Student's Presentations

Monday 12, 15:00-16:36. NETWORKS

15:00-15:10 Enys Mones, Eötvös Loránd University, Hungary
Measuring the Extent of Hierarchy in Complex Networks
Enys Mones and Tamás Vicsek
Department of Biophysics, Eötvös University, Hungary
ABSTRACT: Many of the biological, social and technical networks show hierarchical properties, i.e. the roles of interacting elements are not equal: there are superior and inferior vertices depending on the functions and paths of them. These findings suggest that hierarchy is a significant and essential feature of natural and human-made networks, yet we still lack of a proper measure for hierarchy that fulfills some reasonably conditions (be able to used for both directed and undirected graphs, do not contain ambiguous parameter, etc.). In this presentation we propose a measure that is natural and grabs the essence of hierarchy. We also present the results with real networks.

15:12-15:22 Joaquín Sanz, University of Zaragoza, Spain
Data reliability in complex directed networks
Joaquín Sanz, Emanuele Cozzo and Yamir Moreno
Institute for Biocomputation and Physics of Complex Systems (BIFI) and Departamento de Física Teórica, Universidad de Zaragoza
ABSTRACT: Within every area in which networks theory comes developing its applications program during the last decade, quantification of experimental data reliability constitutes a fundamental concern. So, from Biology to Sociology and Economy, identification of false and missing positives in very diverse kind of experiments is a classical problem that, consequently, has been daily faced within the context of the historical development of each isolated discipline. The new and complementary approach of network theory to this problem consists on questioning the reliability of single elements in a networked system according to its topological context inside the whole network, rather than to internal, specific details associated to the single element and the experimental framework it comes from. This kind of approach -that can be generally applied to very different fields to test the reliability of data associated to very different kind of experiments- has been used to generate several models of data reliability determination, most of them developed for analyzing the base case of unweighted, undirected networks. In this work we extend one of the newest, best performing models -by Guimerá and Sales-Pardo in 2009- to directed networks. The new model is able to identify missing and spurious directed interactions; which rends it particularly useful to analyze data reliability in systems like trophic webs, gene regulatory networks or certain directed communication patterns and social systems.

15:24-15:34 Luce Prignano, University of Barcelona, Spain
Extracting topological features from dynamical measures in networks of Kuramoto oscillators
Luce Prignano and Albert Diaz Guilera
Department of Fundamental Physics, Barcelona University, 08028 Barcelona, Spain
ABSTRACT: Not Available.

15:36-15:46 Emanuele Cozzo, BIFI, Spain
Dynamical Simulations on TB Regulatory Network
Emanuele Cozzo and Yamir Moreno
Institute for Biocomputation and Physics of Complex Systems (BIFI), Universidad de Zaragoza. Spain
ABSTRACT: Not Available.

15:48-15:58 Pablo Fleurquin, IFISC (UIB-CSIC), Spain
Study of delay propagation and optimization of flux of passengers of the European air-traffic network.
José Javier Ramasco, Victor M. Eguiluz and Pablo Fleurquin
Instituto de Física Interdisciplinar y Sistemas Complejos, IFISC (CSIC-UIB), Campus Universitat Illes Balears, 07122 Palma de Mallorca, Spain
ABSTRACT: Not Available.

16:00-16:10 Arnau Gavalda, Universitat Rovira i Virgili, Spain
Human Dynamics in the Internet
Arnau Gavalda, Jordi Duch, and Roger Guimera
SEES:lab and PhysComp2, Universitat Rovira i Virgili, Spain.
ABSTRACT: Not Available.

16:12-16:22 Jose Luis Herrera Diestra, Universidad de Los Andes, Venezuela
General Coevolution of Topology and Dynamics in Networks
J.L. Herrera, M.G. Cosenza, K. Tucci and J.C. Gonzalez-Avella
Centro de Física Fundamental,Universidad de Los Andes, Venezuela
ABSTRACT: Not Available.

16:24-16:34 Hans Hooyberghs, KU Leuven, Belgium
Criterion for Explosive Percolation Transitions on Complex Networks
H. Hooyberghs and B. Van Schaeybroeck
Institute of Theoretical Physics, Katholieke Universiteit Leuven, Belgium
ABSTRACT: The percolation problem, which deals with the structure and connectivity of a network as certain of its nodes or edges are removed, is one of the most widely studied second order phase transitions in network theory. Recently, Achlioptas et al. have discovered a new class of percolation transitions. In the so-called explosive percolation, the width of the transition vanishes in the thermodynamical limit. Based on the number of clusters in the network at the onset of the phase transition, we present theoretical insights and a criterion for the occurrence of explosive transitions. Simulations and analytical calculations on various models support our findings.

