled neural circuits in the presence of a relay population.
SENC Meeting 2021 (Lleida, Spain).
Sánchez-Claros, Jaime; Pariz, Aref; Valizadeh, Alireza; Canals, Santiago; Mirasso, Claudio.
November 03

Noise effects on time delay reservoir computing using silicon microring resonators.
International Photonics West Conference, San Francisco, USA.
Donati Giovanni, Argyris Apostolos, Mirasso Claudio, Mancinelli Mattia, Pavesi Lorenzo
January 21

Quantum associative memory with a single driven-dissipative non-linear oscillator.
ICE-7 Granada.
Adrià Labay-Mora, Roberta Zambrini, Gian Luca Giorgi
May 23

Non-Abelian Quantum Transport and Thermosqueezing Effects.
ICE-7. 8th Conference on Quantum Information in Spain (Granada).
Manzano, Gonzalo; Parrondo, Juan M. R.;Landi, Gabriel T.
May 23

Modelling and dynamics of the CA1-CA3 circuit of the hippocampus.
EMBO Workshop - Dendrites 2022: Dendritic anatomy, molecules and function (Heraklion, Greece).
Sánchez Claros, Jaime; Canals, Santiago; Mirasso, Claudio.
May 23

Vector-borne diseases with non-stationary vector populations: the case of growing and decaying populations.
ISPVE, International Symposium of Plant Virus Epidemiology, CSIC, Spain.
Giménez-Romero, Àlex; Flaquer-Galmés, Rosa; Matías, Manuel A.
June 06

Detecting the topological phase of the Kitaev Model via network analysis
New trends in complex quantum systems dynamics 2022 (San Sebastián), Spain.
Llodrà, Guillem; Zambrini, Roberta; Giorgi, Gian Luca.
June 20

Quantum associative memory with a single driven-dissipative non-linear oscillator.
Quantum Matter 2022 Barcelona.
Adrià Labay-Mora, Roberta Zambrini, Gian Luca Giorgi
June 21

Time-Series Processing with Quantum Measurements.
Quantum Matter 2022 (Barcelona).
Mujal, Pere; Martínez-Peña, Rodrigo; Giorgi, Gian Luca; Cornelles Soriano, Miguel; Zambrini, Roberta
June 21

Quantum consensus dynamics by entangling Maxwell demon.
Quantum Thermodynamics Conference 2022, Belfast (Reino Unido).
Ryu, Sungguen; López, Rosa; Toral, Rául
June 27

Quantum simulation of dissipative collective effects on noisy quantum computers.
TQC 2022 (Urbana-Champaign, USA).
Cattaneo, Marco
July 11

Outperforming Carnot efficiency using periodically driven quantum chiral conductors.
Entropy and the Second Law of Thermodynamics- The past, the present, and the future, WE-Heraeus- Seminar, Bad Honnef (Alemania).
Ryu, Sungguen; López, Rosa; Serra, Llorenç; Sanchez, David
July 14

12th International Conference on Metamaterials, Photonic Crystals and Plasmonics.
Sensing enhancement of high-contrast grating VCSEL by Fano effect.
M. Marciniak, W. Głowadzka, Ł. Piskorski, T. Czyszanowski
July 18

How well is a Kantz-Grassberger-type relationship satisfied for local finite-time characteristics of transient chaos?.
Dynamics Days Europe 2022. Aberdeen, UK.
Drótos, G. ; Hernández-García, E.; López, C.
August 22

Echo chambers and information transmission biases in homophilic and heterophilic networks.
X GEFENOL Summer School on Statistical Physics of Complex Systems.
Diaz-Diaz, Fernando; San Miguel, Maxi; Meloni, Sandro
August 29

Hubs-biased dynamics induce explosive synchronization in network.
GEFENOL Summer School 2022.
Miranda, manuel; Estrada, Ernesto
August 29

A simple model for pattern formation in coral reefs.
X GEFENOL Summer School on Statistical Physics of Complex Systems.
Álvarez-Alegría, Miguel; Matias, Manuel A.; Gomila, Damià
August 29

