LAWNP'09

Buzios, 05-09 October, 2009

ABSTRACT BOOK

LAWNP'09, 05-09 Oct. 2009, Buzios-Brazil

International Advisory Committee

Hilda Cerdeira (Brazil), Dante Chialvo (USA), Patricio Cordero (Chile), Leticia Cugliandolo (France), Theo Geisel (Germany), Peter Grassberger (Canada), Celso Grebogi (UK), Susana Hernández (Argentina), Vasudev M. Kenkre (USA), Joseph Klafter (Israel), Katja Lindenberg (USA), Grégoire Nicolis (Belgium), Alfredo M. Ozório de Almeida (Brazil), Arkady Pikovsky (Germany), Alberto Robledo (Mexico), David Ruelle (France), Stefano Ruffo (Italy), Constantino Tsallis (Brazil), Horacio Wio (Spain)

Regional Advisory Committee

Marcus A. M. de Aguiar (Brazil), Roberto Andrade (Brazil), Marcel Clerc (Chile), Mario Cosenza (Venezuela), Evaldo Curado (Brazil), Wagner Figueiredo (Brazil), Jason Gallas (Brazil), Marcelo Kuperman (Argentina), José Roberto Rios Leite (Brazil), Marcelo L. Lyra (Brazil), Arturo Martí (Uruguay), Gustavo Martinez-Mekler (Mexico), Octavio Miramontes (Mexico), Cristian Moukarzel (Mexico), Roberto Mulet (Cuba), Mário de Oliveira (Brazil) , Silvina Ponce-Dawson (Argentina), Francisco Tamarit (Argentina), Gabriel Téllez (Colombia)

Conference Chairs

Celia Anteneodo, PUC-Rio, Rio de Janeiro, Brazil
Marcos G. E. da Luz, UFPR, Curitiba, Brazil
e-mail: lawnp09@puc-rio.br webpage: http://lawnp09.fis.puc-rio.br/

We acknowledge financial support from

Capes, Claf, CNPq, CAIS, ICTP, Itaup binacional, PUC-Rio, UFPR

Contents

INVITED TALKS

Jahn-Teller and Renner-Teller intersections in a quantized Sinai billiard

F. M. de Aguiar
UFPE, Recife, Brazil

Two-fold degeneracies in a set of quantized Sinai-type billiards with partially broken symmetry are numerically investigated. Conical (Jahn-Teller) intersections of adjacent energy surfaces are found and confirmed through sign-reversal tests on the eigenfunctions. Sequences of such level crossings exhibiting a geometric phase of $\pi(2\pi)$ for an odd (even) number of encircled points of degeneracy are observed [1]. In addition, we report evidence of a glancing (Renner-Teller) intersection accompanied by a satellite conical intersection [2]. Experiments in isomorphic flat microwave resonators are shown to exhibit excellent agreement with computed eigenvalues and eigenfunctions.

[1] M. Baer, Beyond Born-Oppenheimer: Electronic Non-Adiabatic Coupling Terms and Conical Intersections (Hoboken, NJ: Wiley), 2006. [2] G. J. Halasz, Ã. Vibak, R. Baer and M. Baer, J. Phys. A: Math. Theor. 40, F267 (2007).

Neutral speciation in spatially distributed populations

M.A.M. de Aguiar[1,2], M. Baranger[2,3], E.M. Baptestini[1], L. Kaufman[2,4], Y. Bar-Yam[2]
[1]Universidade Estadual de Campinas, Unicamp 13083-970, Campinas, SP, Brasil; [2]New England Complex Systems Institute, Cambridge, MA 02138,USA; [3]University of Arizona, Tucson, AZ 85719, USA; [4]Boston University, Boston, MA 02215, USA

The number of living species on Earth has been estimated to be between 10 and 100 million. Understanding the processes that have generated such remarkable diversity is one of the greatest challenges in evolutionary biology. We proposed recently a new mechanism of speciation in which a population, with genetically identical individuals homogeneously distributed in space, spontaneously breaks up into species when subjected to mutations and to two mating restrictions: individuals can select a mate only from within a maximum spatial distance S from itself and only if the genetic distance between itself and the selected partner is less than a maximum value G. Species develop depending on the mutation rate and on the parameters S and G. The resulting species-area relationships and abundance distributions thus obtained is consistent with observations in nature.

On the interplay between spatial and time discrete scale invariance in dynamical processes in fractal media.

Ezequiel V. Albano
Instituto de Investigaciones Fisicoqumicas Teóricas y Aplicadas (INIFTA), Universidad Nacional de La Plata, CONICET, CCT-La Plata CONICET, Sucursal 4, CC 16 (1900) La Plata, Argentina

We address dynamical processes occurring in fractal media having spatial Discrete Scale Invariance (DSI), with a fundamental length scale L. Then, if a dynamical process has a time depending (characteristic) length scale, e.g., a correlation length, of the form x $t^{1/z}$, we conjectured that it would exhibit time DSI with a fundamental period $t = L^z$, where z is a dynamical exponent. Time DSI is evidenced in numerical simulations by the onset of log-periodic oscillations of the relevant physical observables. The conjecture is tested in many archetypical models in the field of Statistical Physics, including random walks, diffusion controlled reactions, the Ising and Voter models, the Contact Process, ballistic deposition, etc.