Monday 12, 17:00-18:00: GRANULAR MEDIA & TRANSPORT

17:00-17:10 Jose Alberto de la Cruz Damas, University of Navarra, Spain
Collective Phase Transition in Granular Media
José Damas, Herve Caps and Diego Maza
Departamento de Física y Matemática Aplicada, Universidad de Navarra, Spain
ABSTRACT: We studied the collective behavior of a granular media in a rotating cell with a fixed angular velocity. For different number of particles (5-200 with a delta of 10) we performed a particle tracking in order to find the behavior of every particle, using a high speed camera.

17:12-17:22 Celia Lozano Grijalba, Universidad de Navarra, Spain
Experimental Analysis of the Stability of Arches
C. Lozano, I. Zuriguel, A. Garcimartín and G. Lumay
Departamento de Física y Matemática Aplicada, Universidad de Navarra, Spain
ABSTRACT: One of their most salient features of the granular materials is the formation of bridges. A bridge, or arch, is a stable collective structure comprising several grains that can withstand the weight above them. Those bridges can cause the jamming of grains in a fixed configuration that is mechanically stable. Previous studies had addressed the question of arch formation and breaking under vibration, in a three dimensional silo [1]. There are also experimental results on the shape of arches that block the outlet of a two-dimensional silo. [2]. In this work I study the stability of the arches formed in a 2D silo when submitted to a controlled vibration. I will try to establish a relationship between the shape of the arch and its stability. To do this, we designed and built an automated mechanical device, along with the measurement system and the software required to analyze the data. The first results we obtained show a relationship between the stability of an arch and the existence of defects in it. A defect is a particle that hangs from its neighbours at an angle greater than 180 º.
[1] C. Mankoc, A. Garcimartín, I.Zuriguel, D. Maza, Luis A. Pugnaloni, .Phys. Rev. E **80**, 011309 (2009).
[2] A. Garcimartín, I.Zuriguel, Luis A. Pugnaloni, A.Janda, Phys. Rev. E **82**, 031306 (2010).

17:24-17:34 Steffen Martens, Humboldt-Universität zu Berlin, Germany

Biased Brownian Motion in Confined Geometries

S. Martens[1], G. Schmid[2], L. Schimansky-Geier[1], and P. Hänggi[2]

1. Humboldt-Universität zu Berlin, Department of Physics, Newtonstr. 15, 12489 Berlin, Germany

2. Department of Physics, Universität Augsburg, Universitätsstr. 1, D-86135 Augsburg, Germany

ABSTRACT: Diffusive transport of particles or, more generally, small objects, is a ubiquitous feature of physical and chemical reaction systems. In microsized geometries with confining walls and constrictions, transport is controlled both by the fluctuations of the jittering objects and the phase space available to their dynamics. For particles moving in static suspension media enclosed by confining geometries and driven by a constant external force, transport exhibits intriguing features such as 1) a decrease in nonlinear mobility with increasing temperature and 2) a broad excess peak of the effective diffusion coefficient above the free diffusion limit. These paradoxical aspects can be understood in terms of entropic contributions resulting from the restricted dynamics in phase space. Assuming instantaneous equilibration in orthogonal channel directions allows for a reduction of the dimensionality of the transport in 2D or 3D channels - the Fick-Jacobs (FJ) approach [R. Zwanzig, J. Chem. Phys., **96**, 3926 (1992)]. Within the resulting 1D kinetic equation the bottlenecks account for entropic potential barriers which the particles have to overcome in order to proceed. In this presentation I will demonstrate that this approach is only valid for smoothly modulated channel geometries [S. Martens et. al., Phys. Rev. E **83**, 051135 (2011), S. Martens et al., arXiv:1108.4374 (2011)].

17:36-17:46 Biagio Nigro, Ecole Polytechnique Fédérale de Lausanne, Switzerland

Transport properties of conductor-insulator composites

Biagio Nigro

Laboratoire de Production Microtechnique, Ecole Polytechnique Fédérale de Lausanne, Switzerland.

ABSTRACT: Not available.

17:48-17:58 Marcela Reale, Universidad Nacional de General Sarmiento, Argentina

Transport properties and current inversion by white Gaussian noise in a coupled ratchet model

A.J. Fendrik[1,2], M. Reale[1,2] and L. Romanelli[1,2]

1. Instituto de Ciencias, Universidad Nacional de General Sarmiento, Argentina

2. Consejo Nacional de Investigaciones Científicas y Técnicas, Argentina

ABSTRACT: We have found, by varying two parameters, several stationary trajectories in a system consisting in many elastically coupled particles that are placed in a periodic ratchet potential on a ring. The system is assumed to be over-damped and driven by an external potential that is periodic both in space and time. The transport properties of these orbits are quite different and their values are quantified. The symmetries allows to study the orbits with and without the presence of thermal fluctuations and it is found current inversions due to the addition of white Gaussian noise.

Tuesday 13, 15:00-16:36. REACTION-DIFFUSION SYSTEMS, PHASE TRANSITIONS, ADVANCED METHODS & APPLICATIONS.