Aging in the Threshold model.
GEFENOL Summer School in Statistical Physics of Complex Systems.
Abella, David; San Miguel, Maxi; Ramasco, José
August 29

Scalable photonic platform for real-time Quantum Reservoir Computing.
Summer School 'Machine Learning Photonics' in Lake Como, Italy
García-Beni, Jorge
August 29

Echo chambers and information transmission biases in homophilic and heterophilic networks.
Summer School of the Statistical Mechanics on Complex Systems, GEFENOL, Palma de Mallorca, Spain.
Dia-Diaz, Fernando; San Miguel, Maxi; Meloni, Sandro
September 05

Echo chambers and information transmission biases in homophilic and heterophilic networks.
II Summer School on Complex Socio-Technical Systems. Palma de Mallorca, Spain
Diaz-Diaz, Fernando; San Miguel, Maxi; Meloni, Sandro
September 05

Biasing the Leader-Follower dynamics.
II Summer School on Socio-Technical Systems. Palma de Mallorca, Spain
Miranda, Manuel; Estrada, Ernesto
September 05

Aging in the Threshold model.
COMSOTEC Summer School on Complex SocioTechnical Systems. Palma de Mallorca, Spain
Abella, David; San Miguel, Maxi; Ramasco, José
September 05

Quantum associative memory with a single driven-dissipative non-linear oscillator.
Quantum characterization and control of quantum complex systems, Lake Como School of Advanced Studies.Italy.
Adrià Labay-Mora, Roberta Zambrini, Gian Luca Giorgi
September 19

Network studies of coherent structures in large-scale circulations on intraseasonal and interannual time scales.
Weather and Climate Extremes and their Predictability, Barcelona, Spain.
Ehstand, Noémie; Donner, Reik; López, Cristóbal; Hernández-García, Emilio
September 27

Benchmarking the Role of Particle Statistics in Quantum Reservoir Computing
Quantum Techniques in Machine Learning (QTML) 2022; Naples.
Llodrà, Guillem; Charalambous, Christos; Giorgi, Gian Luca; Zambrini, Roberta.
November 07

Posters presented at FISES, XXIII Congreso de Física Estadística, May 11-12, Zaragoza, Spain:

Lagrangian betweenness and bottlenecks in ocean flow networks.
Ser-Giacomi, E.; Baudena, A.; Rossi, V.; Follows, M.; Clayton, S.; Vasile, R.; Lopez, C.; Hernandez-Garcia, E.

Liquid-Hexatic-Solid phases in active and passive Brownian particles determined by stochastic birth and death events.
Almodóvar, Alejandro; Galla, Tobias; López, Cristóbal

Aging effects in complex contagion.
Abella-Bujalance, David; Ramasco, José J.; San Miguel, Maxi

The biased voter model: How persuasive a small group can be?.
Czaplicka, A.; Charalambous, C.; Toral, R.; San Miguel, M.

Ordering Dynamics and Path to Consensus in Multi-State Voter Models.
Ramirez, Lucía; San Miguel, Maxi; Galla, Tobias

Vector-borne diseases with non-stationary vector populations: the case of growing and decaying populations.
Giménez-Romero, Àlex; Flaquer-Galmés, Rosa; Matias, Manuel A.

A simple model for pattern formation in coral reefs.
Álvarez-Alegría, Miguel; Matias, Manuel A.; Gomila, Damià

Global risk predictions for Pierces disease of grapevines.
Giménez-Romero, Àlex; Galván, Javier; Montesinos, Marina; Bauzà, Joan; Godefroid, Martin; Fereres, Alberto; Ramasco, José J.; Matias, Manuel A.; Moralejo, Eduardo

Modelling parasite-induced marine diseases of immobile hosts.
Giménez-Romero, Àlex; Vazquez, Federico; López, Cristóbal; Matias, Manuel A.