Phase transitions in swarming systems: A recent debate

M. Aldana, H. Larralde
Instituto de Ciencias Fisicas, UNAM, Mexico

An important characteristic of flocks of birds, schools of fish, and many similar assemblies of self-propelled particles is the emergence of states of collective order in which the particles move in the same direction. When noise is added into the system, the onset of such collective order occurs through a dynamical phase transition controlled by the noise intensity. While originally thought to be continuous, the phase transition has been claimed to be discontinuous on the basis of recently reported numerical evidence. This has originated a (heated) debate about the nature of the phase transition, i.e. whether it is continuous or discontinuous. In this talk I will present evidence showing that the phase transition actually depends crucially on the way in which the noise is introduced into the system. Such a dependence was not taken into account in previous studies of swarms and flocks, which is probably what caused all the confusion about the onset of collective order in these systems. Additionally, I will present evidence showing that the apparent discontinuity observed in the numerical simulations is an artifact of the periodic boundary conditions.

Nonunitary evolution of the density operator

Alfredo M. Ozório de Almeida
CBPF, Brazil

The semiclassical evolution of the density operator naturally extends time dependent WKB theory into a doubled phase space. In the case of quantum Markovian evolution, generated by the Lindblad equation, such a setting leads to the definition of a classical double phase space Hamiltonian, which allows for the inclusion of dissipation. The evolution of localized interference terms, such as in Schröedinger cat states, can also be approximated in a generalization of semiclassical wave packet theory, or in a more refined construction based on complex (double) trajectories.

Quantifying the dynamics of real ants

E. Altshuler, C. Perez-Penichet, J. Fernandez, O. Ramos, G. Quintero, R. Mulet
"Henri Poincare" Group of Complex Systems, Physics Faculty, University of Havana, 10400 Havana, Cuba

Using a specially designed "activity" sensor, we measure the traffic at the entrance of an ant's nest during foraging. Our massive wealth of data is analyzed regarding temporal correlations, distribution of the sizes of "activity bursts", etc. Using a simple computational model of two-lane traffic, we attempt to interpret the results, in order to evaluate how far from the "jamming transition" the foraging traffic self-organizes.

Optimal path cracks: A model for the collapse of transportation networks

José S. Andrade Jr.
Universidade Federal do Ceará, Fortaleza, Ceará, Brazil

We study the topology of a fracture interface generated by iteratively applying the Dijkstra algorithm to a two-dimensional random energy landscape. At each iteration, we remove from the resulting optimal path the site of highest energy until a macroscopic fracture composed of these local "cracks" that divides the whole system in two can be identified. In the limit of strong disorder, our numerical results show that all these cracks are located on a single connected line (fracture backbone) which has self-similar geometry, $M_b \sim L^{D_b}$, where M_b is the "mass" (number) of cracks, L is the system size and $D_b \approx 1.22$ is the fractal dimension. For weak disorder, the system is much more resilient. The number of cracks increases as L^2, spreading all over the network before global connectivity is lost. This behavior should have important implications to design strategies for transportation networks with improved robustness against global failure.

Dynamic and thermodynamic anomalies in water

Marcia C. Barbosa
Instituto de Física, Universidade Federal do Rio Grande do Sul; Caixa Postal 15051, 91501-970, Porto Alegre, Rio Grande do Sul

Most liquids contract upon cooling. This is not the case of water, a liquid where the specific volume at ambient pressure starts to increase when cooled below $T \approx 4^oC$. Besides, in a certain range of pressures, water also exhibits an anomalous increase of compressibility and specific heat upon cooling. Experiments for Te, Ga, Bi, S, and $Ge_{15}Te_{85}$ and simulations for silica, silicon and BeF_2, show the same density anomaly. Water also has dynamic anomalies. Experiments show that the diffusion constant, D, increases on compression at low temperature, T, up to a maximum $D_{\max}(T)$ at $p = p_{D\max}(T)$. The behavior of normal liquids, with D decreasing on compression, is restored in water only at high p, e.g. for $p > p_{D\max} \approx 1.1$ kbar at 10^{o}C. In this work we show that all these water-like anomalies can be recovered in two length scales spherical symmetric potential.

Weak ergodicity breaking and it relation to weak chaos

Eli Barkai
Bar Ilan, Ramat Gan, Israel

In nature the noisy signal representing a physical observable is in many cases unpredictable, though the long time average of the signal converges in statistical sense to the ensemble average (ergodicity). Recently, observations of dynamics of single particles, e.g. blinking quantum dots [1], revealed nonergodic processes, characterized by power law sojourn times, in micro states of the system (e.g. in state on and off for the dots). We briefly review the statistical theory of weak ergodicity breaking [2], and discuss its foundation using the Pomeau-Manneville map. The map has a zero Lyapunov exponent $\lambda = 0$, hence the usual Pesin identity: Kolmogorov-Sinai entropy h_{ks} equals the Lyapunov exponent, gives $\lambda = h_{ks} = 0$. We show how sub exponential separation of nearby trajectories, is related to theory of weak ergodicity breaking, to the infinite invariant density, and to entropy.

[1] F. D. Stefani, J. P. Hoogenboom, and E. Barkai *Beyond Quantum Jumps: Blinking Nano-scale Light Emitters*, Physics Today **62** nu. 2, p. 34 (February 2009); [2] A. Rebenshtok, E. Barkai, *Weakly non-Ergodic Statistical Physics*, Journal of Statistical Mechanics **133** 565 (2008); [3] N. Korabel, E. Barkai *Pesin-Type Identity for Intermittent Dynamics with a Zero Lyapunov Exponent*, Phys. Rev. Lett. **102**, 050601 (2009).