15:00-15:10 Darío Martin Escala, Universidad Santiago de Compostela, Spain

Changes in Buoyancy-driven Instabilities in Reaction-Diffusion-Advection System

Darío Martín Escala, Jacobo Guiu-Souto, Jorge Carballido-Landeira and Alberto Pérez Muñuzuri

Non Linear Physics Group. University of Santiago de Compostela. Faculty of Physics. 15782 Santiago de Compostela, Spain

ABSTRACT: At the interface generated in the mixing of miscible fluids, instabilities can displayed by the difference between the fluids densities and diffusion coefficients. These instabilities generate characteristic patterns that affect the mass transport between the two species. BZ reaction (Belousov-Zhabotinsky) is a chemical reaction where, due to the autocatalysis of its intermediaries and the difference between diffusion coefficients of the same, are generated chemical oscillations and waves that result in pattern formation when the reaction is carried out in two-dimensional media. The aim of this study is to analyze the influence of reaction diffusion on the instabilities caused by the contact of two fluids of different density and diffusion coefficient. The mathematical models involved in these phenomena are solved using numerical methods such as finite differences or finite volumes.

15:12-15:22 Ricardo Martínez García, IFISC (UIB-CSIC), Spain
Temporal Griffiths Phases.
Ricardo Martinez-Garcia[1], Federico Vázquez[2], Juan A. Bonachela[2], Cristóbal López[1] and M.A. Muñoz[3].
1. Instituto de Física Interdisciplinar y Sistemas Complejos, IFISC (CSIC-UIB), Campus Universitat Illes Balears, 07122 Palma de Mallorca, Spain
2. Max-Planck-Institüt für Komplexer System, Germany
3. Dept. of Ecology and Evolutionary Biology. Princeton University, USA.
4. Departamento de Electromagnetismo y Física de la Materia, and Instituto Carlos I de Física Teórica y Computacional, Universidad de Granada, Spain
ABSTRACT: Systems with two symmetric absorbing states are known to exhibit a variety of phase transitions from an active state to an absorbing one depending on the value of the control parameter. In this work, the effect on each phase transition of having a stochastic time dependent control parameter is investigated. The critical behavior is shown to change for dimensions higher than a critical one. Furthermore, a subregion in the active phase where the extinction time scales algebraically with the size of the system and measurable quantities such as the magnetic susceptibility diverge, appears. This region is called Temporal Griffiths Phases because of its phenomenological similarities with the Grifftiths Phases in systems with spatial disorder.

15:24-15:34 Vili Heinonen, Aalto University, Finland
Elasticity in Phase Field Crystal Models
V. Heinonen, C. Achim, K. Elder and T. Ala-Nissilä
Department of Applied Physics, Aalto University, Findland; Department of Physics, Oakland University, Rochester, MI, USA.
ABSTRACT: Phase Field Crystal (PFC) models and their amplitude expansions are a novel attempt to bridge the gap between atomistic and continuum models in materials modeling. The studied quantity is the atomic density field that varies in time and space. Not only do these new models allow longer length scales but also longer time scales: the interesting phenomena happen over diffusive time scales that are beyond the reach of classical molecular dynamics or Monte Carlo methods. Elastic vibrations are coarse-grained from the system leaving only the slower phenomena of diffusive time scales. The problem that arises here is that in order to keep the model self-consistent, the system under study needs to be at elastic equilibrium at all times (elastic vibrations die out immediately). In recent research it is shown that indeed the linear elastic equilibrium can be ensured by forcing certain rules for the evolution of the atomic density field. In this talk the PFC models will be shortly introduced and this result is presented and discussed.

15:36-15:46 Ángel M. Núñez, Universidad Politécnica de Madrid, Spain
Visibility algorithms as a method of mapping time series into graphs
Lucas Lacasa and Ángel M. Núñez
Applied Mathematics Department, Aerospace Engineering, Universidad Politècnica de Madrid, Spain.
ABSTRACT: Not available.

15:48-15:58 Aldo Di Biasio, Università di Parma, Italy
Interpolating Techniques in Statistical Physics
Aldo Di Biasio
Dipartimento di Fisica, Università di Parma, Viale G.P. Usberti, 7a, 43124 Parma, Italy
ABSTRACT: Most of the rigorous results in the mean-field spin glass model, such as convergence of the free energy and correctness of the Parisi ansatz, have been achieved in recent years through interpolating techniques which use a generalized partition function, depending on auxiliary parameters. I will give an introduction to this topic by showing how things work in the simple Curie-Weiss model, and then show the first step of replica symmetry breaking in the the mean-field spin glass model.

16:00-16:10 Anna Deluca, Centre de Recerca Matemàtica, Spain
Universality of Rain Event Size Distributions
Anna Deluca and Alvaro Corral
Centre de Recerca Matemàtica, Campus de Bellaterra, Edifici C, 08193 Bellaterra, Spain
ABSTRACT: Not available.