Effects of demand control on the complex dynamics of electric power system blackouts.
Carreras, Benjamín A.; Tchawou Tchuisseu, Eder Batista; Reynolds-Barredo, José M.; Gomila, Damià; Colet, Pere

Effects of high penetration of wind power in the frequency fluctuations of Gran Canaria's power grid.
Martínez-Barbeito, María; Gomila, Damià; Colet, Pere

Time and space generalized diffusion on graphs/networks.
Diaz-Diaz, Fernando; Estrada, Ernesto

A Machine Learning Approach for Animal Trajectory Classification.
Medina Hernández, Jorge; P. Rodríguez, Jorge; M.M. Sequeira, Ana; Lacasa, Lucas; M. Eguíluz, Víctor

An improved estimator of Shannon entropy of Shannon entropy with applications to systems with memory.
De Gregorio, Juan; Sánchez, David; Toral, Raúl

Noisy Voter Model with time-varying influencers.
Annalisa Caligiuri, Tobias Galla

Biased Diffusion-Advection on undirected networks.
Miranda, Manuel; Estrada, Ernesto

Biased voter model: How persuasive a small group can be?.
Christos Charalambous, Agniezcka Czaplicka, Raul Toral, Maxi San Miguel

Spatial effects in parasite induced marine diseases of immobile hosts.
Giménez Romero, Àlex; Vázquez, Federico; López, Cristóbal; Matías A., Manuel

Air traffic flow dynamics under the lens of ordinal patterns statistics.
Olivares, Felipe; Zanin, Massimiliano

Bifurcation structure of traveling pulses in Type-I excitable media.
Pablo Moreno Spiegelberg

Ordering Dynamics and Path to Consensus in Multi-State Voter Models.
Lucia Ramirez, Maxi San Miguel, Tobias Galla

Complex dynamics in seagrass meadows in the Mediterranean Sea in a global warming scenario.
Sintes, T. ; Llabrés, E.

Universal patterns in information ecosystems.
Calleja-Solanas, Violeta; Palazzi, María; Plata, Carlos A.; Solé-Ribalta, Albert; Borge-Holthoefer, Javier; Suweis, Samir; Meloni, Sandro

Using batteries for frequency control in power grids with renewable sources.
Ruzzene, Giulia; Gomila, Damià; Colet, Pere

Data analysis of frequency fluctuations in the Balearic grid before and after coal closure.
Martínez-Barbeito, María; Gomila, Damià; Colet, Pere

Assessing blackout risk in scenarios of high penetration of variable renewable energies.
Carreras, Benjamín A.; Colet, Pere; Reynolds-Barredo, José M.; Gomila, Damià

Analysis of the blackout risk reduction when segmenting large power systems using HVDC lines.
Gomila, Damià; Carreras, Benjamín A.; Reynolds-Barredo, José M.; Colet, P.; Gomis-Bellmunt, Oriol

Posters presented at CCS2022, Conference on Complex Systems, October 17, Palma de Mallorca, Spain:

Evolution of air delay propagation patterns in Europe from 2015 to 2018: an information processing perspective.
Pastorino, Luisina; Zanin, Massimiliano

Structure, resilience and evolution of the European Air Route Network from 2015 to 2018.
Esteve, Pau; Ramasco, Jose Javier; Zanin, Massimiliano

Reconstruction and characterisation of aircraft interaction networks.
López Martín, Raúl; Zanin, Massimiliano

Short-term correlation in air traffic flow.
Olivares, Felipe; Zanin, Massimiliano

A network percolation framework to anticipate sudden shifts in irregular climate oscillations.
Ehstand, Noémie; Donner, Reik; López, Cristóbal; Hernández-García, Emilio

Subdiffusive processes ruled by biased Laplacians.
Miranda, Manuel; Estrada, Ernesto

Coupled dynamics of node and link states in a coevolving complex network: A model for language competition.
Christos Charalambous, David Sanchez, Raul Toral.