Complex systems with time scale separation: New applications of superstatistical techniques

Christian Beck
School of Mathematical Sciences, Queen Mary, University of London, Mile End Road, London E1 4NS, UK

Many complex driven nonequilibrium systems are effectively described by a superposition of several statistics on different time scales, in short a 'superstatistics'. A simple example is a Brownian particle moving in a spatially inhomogeneous medium with temperature fluctuations on a large scale, but the concept is much more general. In recent years superstatistical techniques have been successfully applied to a variety of complex systems, for example turbulence (Lagrangian, Eulerian, environmental), hydroclimatic fluctuations, pattern formation, mathematical finance, traffic delay statistics, random matrix theory, networks, scattering processes in high energy physics, as well as medical and biological applications. In this talk I will first give a general overview on this concept and its recent applications and then describe some newly developed techniques that test if a given experimentally measured time series is superstatistical. I will explain how to extract the relevant superstatistical parameters and universality classes out of a given time series.

[1] C. Beck, Phys. Rev. Lett. 98, 064502 (2007); [2] E. Van der Straeten, C. Beck, Phys. Rev. E 78, 051101 (2008); [3] L. Leon Chen, C. Beck, Physica A 387, 3162 (2008); [4] C. Beck, Eur. Phys. J. A 40, 267 (2009); [5] E. Van der Straeten, C. Beck, arXiv:0901.2271

Statistics planetary systems: Variations on a model by Laskar

L. Benet[1], C.H. Mena [2]
[1]Instituto de Ciencias Fisicas, UNAM, capus Morelos, Mexico;
[2]Facultad de Ciencias, UAEM, Cuernavaca, Mexico

In 2000, J. Laskar [Phys. Rev. Lett vol 84, 3240 (2000)] introduced a simplified model for planetary formation, where the accretion processes conserve mass and angular momentum, and the final stage of the planetary systems satisfies the angular-momentum-deficit stability criterion. Within the limitations of the model he derived generic properties of the formed planetary systems. We reconsider Laskar's model using as the statistical significant quantity the total angular momentum of the system instead of the angular-momentum deficit, and obtain numerically relevant scaling laws. In our implementation we also include a mass-dependence probability for the accretion processes and restrictions on the relative velocity of the colliding particles. We discuss the emergence of planetary separation laws with these modifications of the model.

The magnetisation curve in the Spin Ice Dy2Ti2O7 for H//[111]: Experiments at low temperatures

R. A. Borzi
Departamento de Fisica, UNLP; Instituto de Fisica de La Plata; INIFTA, La Plata, Argentina

The way in which Dy2Ti2O7 is disordered, even down to the lowest temperatures, makes this material one of the few spin analogues of water ice. Being magnetic, the "Spin Ice" systems offer a splendid opportunity for studying frustrated materials under a perturbation that can be controlled with easiness and precision. In this manner, the study of Spin Ice materials under a magnetic field applied along the different crystallographic directions has made possible, in a series of papers published along the last decade, to ratify the Spin Ice model at low temperature as a good starting point, and to improve this model by including other indispensable ingredients. Notable among these, the need to take into account dipolar interactions allows a mapping of the spin system into one of magnetic monopoles. For magnetic fields applied along [111] the magnetisation curve for Dy2Ti2O7 below 1 K has, as a distinctive feature, two consecutive plateaux. The first one corresponds to the "Kagome Ice" phase, while the second marks the saturation of the Ising spins. While this has been previously explored both theoretically and in experiments, in this talk we will discuss some important details on how the actual magnetisation process takes place. We will see that before reaching the Kagome Ice plateau the system shows marked non-equilibrium effects, characterised by the appearance of abrupt jumps in the magnetisation. Their occurrence and particularities depend dramatically on the field sweep rate. The second issue of interest is the metamagnetic transition by which the Kagome Ice phase gives place to a fully saturated state. Using extremely sensitive magnetic measurements we observe that, contrary to theory and current interpretation of the experiments, the process occurs in two well-defined stages. This suggests that a new intermediate phase exists in the system, stabilising in a narrow field range limited by the two critical magnetic fields.

Modeling animal movement in complex environments

Denis Boyer
UNAM-México

The movement patterns of many living organisms, ranging from insects, seabirds or primates, are well described by power-law probability distributions. Unlike random walkers, many animals use cognitive skills to navigate heterogeneous and changing environments. We present a recent modeling approach where agents use memory to take decisions on movement steps and update their knowledge depending on resource availability. These models reproduce several patterns observed in animals (in particular primates) such as a heterogeneous occupation of space characterized by power-law waiting time distributions, Levy-like step length distributions, territoriality or the formation of home ranges. Systems of many, weakly-interacting foragers exhibit rich cooperative properties. Applications to disease spreading among foraging animals will be discussed.

Long range dispersal and pattern formation in natural invasion processes

S. A. Cannas
FaMAF- Universidad Nacional de Córdoba

Occupancy of new habitats through dispersion is a central process in nature. In particular, long distance dispersal (LDD) mechanisms, even if represented by rare events, are increasingly recognized as the main factor involved in the fast spread of species and epidemics, for example, pathogen dispersal by air and biological invasions by plants through wind dispersal of seeds. In addition, considering cancer as an ecological process, spread from primary tumors can be thought as a biological invasion from cancer cells spreading and invading new tissues. Using simulations and real data we show that LDD combined by local proliferation (reproduction) leads to characteristic spatio-temporal patterns of occupancy, with fractal geometry of the boundaries of parches generated and a power law scaled, disrupted patch size distribution. This pattern is observed both in invasive plants species spread and early spread of cancer cells far away of the primary tumor. In contrast, invasions involving only dispersal but not subsequent proliferation (physiological invasions) like trophoblast cells invasion during normal human placentation did not show the patch size power-law pattern. Our results are consistent under different temporal and spatial scales, and under different resolution levels of analysis. We conclude that the scaling properties are a hallmark and a direct result of long-distance dispersal and proliferation, and that they could reflect homologous ecological processes of population self- organization during cancer and species spread. Our results are significant for the detection of processes involving long-range dispersal and proliferation like cancer local invasion and metastasis, biological invasions and epidemics.