16:12-16:22 Barbara Fresch, University of Liege, Belgium

Kinetic Model for Transient Current Spectroscopy on Single Dopant Devices and its Potential for Quasiclassical Parallel Computing

Barbara Fresch and Francoise Remacle

Laboratoire de Chimie Physique Théorique, Université de Liège, Belgique

ABSTRACT: The design and building of physical systems capable of performing complex logic functions at the nanometric and molecular scales introduced new concepts in chemistry and opened the way to innovative applications in the fields of intelligent sensing, communication technology and molecular logic. We shall consider a single dopant atom addressed by a potential drop between the source and the drain electrodes and gated from the top by a third electrode which can be used to apply a gate potential. Such a device can act as a single electron transistor (SET). Our approach is that of exploiting the inherent complexity of the structure and the dynamics of this physical system to perform entire logic operations on the single device. In other words a SET is not used here as a simple switch, instead we take advantage of the complexity of a physically based analytical SET model in order to implement a complex logical task without the necessity of networking many switches. The selected application of this paradigm consists in the solution of the logical problem of identifying one of four alternatives by a single query of an Oracle [1]. The example is to single out one of the four Boolean functions of a single variable. The algorithm uses quasi-classical logic [2] that operates on the occupancy of the energy levels of a dopant atom but not on the phase. Parallelism arises from the possibility of implementing a mixed initial state in the kinetic scheme used to describe incoherent electron transport through the transistor driven by a pulsed gate voltage.

[1] D. Deutsch and R. Jozsa, Proc. R. Soc. Lond. A **439**, 553 (1992).

[2] F. Remacle and R. D. Levine Proc. Natl. Acad. Sci. U.S.A. **101**, 12091 (2004).

16:24-16:34 Sela Samin, Ben-Gurion University of the Negev, Israel

Attraction Between Like-Charge Colloids in Polar Mixtures

Sela Samin and Yoav Tsori

Chemical Enginnering, Ben Gurion University of the Negev, Beer-Sheva 84105, Israel.

ABSTRACT: We examine the force between two similarly charged colloids immersed in an aqueous mixture near the coexistence curve. When the distance between the colloids is decreased, dielectrophoretic and solvation-related forces promote the condensation of a water-rich phase from an initially water-poor phase, at a distance in the range 1-100nm. At this distance the osmotic pressure can become negative leading to a strong long-range attraction between the colloids. When distance between the colloids is further decreased, the osmotic pressure vanishes, representing a very deep metastable or globally stable energetic state. We give analytical and numerical results for this transition on the Poisson-Boltzmann level. The mechanism we describe may be relevant to the attraction seen between colloids and surfaces in critical mixtures and attributed to the critical Casimir force. It should also be at play in the reversible aggregation of colloids in mixtures near the coexistence curve.

Tuesday 13, 17:00-18:00. NON-LINEAR DYNAMICS, DELAY & NOISE

17:00-17:10 Luis Lafuerza, IFISC (UIB-CSIC), Spain

Role of Delay in the Stochastic Birth and Death Process

Luis F. Lafuerza and Raul Toral

Instituto de Física Interdisciplinar y Sistemas Complejos, IFISC (CSIC-UIB), Campus Universitat Illes Balears, 07122 Palma de Mallorca, Spain

ABSTRACT: We consider simple birth and death processes in which creation and degradation reactions are initiated stochastically but may take a finite time to be completed (delay). We show that when the delay is present in the creation reaction, and the creation rate depends on the state of the system (feedback), the fluctuations may be amplified or dampened as the delay is increased, depending on the sign of the feedback. When the delay is present in the degradation, the system has always Ppoissonian character.

17:12-17:22 Jade Martínez Llinàs, IFISC (UIB-CSIC), Spain

Synchronization in delayed mutually coupled optoelectronic oscillators

Jade Martínez-Llinàs and Pere Colet

Instituto de Física Interdisciplinar y Sistemas Complejos, IFISC (CSIC-UIB), Campus Universitat Illes Balears, 07122 Palma de Mallorca, Spain

ABSTRACT: In this work we study the synchronization between two delayed mutually coupled optoelectronic oscillators. In particular, we consider the interplay of the different delays in achieving synchronized behaviour. The cross-correlation coefficient is computed as a parameter of order to characterize the synchronization. In the limit

of low coupling strengths, we find multiple periodic solutions completely synchronized in antiphase for specific ratios between the coupling and self-feedback delays. Increasing the coupling leads to less synchronized states such as chaotic breathers. Finally, the chaotic regime exhibits lag synchronization with cross-correlation coefficients higher than 0.99.