Spatial effects in parasite induced marine diseases of immobile hosts.
Giménez-Romero, Àlex; Vázquez, Federico; López, Cristóbal; Matías A., Manuel

Short-term correlation on air traffic flow.
Olivares, Felipe; Zunino, Luciano; Zanin, Massimiliano

Quantifying mobility responses to COVID-19 containment strategies in Spain.
Cuevas-Blanco, Mar; Meloni, Sandro.

Complex dynamics in seagrass meadows in the Mediterranean Sea. Species interaction in a global warming scenario.
Sintes, T.; Llabrés, E.

The impact of highly-connected individuals in the evolution of an epidemic spreading with social-distance restrictions.
Alvarez-Zuzek, Lucila; Velásquez-Rojas, Fátima; Herrera-Diestra, José Luis

Using batteries for frequency control in power grids with renewable sources.
Ruzzene, Giulia; Gomila, Damià; Colet, Pere

Structure, resilience and evolution of the European Air Route Network from 2015 to 2018.
Esteve, Pau; Ramasco, Jose Javier; Zanin, Massimiliano

Modelling and dynamics of the CA1-CA3 circuit of the hippocampus.
Sánchez Claros, Jaime; Canals, Santiago; Mirasso, Claudio.

a.6.4 Seminars and talks in other research centers

Ultrafast photonic reservoir computing: From fundamental properties to real-world applications.
Online seminar for the Spanish Network of AI for Condensed Matter and Materials Science.
Soriano, Miguel Cornelles
March 13

De los circuitos neuronales a la Inteligencia Artificial.
Conferencia a alumnos de bachiller, colegio IES Madina Mayurqa.
Mirasso, Claudio
April 4

Modelling Parasite-Produced Marine Diseases: spatial vs non-spatial models.
Applied Math Seminar, Utah State University - Department of Mathematics and Statistics.
Giménez-Romero, Àlex
April 27

Non-Gaussian random matrices predict the stability of feasible Lotka-Volterra communities.
Université Paris Cité, France.
Galla, Tobias
May 31

Reservoir Computing with Quantum Systems.
Optics group of the University of Salamanca (USAL), Spain.
Martínez-Peña, Rodrigo
June 9

Quantum Stochastic Thermodynamics.
CQT Kwek group meeting. Centre for Quantum Technologies (Singapore).
Manzano, Gonzalo
July 26

Active and Passive cluster crystals.
Quantitative Life Sciences group, ICTP, Trieste, Italy.
López, Cristóbal
August 24

Implementations of Quantum Machine Learning and Reservoir Computing.
Summer School on Quantum Computing Theory and Implementations UIMP, Santander, Spain.
Zambrini, Roberta
September 5

a.7. Other Activities

a.7.1. Master Thesis

Functional networks of weather events propagation between airports
López Martín, Raúl (supervisor: Massimiliano Zanin)
December 12

Analysis and the Action Curve of Agent Zero: Theory and Simulation
Fried, Benjamin (supervisor: Maxi San Miguel)
October 24

Network-based measure of the finite size Lyapunov exponent
Antich Navarro, Joan (supervisors Enrico Ser-Giacomi and Cristobal Lopez)
October 22

Partisan voter model: noise-induced transitions
Llabrés Rubio,Jaume (Supervisors: Maxi San Miguel, Raúl Toral)
October 19

Network analysis of marine megafauna movement
Lina Estefanía Navarro Alvarado (J.P. Rodríguez; V.M. Eguíluz)
October 14

Epidemiological approach to tau propagation in Alzheimer's disease
Buenvarón Campo, Gorka (Advisors: Ramasco, José J.; Matias, Manuel A.; Ramos-Miguel, Alfredo)
October 13

Multilayer analysis of online social interactions
Ramos Fernández, José María (Advisor: Meloni, Sandro)
October 10

Deep learning applied to the analysis of dissolved carbon dioxide in coastal areas of the Balearic Sea
Tiwari, Akshay (Advisors: Matias, Manuel A.; Hendriks, Iris. E.)
October 5

The effects of coherence in quantum absorption refrigerators
Almanza Marrero, Jose Antonio; (Advisors: Manzano, Gonzalo; Zambrini, Roberta)
October 4