Classical and quantum transport: From Fourier law to thermoelectric efficiency

G. Casati
Center for nonlinear and complex systems, Universitá degli studi dell'Insubria, Como, Italy

The understanding of the underlying dynamical mechanisms which determines the macroscopic laws of heat conduction is a long standing task of non-equilibrium statistical mechanics. A better understanding of such mechanism may also lead to potentially interesting applications(thermal diodes and thermal transistors) based on the possibility to control the heat flow. Of particular interest is the problem, almost completely unexplored, of the derivation of Fourier law from quantum dynamics. To this end we discuss heat transport in a model of a quantum interacting spin chain and we provide clear numerical evidence that Fourier law sets in above the transition to quantum chaos. Finally we discuss the problem of thermoelectric power generation and refrigeration and we show that appropriately chosen dynamical models may lead to thermoelectric engines approaching the Carnot efficiency.

Movement patterns and social organisation: How ants move inside their nests

Ana B. Sendova-Franks[1], Chia Yi Chng[2], David Butcher[2], Edward J. OReilly[2], Yi-Xi Chau[2], Kim Christensen[2,3]
[1]Dept. of Mathematics and Statistics, University of the West of England, Bristol, BS16 1QY, U.K.; [2]Dept. of Physics, Blackett Laboratory, Imperial College London, South Kensington, SW7 2AZ, U.K.; [3]Institute for Mathematical Sciences, 53 Prince's Gate, Imperial College London, South Kensington, SW7 2PG, U.K.

Movement is the observable signature of behaviour. Excitingly, in recent years, studies of animal movement patterns have increased due, at least in part, to the development of tracking technologies. In a diverse species among the insects, fish, birds and mammals, movement is studied in relation to searching, foraging, defence, dispersal, migration, aggregation and segregation. In social insects, studying the movement of individuals within the confines of the colony nest is crucial for understanding their social organisation. Here we show our first results from studying the movement patterns of individual workers within the nest. We manipulated population density by offering each colony to occupy in a temporal sequence of nests with increasing or decreasing area. We found that the distribution of individual average moving velocity is continuous at both high and low population density. There is also evidence of some constraint on individual movement at high density. Instantaneous velocity is lower and flight length shorter when the nest area is smaller. Furthermore, at low density, a worker's average moving velocity is positively related to the fraction of time it was moving (a measure of its activity) while this relationship appears to be absent at high density. Yet there is no evidence that this impacts on the amount of work done. Our results also show that flight length follows a broad Levy-like distribution and that movement bout duration has a fractal character. These two signatures of a complex system pose the question whether the observed individual movement patterns are due to interactions or to individual ant behaviour.

Driven front propagation in 1-D spatially periodic media: Experiments and theory

U. Bortolozzo[1], M.G. Clerc[2], R.G. Elías[2], F. Haudin[1], S.Residori[3], and R.G. Rojas[3]
[1]INLN, Université de Nice Sophia-Antipolis, CNRS, 1361 route des Lucioles 06560 Valbonne, France; [2]Departamento de Física, FCFM, Universidad de Chile, Casilla 487-3, Santiago, Chile; [3]Instituto de Física, Pontificia Universidad Católica de Valparaíso, Casilla 4059, Valparaíso, Chile

We study front propagation in one-dimensional spatially periodic media. Based on an optical feedback with spatially amplitude modulated beam, we setup a one-dimensional forced experiment in a nematic liquid crystal cell. By changing the forcing parameters, the front exhibits pinning effect and oscillatory motion, which are confirmed by numerical simulations for the average liquid crystal tilt angle. A spatially forced dissipative ϕ^4-model, derived at the onset of bistability, accounts qualitatively for the observed dynamics.

Synchronization induced by intermittent versus partial drives in dynamical networks

M. G. Cosenza[1], O. Alvarez-Llamoza[2]
[1]Centro de Fisica Fundamental, Universidad de Los Andes, Mérida, Venezuela; [2]FACYT, Universidad de Carabobo, Valencia, Venezuela

We show that the synchronized states of two networks of identical chaotic maps subject to either, a common drive that acts with a probability p in time or to the same drive acting on a fraction p of the maps, are similar. The synchronization behavior of both systems can be inferred by considering the dynamics of a single chaotic map driven with a probability p. We show that the complete synchronized states in both, the intermittently and the partially driven systems, are equivalent. Our results reveal that the presence of a common external drive for all times is not essential for reaching synchronization in a system of chaotic oscillators, nor is the simultaneous action of the drive on all the elements in the system. Rather, a crucial condition for achieving either complete or generalized synchronization is the sharing of some minimal, average information by the elements in the system over long times. Furthermore, we show that the source of the common information being received by the elements in the network is irrelevant; it could consist of an external drive, or an autonomous global interaction field. At the local level, each element in the system is subject to an influence that eventually induces complete or generalized synchronization between that influence and the element. This result implies an equivalence in the collective behaviors of driven and autonomous dynamical systems. Our work is motivated by the practical aspect of searching for minimal requirements for the emergence of synchronization and other collective behaviors in dynamical systems.

Internal gravity waves in stratified fluids

T. Dauxois
ENS Lyon and CNRS, France

Internal gravity waves propagate in density-stratified fluids owing to the restoring effect of buoyancy. They are ubiquitous in the ocean and their amplitude may be large enough for these waves to be observed in satellite images as striking band-like features that travel for thousands of kilometers across the ocean. This is only the surface signature of large internal motions. I will focus on physical mechanisms of internal waves, a necessary stage aside oceanographic projects. From the physicist's point of view, internal gravity waves are particularly interesting. They are transverse waves (group and phase velocity being perpendicular), that do not respond to our classical perception of wave phenomena. Linear solutions are often also solutions of the nonlinear equations, reflection laws are completely different from the usual Snell-Descartes laws, the Huyghens-Fresnel diffraction laws are not valid anymore. All these reasons lead to paradoxes that are of high interest from the 'fundamental physics' point of view. In the first part, I will concentrate on the generation of large amplitude interfacial waves in multi layers stratified fluids, in relation to the dead-water phenomenon. In the second part, I will discuss the generation, propagation, reflection, diffraction and scattering of internal waves when the fluid is linearly stratified. The interaction between these waves and topographical features will be particularly emphasized.