17:24-17:34 Jordi Zamora Munt, Universitat Politècnica de Catalunya, Spain
Crowd synchrony in semiconductor lasers with time delay
Jordi Zamora-Munt[1], Cristina Masoller[1], Jordi Garcia-Ojalvo[1], and Rajarshi Roy[2]
1. Universitat Politècnica de Catalunya, Spain
2. University of Maryland, USA
ABSTRACT: Crowd synchrony and quorum sensing arise when a large number of dynamical elements communicate with each other via a common information pool. Previous evidence in different fields, including chemistry, biology and civil engineering, has shown that this type of coupling leads to synchronization, when coupling is instantaneous and the number of coupled elements is large enough. Here we consider a situation in which the transmission of information between the system components and the coupling pool is not instantaneous. We model a system of semiconductor lasers optically coupled to a central laser with a delay. Our results show that, even though the lasers are nonidentical due to their distinct optical frequencies, zero-lag synchronization arises. By changing a system parameter, we can switch between two different types of synchronization transition.

17:36-17:46 Maria Moreno, IFISC (UIB-CSIC), Spain
Tuning Quantum Correlations with Intracavity Photonic Crystals
Maria M. de Castro[1], Miguel Angel García-March[2], Damià Gomila[1] and Roberta Zambrini[1].
1. Instituto de Física Interdisciplinar y Sistemas Complejos, IFISC (CSIC-UIB), Campus Universitat Illes Balears, 07122 Palma de Mallorca, Spain
2. Department of Physics, Colorado school of Mines, golden, CO, 80401, USA.
ABSTRACT: We show how to tune quantum noise in nonlinear systems by means of periodic spatial modulation. We prove that the introduction of an intracavity photonic crystal in a multimode optical parametric oscillator inhibits and enhances light quantum fluctuations. Furthermore, it leads to a significant noise reduction in field quadratures, robustness of squeezing in a wider angular range, and spatial entanglement. These results have potential benefitss for quantum imaging, metrology, and quantum information applications and suggest a control mechanism offlfluctuations by spatial modulation of interest also in other nonlinear systems.

17:48-17:58 Neus Oliver, IFISC (UIB-CSIC), Spain
Fast random bit generation using chaotic semiconductor laser dynamics
N. Oliver, M. C. Soriano, D. Sukow and I. Fischer
Instituto de Física Interdisciplinar y Sistemas Complejos, IFISC (CSIC-UIB), Campus Universitat Illes Balears, 07122 Palma de Mallorca, Spain
ABSTRACT: Not available.

Monday 19, 15:00-16:24. BIOLOGICAL SYSTEMS

15:00-15:10 Claudio Borile, Università degli studi di Padova, Italy
Statistical Physics Based Methods in Genetics: Identifying Subspecies Among Clonal Organisms
C. Borile, M. Labarre, S. Franz, C. Sola and G. Refregier
Univ. di Padova, Italy and Univ. Paris-Sud 11, France
ABSTRACT: Not Available.

15:12-15:22 Maria D Correa Rodríguez, National Institute of Genomic Medicine, Mexico
Memory Functions and Non-equilibrium Thermodynamics of Gene Transcription
Maria D. Correa-Rodríguez
National Institute of Genomic Medicine, Mexico and UNAM, Mexico.
ABSTRACT: Not Available.

15:24-15:34 David Frigola, University of Barcelona, Spain

Asymmetric Stochastic Switching Driven by Intrinsic Fluctuations in Autoactivating Genetic Circuits.

David Frigola, Laura Casanellas, José María Sancho and Marta Ibañes

Dept. Estructura i Constituents de la Materia, Universitat de Barcelona, Spain

ABSTRACT: In living cells, the interaction between different genes sets genetic circuits, which can show multistable dynamics. Genes can become functional when they are expressed in terms of proteins through a series of steps involving different molecules. These molecules are found in low copy numbers in cells, which drives stochastic gene expression. For multistable genetic circuits, these intrinsic fluctuations can enable stochastic switching between states, eliciting variability in the cellular response to identical external conditions. Through Master, Fokker-Planck and Langevin equations, we studied the role of intrinsic fluctuations in stochastic switching in a genetic circuit composed of a single gene that self-activates. We show that in this circuit the intrinsic fluctuations, which are inherently state-dependent, drive asymmetric switching. This asymmetry is consistent with experimental measurements previously performed on a genetic network in yeast. Our study unravels that intrinsic fluctuations are fundamental to understand stochastic switching and the stability of multiple states, highlighting the importance of properly accounted for noise in some biological contexts.

15:36-15:46 Oriol Güell, Universitat de Barcelona, Spain

Complex Networks of Molecular Interactions in the Cell: from Structure to Function

Oriol Güell Riera, Francesc Sagués and M. Àngels Serrano

Departament de Química Física, Universitat de Barcelona, Spain

ABSTRACT: Biological systems are intricate and thus amenable to be modeled using complex networks. In particular, metabolic networks show characteristic features, such as scale-free degree distributions or the small world property, and have been found to be robust at the topological level. Here, we study the topological robustness of the metabolic network of Mycoplasma Pneumoniae, which is a human pathogen that causes atypical pneumonia and that has been recently proposed as a new model organism for bacterial and archaeal systems biology. We measure the effects of single and pair reactions failures using a cascade algorithm that gives an idea of the resistance of this organism to external factors, and we compare the results with those for E. coli. Moreover, the failure of reactions can be related with knockout of genes, which allows us to study the response of the network to knockouts of clusters of coexpressed genes. We find that genes related to reactions that yield higher damages are always functionally essential.