Sampling rare trajectories in stochastic systems
Sara Oliver Bonafoux (Supervisors: Raúl Toral, Tobias Galla)
October 1

Modeling preferences in language contact
Rosillo-Rodes, Pablo (advisors: Sánchez, David; San Miguel, Maxi)
September 26

In search of anticipated synchronization in the dentate gyrus
Chalkiadakis, Dimitrios (advisors: Claudio R. Mirasso and Panayiota Poirazi)
September 23

Creativity as a random walk search on a semantic network
Kyosovska, Nicoleta (advisors: Raúl Vicente and Víctor M. Eguíluz)
September 22

Effects of passive dendritic arborization on neuronal response in extended integrate and fire models
Jacopo Giorgi (Supervisor: Claudio R. MIrasso)
July 28

Generating functional analysis of Lotka-Volterra equations with Hebbian couplings
Rozas, Enrique (director: Galla, Tobias)
July 28

Precipitation sources and moisture transport in atmospheric rivers from a Lagrangian perspective
Crespo, Alfredo (Supervisors: Hernandez-Garcia, Emilio and Lopez, Cristobal)
July 27

Characterization of hypergraphs in ecological networks
Cebrián, Daniel (Advisors: P. Colet, L. Lacasa, V.M. Eguíluz)
July 26

Coevolution in Coordination Games
González-Casado, Miguel Angel. (Supervisors: Sanchez, Anxo; San Miguel, Maxi)
July 2

Analysis of the European air route network: properties, evolution and resilience
Esteve, Pau (Advisors: Massimiliano Zanin & Jose J. Ramasco)
June 14

Quantifying mobility responses to COVID-19 containment strategies in Spain
Cuevas Blanco, Mar (Advisor: Sandro Meloni)
June 7

Understanding the effects of COVID-19 on Financial Market Structures: A study of the USA & Brazil
Ola Megahed Ali (Advisor: Pere Colet)
April 13

Seagrass spatiotemporal dynamics with a time-dependent mortality
Mampel, Jorge (Advisors: Gomila, Damià; Ruiz-Reynés, Daniel)
April 8

a.7. 2. Research stays in other centers

Queen's University, Kingston, Ontario, Canada.
Collaboration with Bhavin Shastri.
Estébanez, Irene
March 1 to June 28

Allen Institute for Brain Science, Seattle, USA.
Galván Fraile, Javier
September 27 to December 13

IN3@UOC.
Visit to the group of Dr. Javier Borge Holthoefer and Dr. Albert Solé-Ribalta to work on problems at the interface of ecological and socio-technological systems.
Fernández-Gracia, Juan
March 1-31

ICTP, International Center for Theoretical Physics, Trieste, Italy.
López, Cristóbal
June 1 to Auguts 31

Department of Network and Data Science, Central European University, Vienna, Austria.
Collaboration with Marton Karsai.
Louf, Thomas
September 5 to December 22

ICTP, International Center for Theoretical Physics, Trieste, Italy.
Collaboration on stochastic thermodynamics.
Manzano, Gonzalo
Februray 7-11 and July 8-17.

Institute for Quantum Optics and Quantum Information, Vienna, Austria.
Manzano, Gonzalo
April 27-30

School of Engineering of HES-SO, Switzerland.
Collaboration with the group of Prof. Philippe Jacquod in Sion.
Martínez-Barbeito, María
August 22 to November 22

Gotham Lab, Zaragoza, Spain.
Meloni, Sandro
May 9-12

Liph lab, Department of Physics, University of Padova, Italy.
Meloni, Sandro; Arregui, Beatriz
November 27 to December 2

Rijksuniversiteit Groningen, Sweden.
Collaboration at the MINDS group lead by Herbert Jaeger.
Goldmann, Mirko
November 1 to January 31