Recent results on absorbing-state phase transitions

Ronald Dickman
UFMG, Belo Horizonte-MG, Brazil

Stochastic processes with an absorbing state arise frequently in statistical physics. In systems with spatial structure, absorbing-state phase transitions are of great interest in the context of self-organized criticality, the transition to turbulence, and questions of universality in critical phenomena far from equilibrium. Recently interest in such problems was stimulated by experimental observation of absorbing-state phase transitions in a liquid crystal system and in a colloidal suspension. The contact process (CP), which describes the propagation of an epidemic, is a simple model exhibiting an absorbing-state transition. The behavior of this model is well understood, and is known to belong to the directed percolation universality class. The behavior of the CP subject to fixed or mobile disorder is, however, not fully understood. The properties of other absorbing-state models, which possess a conserved quantity, remain to be determined. In this talk I shall present recent results on the contact process with various kinds of disorder, and review findings on the triplet creation model, the diffusive epidemic model, and the stochastic sandpile, which offer a more complete perspective on the universality classes associated with absorbing-state phase transitions. Recent advances in numerical methods for the study of such transitions, in particular, analysis of the exact quasi-stationary probability distribution of small systems will also be discussed.

Catastrophic shifts in ecosystems: Early warnings and management procedures (inspired in the physics of phase transitions)

Hugo Fort
Univesidad de la República, Uruguay

Complex systems can respond to gradual changes of their conditions by a sudden shift to a contrasting regime. This is the case of ecosystems which are subject to changes in exploitation, nutrient loading, etc., which often produce catastrophic transitions to an alternative stable state (ASS). Predicting such critical points before they are reached is extremely difficult and the task of providing early warnings, of such catastrophic regime shifts, is fundamental to design management protocols for ecosystems. Here we study different spatial versions of popular ecological models which are known to exhibit ASS. The spatial heterogeneity is introduced by a local parameter varying from cell to cell in a regular lattice. Transport of biomass among cells occurs by simple diffusion. We investigate whether different quantities from statistical mechanics -like the variance, the two-point correlation function and the patchiness- may serve as early warnings of catastrophic phase transitions between the ASS. In particular, we find that the patch-size distribution follows a power law when the system is close to the catastrophic transition. We also provide links between spatial and temporal indicators and analyze how the interplay between diffusion and spatial heterogeneity may affect the earliness of each of the observables. The more negligible the diffusion between cells, the more gradual is the response of the system to a gradual change in some stressor (e.g. harvesting, nutrient load). Therefore, the possible remedial procedures, which can be followed after these early signals, are more effective the lower the diffusion is. Finally, we comment on similarities and differences between these catastrophic shifts and paradigmatic thermodynamic phase transitions like the liquid-vapor change of state for a fluid like water.

Structuring of periodic and chaotic behaviors in nonpolynomial kinetics: the case of the Belousov-Zhabotinsky reaction

Jason Gallas
UFRGS, Brazil

We describe recent numerical investigations about the relative abundance of periodic and chaotic oscillations in phase diagrams for the Belousov-Zhabotinsky reaction when modeled by a nonpolynomial, autonomous, three-variable model suggested by Gyorgyi and Field [Nature, 1992]. The model contains 14 parameters that may be tuned to produce rich dynamical scenarios. By computing high-resolution Lyapunov phase diagrams, we show that the structuring of periodic and chaotic phases of the BZ reaction displays rather unusual global patterns, very distinct from those recently found for gas and semiconductor lasers, for electric circuits, and for a few other familiar nonlinear oscillators. The unusual patterns found for the Belousov-Zhabotinsky reaction are surprisingly robust and independent of the parameter explored. We also comment about phase diagrams for mixed-mode oscillations.

Phase transitions towards self-organized criticality in neuronal systems

Theo Geisel*
Max Planck Institute for Dynamics and Self-Organization; Faculty of Physics, University of Goettingen; Bernstein Center for Computational Neuroscience Goettingen

In recent work we have demonstrated the existence of genuine self-organized criticality (SOC) in neuronal networks[1] caused by depressing dynamical synapses, i.e., where the synaptic coupling exhibits fatigue under repeated presynaptic firing. This adaptation mechanism drives the network into a self-organized critical regime by adjusting the average coupling strengths to a critical value. The size distribution of critical avalanches exhibits an inverse power law, which has been observed in the same form experimentally in neuronal cultures as well as in awake monkeys. We have now generalized this study to include facilitating besides depressing synaptic dynamics as found in biological systems. We show analytically that the generalized model attains SOC in an extended region of parameter space that is reached through phase transitions. The critical region of the connectivity parameter is sandwiched between a sub- and a supercritical regime which also can be reached experimentally by a manipulation of the synaptic strengths. The system exhibits a rich dynamical behaviour including a hysteresis between critical and noncritical dynamics, switching of the dynamics in dependence of external inputs, and first- and second-order phase transitions that form a cusp bifurcation[2]. This is the first observation of a complex classical bifurcation scenario combined with a SOC phase.