15:48-15:58 Jorge Hidalgo, Universidad de Granada, Spain

Stochastic Amplification in UP and Down States

Jorge Hidalgo, Luís F. Seoane and Miguel A. Muñoz

Departamento de Electromagnetismo y Física de la Materia, and Instituto Carlos I de Física Teórica y Computacional, Universidad de Granada, Spain

ABSTRACT: Mathematical models can explain a variety of patterns in the brain. Some of the most relevant are the so-called UP/DOWN oscillations, where high-activity periods alternate with quiescent intervals. It is important to understand them well, because they are related to fundamental processes as working memory, attention and memory consolidation. We investigate the fluctuations around both UP and DOWN states, which seem to be describable by means of white noise. For this, we simulate numerically a network of excitatory leaky-integrate-and-fire neurons with depression. Also, a mean-field theory can be developed to analyze the power-spectrum of fluctuations. Surprisingly, a characteristic frequency is found, and a resonant-like phenomenon arises: this is the Stochastic Amplification.

16:00-16:10 Ignacio A. Martínez Sánchez, Institute of Photonics Sciences, Spain

New Results in Biophysics and Statistical Mechanics Obtained with Optical Trapping Technique

Ignacio A. Martínez, Saurabh Raj, Juan Manuel R. Parrondo and Dmitri Petrov

ICFO -- The Institute of Photonic Sciences, Castelldefels (Barcelona), Spain, Universidad Complutense de Madrid, Spain, and ICREA - Institucio Catalana de Recerca i Estudis Avancats, Barcelona, Spain

ABSTRACT: For last twenty years the optical tweezers technique has been a fundamental tool to study several topics in biophysics and statistical mechanics. Here, we demonstrate experimental results recently obtained at the group of Optical Tweezers at ICFO, namely 1. the observation of colored noise components in a motion of a single DNA molecule that is anchored between two optically trapped dielectric beads, or between an optically trapped bead and a surface; and 2. the study of the motion of a microsphere in an optical trapping potential when an additional (to the inherit thermal noise) random force perturbs the Brownian motion of the sphere. In the case of the DNA experiments, we studied the power spectral density of the position fluctuations of the optically trapped beads connected to a single DNA molecule for different extensions of the molecule and then we compared the

results with those obtained from the same bead without the molecule attached. Our experiments showed that the fluctuations of the DNA molecule extended up to 80% by a force of 3 pN have the colored noise spectra proportional to f-a with a=0.75 and f is the frequency. In another set of experiments, we trapped optically a polystyrene sphere between two metal electrodes. Due to the intrinsic electrical charge of colloidal particles, it is possible to perturb the Brownian motion of the trapped sphere applying electrical signals of different power spectral densities. In particular, we studied the motion of the sphere in the presence of noisy signals with Ornstein-Uhlenbeck, white and blue spectra. Responses of the sphere showed an increment of the virtual temperature of the system in the case of colored noise, and a decrease of the temperature in the case of a sine signal with a frequency of around one over the characteristic time of the sphere motion in a viscous medium. Thermodynamics parameters the sphere motion corresponding to each noise spectra are also calculated.

16:12-16:22 Marco Leoni, University of Bristol, United Kingdom
Swimmers in Thin Films: From Swarming to Hydrodynamic Instabilities
M. Leoni, T. B. Liverpool
Department of Mathematics, University of Bristol, United Kingdom
ABSTRACT: Self propelling particles [1] constitute an intriguing realization of soft active systems. Here microscopic constituents can drive themselves mechanically by the uptake of energy and show a rich variety of collective behavior, including dynamical order-disorder transitions and pattern formation on various scales. Biology provides us with an important example: collective phenomena are observed for in- stance when a large number of microorganisms swim together in biological fluids and show an high level of organization in ordered structures [2, 3]; Another important example is given by artificial swimmers driven chemically [4]. Motivated by this we investigate analytically the existence of a macroscopically ordered phase in systems of mechanical swimmers with only hydrodynamic coupling using methods from non-equilibrium statistical mechanics.
[1] Vicsek, T. et. al., Phys. Rev. Lett. **75**, 1226–1229 (1995).
[2] Wu, X.-L. and Libchaber, A. , Phys. Rev. Lett. **84**, 3017–3020 (2000).
[3] Riedel, I. H. and Kruse, K. and Howard, J., Science **309**, 300-3 (2005).
[4] Paxton, W. F. et. al., J. Am. Chem. Soc. **126**, 13424 (2004).