Nanyang Technological University, Singapore.
Collaboration with prof. Juan-Pablo Ortega.
Martínez-Peña, Rodrigo
August 1 to October 31

a.8. Press and Media

The titles are linked to the document or media clip

a.8.1 Press and digital Media

Captar la diversitat de les societats multilingües
El Diari de la UIB
January 12

Descobreixen que la coexistència lingüística és possible en societats multilingües quan es facilita l'aprenentatge de la llengua en perill
Diari Balears
January 12

La UIB estudia las sociedades bilingües a través de la Física
Última Hora
EFE Servicios
January 12

Los bilingües actúan como reserva de las lenguas en peligro, según un estudio
Última Hora
Periódico de Ibiza y Formentera
January 13

La UIB estudia las sociedades bilingües a través de la Física
Menorca
January 13

La UIB aplica la Física al estudio de las sociedades bilingües
Diario de Mallorca
January 13

Investigadores del CSIC identifican qué países se encuentran en alto riesgo de congestión por basuras
CSIC
El Diari de la UIB
Agencia SINC
Retema
El Diario de León
El Boletín
El Imparcial
Epe
EFE Verde
Faro de Vigo
Diario de Ibiza
La Nueva España
Diario de Mallorca
Diario de Las Palmas
El Periódico Mediterráneo
Información
Siglo XXI
Europa Press
República
El Imparcial
Vox Populi
Yahoo! España
COPE
El Periódico de Cataluña
El Periódico
DICYT
Portal Ambiental
La Nota Antropológica
Entorno Inteligente
Enfoque Noticias
Minuto NQN
Kiratas
El Tiempo
Eco Avant
Yo Amo El Fútbol
21 Noticias
El Español
Eco Portal
Ojalá
Hecho en California
El Espectador
REDIB Informa
March 29

This is how waste is sent from rich countries to poor ones
Taketo News
Blaze Treds
The Canadian News
March 29

La gestión de residuos peligrosos pone en riesgo a ciudadanos de 28 países
RTVE
El País
Levante Mercantil Valenciano
Diario Abierto
La Sexta
Noticias De
Tecno Xplora
Sticj Noticias
La Vanguardia
Residuos Profesional
The Objective
Ambientum
Ámbito
Impulso Negocios
Público
March 29

Los países del mundo que acumulan más residuos peligrosos
National Geographic
March 29

Environment: Assessing the world-wide hazardous waste web
Nature Asia
March 30

Welcome to the worldwide waste web
Cosmos
Phys
March 30

Los aprendices de periodista que salvarán la posidonia
Diario de Mallorca
April 7

Un análisis de la red mundial de residuos revela dónde se acumulan los más peligrosos
Muy Interesante
April 11

¿Aumentan las renovables el riesgo de apagones en la red eléctrica?
The Conversation.
April 18

El Chernóbil que puede crear la guerra de Putin en suelo ucraniano: 'ecocidios' y décadas de recuperación
El Español
April 20

Conoce al jurado de la II Edición de los Premios Internacionales de Movilidad
FuturEnergy
May 03

El CSIC crea AIHUB.CSIC, una plataforma para potenciar la investigación en inteligencia artificial
CSIC
May 03

El Govern recurre a miles de cuentas de Twitter para calcular la población flotante
Periódico de Ibiza y Formentera
Última Hora
May 04

Government tracking floating population via twitter
Majorca Daily Bulletin
May 04

Los países del mundo que acumulan más residuos peligrosos
Expreso de Tuxupan
May 04

La física estadística rechaza la teoría de las dos Ucranias
EFE
La Vanguardia
Yahoo! España
República
COPE
El Diario
15 Minutos
El Periódico de México
May 24

Los primeros dos investigadores del campus con la beca más competitiva de Europa
Diario de Mallorca
June 22

Cerebros artificiales llenos de luciérnagas ultrarrápidas
CSIC
July 14

Una beca millonaria para buscar una solución a los retrasos aéreos
Diario de Mallorca
August 16

Wie ein Wissenschaftler auf Mallorca Flugverspätungen ein
Ende setzen will
Mallorca Zeitung
August 28