[1] A. Levina, J. M. Herrmann, and T. Geisel, Dynamical Synapses Causing Self-Organized Criticality in Neural Networks, Nature Physics 3, 857 (2007); [2] A. Levina, J. M. Herrmann, and T. Geisel, Phase Transitions towards Criticality in a Neural System with Adaptive Interactions, Phys. Rev. Lett. 102, 118110 (2009).

*Work in collaboration with A. Levina and J.M. Herrmann

Modeling brain functional networks

I. Gomez Portillo[1,2], P. M. Gleiser[1,2]
[1]Instituto Balseiro, Bariloche, Argentina; [2]Centro Atómico Bariloche, Bariloche, Argentina

Brain functional networks are graph representations of activity in the brain, where the vertices represent anatomical regions and the edges their functional connectivity. These networks present a robust small world topological structure, characterized by highly integrated modules connected sparsely by long range links. Recent studies showed that other topological properties such as the degree distribution and the presence (or absence) of a hierarchical structure are not robust, and show different intriguing behaviors. In particular, Eguiluz et al. (Phys Rev Lett 94: 018102) used functional magnetic resonance imaging (fMRI) to extract functional networks connecting correlated human brain sites in subjects performing tasks. They found that these are small-world networks with power law degree distributions and no signs of a hierarchical structure. On the other hand, Achard et al. (The Journal of Neuroscience 26(1): 63-72) and Ferrarini et al. (Hum Brain Mapp (2008)) built functional brain networks in subjects at rest, and found truncated power law degree distributions, and a hierarchical network structure. In order to study these different behaviors we present a simple model for human brain functional networks. The microscopic units of the model are dynamical nodes that represent active regions of the brain, whose interaction gives rise to complex network structures. The links between the nodes are chosen following an adaptive algorithm that establishes connections between dynamical elements with similar internal states. We show that the model is able to describe topological characteristics of human brain networks obtained from functional magnetic resonance imaging studies.

Two applications of mutual information to biological data analysis

Peter Grassberger
Department of Physics & Astronomy, University of Calgary, Canada

After introducing the concept of mutual information (MI), I shall discuss first the estimation of similarity between aligned sequences using data compression techniques. After this application of algorithmic MI, I will switch to the more familiar Shannon (probabilistic) frame work and apply a recently developed class of MI estimators to high throughput gene expression data. In particular, I will discuss the problems encountered in inferring transcriptional gene regulation networks.

Queueing phase transition: Theory of translation

Celso Grebogi
Institute for Complex Systems and Mathematical Biology, Kings College, University of Aberdeen, Aberdeen AB24 3UE, United Kingdom

In non-equilibrium statistical physics, the totally asymmetric exclusion process plays a fundamental role. It describes the current of particles on a lattice, where to each site a different hopping probability has been associated and the particles can move only in one direction. I will show that the queueing of the particles behind a slow site can lead to a first-order phase transition, and derive analytical expressions for the configuration of slow sites for this to happen. I will apply this stochastic model to describe the translation of mRNAs and show that the first-order phase transition, uncovered in this work, is the process responsible for the classification of the proteins having different biological functions.

Queueing Phase Transition: Theory of Translation, M. Romano, M. Thiel, I. Stansfield and C. Grebogi, Phys. Rev. Lett. 102, 198104 (2009)

Adsorption, wetting, instabilities and hysteresis on nanopatterned surfaces

E. S. Hernandez
Departamento de Física, Universidad de Buenos Aires, and CONICET, Argentina

We investigate the wetting behavior of helium on nanostructured alkali metal surfaces, at temperatures below and slightly above the bulk superfluidity threshold. Starting from a determination of the phase diagram of helium on semiinfinite planar Cs up to 3 K, performed within finite–range, temperature–dependent density functional theory, we examine the modifications of the isotherms introduced by an infinite array of nanocavities. In either situation, the unstable regions of the isotherms are stabilized by nucleation of drops and/or bubbles. We determine the filling and spreading sequence on the heterogeneous surface and show that the adsorption-desorption diagram presents hysterectic loops.

Robustness of social networks

Hans Herrmann
ETH, Zürich

Networks typically cease to be operational when they fall apart in disconnected pieces. This can be desired as in the case of criminal networks or should be avoided for instance in the case of communication systems. Destruction can happen randomly of due to a malicious attack. I will present various strategies of optimizing the robustness of networks preserving their degree distribution. A novel topology emerges. Applications to power networks, botnets, road systems and brain models will be discussed.

Detecting nonlinearities in fluctuating atmospheric parameters

I. M. Jánosi, B. Gyüre, I. Bartos
Loránd Eötvös University, Budapest, Hungary

Flow phenomena in the atmosphere can be properly described by the Navier-Stokes equation, which is inherently nonlinear. Still time series of many variables, such as temperature, pressure, wind speed, etc. are pretty well fitted by linear (e.g. autoregressive) models. This fact indicates that the signatures of nonlinearity are usually weak, therefore their detection is not always a trivial task. We present the method of empirical response function as a new tool to analyze fluctuating time series and reveal weak nonlinearities. The main example refers to daily surface temperature records. We show that the temperature response function is almost linear explaining the success of classical modeling methods, and climatological mean values represent an almost true (dynamical) equilibrium. Nevertheless clear indications of nonlinearities are exhibited, and the reproduction of the same statistics in a laboratory experiment is demonstrated.

Oscillation patterns in genetic feed-back signalling

Mogens H. Jensen
The Niels Bohr Institute, University of Copenhagen, Blegdamsvej 17, DK-2100 Copenhagen

We model oscillation patterns in four different eucaryotic systems: Hes1, p53-mdm2, NF-kB and Wnt-Notch. In each of the systems we identify the feed-back loops for the genetic regulations. Oscillations are possible when time delays are present, either by directly introducing a delay, by many steps in the loops or by saturated degradation. The oscillations are important for cell apoptosis and the control of inflammation. The Wnt-Notch system is essential in embryo segmentation. We further identify the feed-back dynamics by means of symbolic dynamic and derive general symbolic rules for the oscillatory patterns.