Monday 19, 16:50-18:02 SOCIAL SYSTEMS

16:50-17:00 Adrián Carro Patiño, Université Pierre et Marie Curie, France
Sustainable Development & Spatial Inhomogeneities: The Role of Transportation Costs
Adrián Carro Patiño (adviser: Gérard Weisbuch)
Université Pierre et Marie Curie, France
ABSTRACT: Statistical physics describes the complex phenomena observed in many physical systems in terms of their simple basic constituents and simple interaction laws. Throughout the second half the twentieth century this approach has also proven to be a fruitful framework to describe phenomena outside the traditional realm of physics. Thus, recent years have witnessed an attempt by physicist to study collective behaviors emerging from the interactions of individuals as elementary units in social and economic structures. In this context, agent-based modeling (ABM) has been applied to economics in order to develop a computational study of economies modeled as evolving systems of autonomous interacting agents. We here describe a multi-agent model of sustainable economy (limited supply of resources) in order to figure out the consequences of technical choices, like transportation costs or market mechanisms, on wealth distribution among regions.

17:02-17:12 Ignacio Gomez Portillo, Universidad Autónoma de Barcelona, Spain
Emergence of Cooperation
Ignacio Gomez Portillo
Grupo de Física estadística, Universidad Autónoma de Barcelona, Spain
ABSTRACT: Cooperation is ubiquitous in biological systems. Cells work together to form multicellular organisms. Multicellular organisms work together to form hives, anthills, human society, etc. Cooperation supposes an evolutionary transition from isolated individuals to groups, forming increasingly more complex biological structures. Understanding how this transition arises within the framework of Darwinian theory, is a big conceptual challenge that has received much attention. We explore a minimal model without strategic complexity that promote cooperation in growing systems. First we find the conditions to form cooperative systems under strong natural selection. In particular we show that a triad of cooperators is the minimal structure that can promotes cooperation when a defector joins. Then, we generalize the model to other growth mechanisms and selection intensities, showing a phase transition from non-cooperative to cooperative system depending on the ratio between the benefit provided by a cooperator and the cost to cooperate. This allows us to conclude that, when new individuals initially

make few links with respect to the already existing individuals, it is necessary a high enough cost-benefit ratio and a small initial structure of cooperators to ensure a cooperative growing system of any size and topology.

17:14-17:24 Mario Gutiérrez Roig, Universitat de Barcelona, Spain
Scaling Properties and Universality of First-Passage Time Probabilities in Financial Markets.
Josep Perelló, Mario Gutiérrez-Roig and Jaume Masoliver
Departament de Física Fonamental, Universitat de Barcelona, Spain
ABSTRACT: Not Available.

17:26-17:36 Gerardo Iñiguez González, Aalto University, Finland
Adaptive Social Networks: From Opinion Formation to the Spread of Scientific Information
Gerardo Iñiguez, Julia Tagüeña, Kimmo K. Kaski and Rafael A. Barrio
BECS, Aalto University, Finland; Instituto de Energía, UNAM, Mexico; and Instituto de Física, UNAM, Mexico
ABSTRACT: Social networks are everywhere. They are present in our day-to-day activities, greatly shaping our interactions with other people, how we make up our mind about a controversial topic, and even the amount and kind of information we receive from media. Such networks are not static but adaptive: a dynamical process channeled through them usually affects their topology, which in turn regulates how the process changes in time. We have modeled this co-evolution of structure and dynamics in social networks as having two characteristic time scales, whose separation promotes self-organization and the emergence of social communities. We discuss the usefulness of our theoretical approach in the light of opinion formation processes related to the spread and acceptance of scientific information in society. Quite surprisingly, we show that scientifically sound concepts are more difficult to acquire than superstition, since social networks reorganize themselves to prevent information spreading.

17:38-17:48 Pawel Kondratiuk, Warsaw University of Technology, Poland
Analytical Approach to Model of Scientific Revolutions
Pawel Kondratiuk
Faculty of Physics, Center of Excellence for Complex Systems Research, Warsaw University of Technology, Koszykowa 75, PL-00-662
ABSTRACT: The model of scientific paradigms spreading throughout the community of agents with memory is analyzed. The case of two competing ideas is considered for various networks of interactions. The pace of adopting a new idea by a community is analyzed, along with the distribution of time after which the new idea replaces the old one. For the chain topology the results are extended onto the more general case when more than two ideas compete.

17:50-18:00 Ana Fernández del Río, UNED, Spain
Interdependent binary choices under social influence
Ana Fernández del Río, Elka Korutcheva and Javier de la Rubia
Departamento Física Fundamental, UNED, Spain
ABSTRACT: The use of statistical physics, in particular of the Ising model, in the context of discrete choice settings in socioeconomic problems, will be reviewed. The use of coupled Ising models to study interdependent choices will be presented, with phase diagrams and main results described for unbiased populations (zero external fields).

Monday 19, 17:30-18:30. FLUCTUATION-DISSIPATION.