Inaugurada l'escola d'estiu en Física Estadística
El diari de la UIB
August 28
La UIB inaugura la escuela de verano en Física Estadística de la Real Sociedad Española de Física
Diario de Mallorca
August 30

Un equipo del CSIC identifica la tendencia de acidificación del Mar Balear a través de inteligencia artificial
Europa Press
NoticiasDe
Gente Digital
EFE Verde
COPE
Menorca.info
Humanidad y Medio
September 9

El mar de Baleares se acidifica
Menorca Al Día
September 9

Un equip del CSIC detecta la tendencia d'acidificació de la mar Balear a través d'intel·ligència artificial
Ara Balears
September 9

Un estudio del CSIC detecta tendencia de acidificación del mar en Baleares
Yahoo! España
September 9

Un equipo del CSIC identifica la tendencia de acidificación del Mar Balear a través de inteligencia artificial
La Vanguardia
September 9

CSIC-Studie stellt Trend zur "Versauerung des Meeres" vor
Mallorca fest
Mallorca Services
September 10

El CO2 y el incremento de temperatura disminuyen la acidez del Mar Balear
Última Hora
Periódico de Ibiza y Formentera
September 10

El CSIC consigue identificar la acidificación del Mar Balear
Diario de Mallorca
September 10

Versauerung des Meeres vor Mallorca
Mallorca OK!
September 11

IMEDEA, IFISC, SOCIB e IIM estudian con Inteligencia Artificial la acidez del mar, su impacto climático y en biodiversidad
Salut i Força
September 12

Intel·ligència artificial per identificar la tendència d'acidificació de la mar balear
El Diari de la UIB
September 12

El CSIC determina la tendencia de descenso de acidificación del mar Balear con inteligencia artificial
Industrias Pesqueras
September 12

Modelar l'epidèmia mortal de nacres «Pinna nobilis»
El Diari de la UIB
September 13

El IFISC desarrolla un modelo para entender las epidemias marinas
Última Hora
September 13

Identificando la tendencia de acidificación del mar Balear a través de técnicas de inteligencia artificial
AIHub
September 13
El aumento de la temperatura disminuye el pH de la costa balear
Pasión por el Mar
Nova Ciencia
September 14

Armengol asiste al estreno del show 'La resistencia científica' en el CaixaForum Palma
Europa Press
La Vanguardia
Noticias De
Gente Digital
Diario de Mallorca
Noticias Mallorca
September 26

Casi 300 científicos del CSIC presentan en València los últimos avances sobre la covid-19
Levante El Mercantil Valenciano
October 4

Professional Feature - Ernesto Estrada
DS Web
October 29

Ocho centros del CSIC reciben las distinciones de excelencia Severo Ochoa y María de Maeztu
CSIC
NoticiasDe
Europa Press
Stick Noticias
Siglo XXI
Nova Ciencia
November 7

L'IFISC i l'IMEDEA, reconeguts per la seva excel·lència investigadora
El Diari de la UIB
Diari de Balears
Fora Vila
Salud Ediciones
CSIC Balears
November 11

Baleares: Airbnb quita a los residentes un 37% de la oferta de viviendas
Preferente
December 17

a.8.2 Radio and TV

Societats multilingües
El Replà, IB3 Ràdio
January 12

El flujo mundial de basuras
Principio de Incertidumbre, Canal Extremadura
April 9

La World Wide Waste Web
La Gran Vida, IB3 Ràdio
April 10

Ernesto Estrada: "Los residuos tóxicos, bien gestionados, pueden ser una fuente de riqueza"
EITB
April 13

El superordinador Nuredduna
Cinc Dies, IB3 TV
April 28

Tertulia de divulgación y presentación de 'La Resistència Científica'
Entre avui i demà, IB3 Ràdio
September 16

La Resistència Científica
Tèntol, IB3 Ràdio
September 23

Humor I divulgació a 'La Resistència Científica'
Notícies, IB3 TV
September 26

'La Resistència Científica', una mostra vespertina sobre ciència
El Temps, IB3 TV
September 28