S. Krishna, M.H. Jensen and K. Sneppen, "Spiky oscillations in NF-kappaB signalling", Proc.Nat.Acad.Sci. 103, 10840-10845 (2006); S. Pigolotti, S. Krishna and M.H. Jensen, "Oscillation patterns in negative feedback loops", Proc.Nat.Acad.Sci. 104, 6533-6537 (2007); G. Tiana, S. Krishna, S. Pigolotti, M.H. Jensen and K. Sneppen, "Oscillations and temporal signalling in cells", Physical Biology 4, R1-R17 (2007).

Extinction of refugia of Hantavirus infection in a spatially heterogeneous environment

V. M. Kenkre
Consortium of the Americas for Interdisciplinary Science and Department of Physics and Astronomy, University of New Mexico, Albuquerque, NM 87131, USA

We predict an abrupt observable transition, on the basis of numerical studies, of Hantavirus infection in terrain characterized by spatially dependent environmental resources. The underlying framework of the analysis is that of Fisher equations with an internal degree of freedom, the state of infection. The unexpected prediction is of the sudden disappearance of refugia of infection in spite of the existence of supercritical (favorable) food resources, brought about by reduction of their spatial extent. Numerical results are presented and a theoretical explanation is provided on analytic grounds on the basis of the competition of diffusion of rodents carrying the Hantavirus and nonlinearity present in the resource interactions.

A model for the evolution of geopolitical division of the Ancient World

M. Kuperman
Centro Atómico Bariloche and Instituto Balseiro, Bariloche, Argentina

In this talk, we will present a model based on a competitive dynamics that intends to imitate the processes that lead to geopolitical division. At the same time we will propose an explanation to the fact that most capitols are located far from the borders or coasts.

Correlation length for amorphous solids

J. Kurchan
PMMH ESPCI, 10 rue Vauquelin, 75231 Paris, France

Given several configurations of a the same glass, obtained at different times after the temperature quench, can we order them according to their age? In other words, is there a growing correlation length for such an amorphous system? I will argue that indeed one can define a purely static correlation length, that can be computed on the basis of the configuration alone – without knowing the history or the interactions – just as one recognises crystalline or quasicrystalline order in a single configuration.

Aggregation of retail stores

H. Larralde[1], P. Jensen[2]
[1]Instituto de Ciencias Fisicas, Universidad Nacional Autonoma de Mexico; [2]Lab. d'Economie des Transport, Université Lyon 2 Lab. de Physique, ENS de Lyon Institute de Système Complexes Rhône-Alpes (IXXI)

Most store owners choose the location of their businesses and the price of the merchandise as to maximize their profit. However, it is a trivial observation that there are trades that tend to cluster (e.g. jewelers, art dealers, secondhand book stores, used cars dealers, etc.) while other trades tend to distribute uniformly throughout a city (e.g. barbers, butchers, bakers, etc.). Thus, the common drive of maximum profit leads to markedly distinct geographical distributions depending on the specific trade. From a physics perspective, it is tempting to identify this phenomenon as some kind of condensation phenomenon in which the particle (stores) equilibrate into a condensate or gaseous phase, depending on the parameters of the system. In this talk I will present some of our efforts to identify and model the economic factors that affect the decision of a customer to attend one store or another. In the end, it is the customer's behavior, in regards to each specific trade, what gives rise to effective interactions between stores, and thus, what eventually induces stores to aggregate or separate geographically.

Theory of random packings

H. A. Makse
Levich Institute and Physics Department City College of New York, New York, USA

We present a theory of random packings to describe the statistical mechanics of jammed matter with the aim of shedding light to the long-standing problem of characterizing the random close packing (RCP) and random loose packing (RLP) of particles. We describe the jammed system with equations of state relating observables such as entropy, coordination number, volume fraction, and compactivity as well as the probability distributions of volume and contacts. We follow a systematic route to classify packings into a phase diagram of jamming, from frictionless to frictional particles, from hard to deformable particles, from monodisperse to polydisperse systems, from spherical particles to nonspherical convex particles, in an attempt to understand the packing problem from a unifying perspective. The studies of RCP and RLP includes 2d, nd, and the mean field limit of infinite dimension.

Geometrical depinning and novel crossed-ratchet rectification of extended domain wall motion.

Veronica I. Marconi
Condensed Matter Theory Group, IFFaMAF, Universidad Nacional de Cordoba, 5000 Cordoba, Argentina

The motion of a domain wall in a two dimensional medium with a periodic rectangular array of asymmetric holes is studied, taking into account the internal elastic degrees of freedom of the wall. We calculate the anisotropic critical fields for depinning flat and kinked walls which are relevant for optimizing the crossed ratchet effect recently observed experimentally in patterned ferromagnetic films (*PRL* **100**, *037203, 2008*). We discuss how our results can be used to design rectifiers or effective potential landscapes for controlling the motion of interfaces or invasion fronts in multiply connected spaces or in finite samples with spatially modulated free boundary conditions. In addition we present very recent experimental and numerical results showing the effects of an *ac transverse field* on the kinked domain wall motion.