17:30-17:40 Aki Kutvonen, Aalto University, Finland
The Single Electron Box - A Workbench for Dissipation
A. Kutvonen, J.P. Pekola, T. Ala-Nissilä and D.V. Averin
Department of Applied Physics and Low Temperature Laboratory, Aalto University, Finland
ABSTRACT: Dissipation of energy is something ubiquitous for all physical processes. Generally the dissipation is a complicated function of the phase space and reversibility of the process. In this short introduction I present a clean and controllable system, namely the single electron box, in which the dissipation can be quantified numerically, analytically and experimentally. I also shortly discuss fluctuation theorems in the context. [1] D.V. Averin and J.P. Pekola, Preprint arXiv:1105.0416v1

17:42-17:52 Carlos Perez-Espigares, University of Granada, Spain
Symmetries in Fluctuations Far From Equilibrium
Pablo I. Hurtado, Carlos Pérez-Espigares, Jesús J. del Pozo, and Pedro L. Garrido
Departamento de Electromagnetismo y Física de la Materia, and Instituto Carlos I de Física Teórica y Computacional, Universidad de Granada.
ABSTRACT: Fluctuations arise universally in nature as a reflection of the discrete microscopic world at the macroscopic level. Despite their apparent noisy origin, fluctuations encode fundamental aspects of the physics of the system at hand, crucial to understand irreversibility and nonequilibrium behavior. To sustain a given fluctuation, a system traverses a precise optimal path in phase space. Here we show that by demanding invariance of optimal paths under symmetry transformations, new and general fluctuation relations valid arbitrarily far from equilibrium are unveiled. This opens an unexplored route toward a deeper understanding of nonequilibrium physics by bringing symmetry principles to the realm of fluctuations. We illustrate this concept studying symmetries of the current distribution out of equilibrium. In particular we derive an isometric fluctuation relation that links in a strikingly simple manner the probabilities of any pair of isometric current fluctuations. This relation, which results from the time-reversibility of the dynamics, includes as a particular instance the Gallavotti–Cohen fluctuation theorem in this context but adds a completely new perspective on the high level of symmetry imposed by time-reversibility on the statistics of nonequilibrium fluctuations. The new symmetry implies remarkable hierarchies of equations for the current cumulants and the nonlinear response coefficients, going far beyond Onsager's reciprocity relations and Green–Kubo formulas. We confirm the validity of the new symmetry relation in extensive numerical simulations, and suggest that the idea of symmetry in fluctuations as invariance of optimal paths has far-reaching consequences in diverse fields.

17:54-18:04 Edgar Roldan, Universidad Complutense de Madrid, Spain
Dissipation and irreversibility in stationary stochastic processes
Edgar Roldan and Juan M.R. Parrondo
Departamento de Fisica Atomica, Molecular y Nuclear, Universidad Complutense de Madrid, Spain and GISC (Grupo Interdisciplinar de Sistemas Complejos).
ABSTRACT: The relationship between irreversibility and dissipation is at the core of thermodynamics and statistical mechanics. However, this relationship has not been analysed quantitatively until the recent introduction of fluctuation and work theorems. In this work, we make use of a result that relates the physical entropy produced in a stationary stochastic process with the time irreversibility exhibited by the data produced in the process. We show that even ignoring any physical detail of the system we can still estimate the entropy produced by the mechanism that generated the data. A discrete flashing ratchet model is analysed as a case study, where we estimate the dissipation even when only partial information of the system is available. These results can be applied to distinguish between active and passive processes in biological systems.

18:06-18:16 Koen Willaert, Hasselt University, Belgium
Verification of the fluctuation theorem in different systems
C. Van den Broeck, C. Cleuren, R. Kawai and Koen Willaert
Physics Department, University of Hasselt, *B-3590 Diepenbeek,* Belgium
ABSTRACT: Two systems will be discussed in which the general fluctuation theorem or some of its variants like the Jarzynski equation or Crooks relation can be obtained explicitly and are therefore verified. These two systems include the following setups: The Knudsen cells in which effusion of an ideal gas takes place. And the Joule experiment which consists of a macroscopic convex object moving at constant speed through an ideal gas. In both setups the gas may consist of classical particles, relativistic particles or photons.

18:18-18:28 Tim Willaert, Hasselt University, Belgium
Properties of various distinct contributions to total entropy production
C. Van den Broeck[1], M. Esposito[2,3], U. Harbola[3], S. Mukamel[3] and T. Willaert[1]
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2. Center for Nonlinear Phenomena and Complex Systems, Université Libre de Bruxelles, Campus Plaine, B-1050, Belgium.
3. Department of Chemistry, University of California, Irvine, California 92697, USA
ABSTRACT: The separation of the entropy production into two distinct non-negative contributions is briefly discussed and then applied to a simple example. Then the generating functions for the different contributions to the entropy production are defined and an evolution equation for them is constructed (by means of 1 example). The formal solution and some of its properties are briefly sketched.