Turbulent fountains in stratified flows

D. Freire, C. Cabeza, S. Pauletti, G. Usera, G. Sarasúa, I. Bove, Arturo C. Martí
Instituto de Fisica, Universidad de la República, Montevideo, Uruguay

In this presentation we study turbulent fountains in stratified flows, a clear example of basic scientific problem with important technological applications. This problem is inspired in a frost-protection device called Selective Inverted Sink (SIS). SIS performs the selective extraction of the cold air generated over cropped areas which is responsible of the observed frost damage. The referred selective extraction is made in those areas where cold air is accumulated (low lying areas, cold air flow obstructions, etc.) and where cold air flowing downhill reaches crop. SIS devices also mix the extracted cold air with higher warmer layers of the stratified atmosphere, thus avoiding the effect of cold air over crops sensible tissues. Following a basic approach, a fountain is usually defined as a jet in which, as a result of a difference between the density of the fluid jet and the environment, the buoyancy force is acting in the opposite direction to that of the jet. Traditionally, due to its multiple applications, the study of homogeneous or light sources (the density of the jet is smaller than that of the fluid environment at the base) has received much more attention than the case of heavy sources. This latter problem, despite having been much less studied, it also has important applications as for example in selective withdrawal, desalination plants, or geophysical applications such as replenishment of magma chambers. In our laboratory we generated turbulent fountains injecting cold water in a container filled with water and vertical gradient of temperature for different conditions of the jet: density differences, inclination and swirling of the flow. Through dimensional analysis we estimate the relevant parameters of the problem. At the beginning of the experience, the jet reaches a certain initial height, then, due to the effects of mixing and friction this height is reduced to an intermediate level where the fluid of the jet intrudes at the environment. Using visualization and velocimetry techniques we obtain the initial and intrusion height.

Regulatory network dynamics for sea urchin sperm navigation

G. Martinez Mekler[1,2], M. Aldana[1], J. Espinal[1], A. Darszon[3], A. Guerrero[3], C. Wood[3]
[1]Instituto de Ciencias Fisicas, UNAM, Cuernavaca, Mexico; [2]Centro de Ciencias de la Complejidad, UNAM, Mexico; [3]Instituto de Biotecnologia, UNAM, Cuernavaca, Mexico

Fertilization is one of the fundamental processes of living systems. Here we study how sea urchin sperms swim towards the egg. Several levels of description are involved in this process. In this presentation we focus, at the biochemical level, on how polypeptides secreted by the egg trigger signaling pathways for calcium oscillations in the flagellum. Experiments, some performed within our group, have shown that these oscillations modify sperm navigation and are in some cases related to chemotaxis. Here we construct a regulatory network for this signaling pathway. Our modeling incorporates discrete and semi-continuous dynamical formalisms developed for the study of complex networks. These models give results experimentally observed and predict behaviors, some of which we have corroborated by new experiments. The finding that the discrete network dynamics operates at criticality is revealing. Finally, as an overview, we comment on some aspects of sperm motility related to other levels of description, such as molecular machines present in the flagellum, hydrodynamic considerations and space exploration strategies. A proper understanding and integration of these levels of description is an open challenge.

Quantifying stochastic and coherence resonances and detecting noise-induced order via information theory complexity measures

O. A. Rosso[1], Cristina Masoller[2]
[1]The University of Newcastle, Callaghan, Australia; [2]Universitat Politenica de Catalunya, Terrassa, Spain

In this talk I will discuss how statistical complexity measures can be employed to detect noise-induced order and to quantify stochastic and coherence resonances. I will illustrate the method with two paradigmatic models, one of a Brownian particle in a sinusoidally modulated bistable potential, and the other, the FitzHugh-Nagumo model of excitable systems. The method proposed here is suitable for the study of real-world complex signals, allowing the detection of subtle signatures of noise-induced order.

Bootstrap percolation on networks with long-range links

Cristian Moukarzel
Cinvestav, Mérida, México

Bootstrap Percolation BP (also known as k-core), generalizes Percolation by requiring that a site have k neighbors in the connected cluster in order to belong to it. The cases of k=1 and k=2 are respectively usual and backbone percolation. BP has been recently proposed as a model for jamming, based on the fact that e.g. a spherical particle must be in contact with at least (d+1) jammed neighbors in d dimensions, in order to be itself jammed. A problem with this analogy resides with the fact that BP presents a second-order transition in the universality class of usual percolation in 2d and 3d, but has a (mixed) first-order transition in mean field, while the jamming transition is always first-order in the connected cluster density, in any dimension. Therefore a better understanding of the dimensionality dependence of BP is needed. In this talk I will describe investigations of BP in networks with variable dimensionality, obtained by adding Long-Range links to a d-dimensional lattice. These investigations show how the BP transition goes from being second-order on low-dimensional lattices, to a first-order transition in large-dimensions.

Stochastic fluctuations in population dynamics

T. Tomé, M. J. de Oliveira
Universidade de São Paulo, Brazil

We study the role of stochastic fluctuations in population dynamics focusing on predator-prey systems. We use an approach in which the population dynamics is described by stochastic lattice-gas models. From the master equation we derive a birth-and-death stochastic in the space of prey and predator numbers by a contraction method that reduces the number of degrees of freedom. Next, an expansion in the inverse of system size is performed to get a Fokker-Planck equation and the associate Langevin equation. Although, the deterministic part has of this equation yields only damped oscillations, the noise part plays a crucial role by transforming damped into undamped oscillations. The time correlations are used to characterize the cyclic coexistence of species and its transition to ordinary coexistence.

Nonlinear destruction of Anderson localization in disordered nonlinear lattices

A. Pikovsky[1], D. L. Shepelyansky[2], S. Tietsche[1]
[1]Department of Physics and Astronomy, University of Potsdam, Germany; [2]Université de Toulouse, UPS, Laboratoire de Physique Théorique (IRSAMC), Toulouse, France

We discuss what happens to Anderson localization in a disordered lattice if a nonlinearity is present. This situation is relevant for lattices of coupled oscillators, for a Bose-Einstein condensate (described by a nonlinear Gross-Pitaevsky equation) in a disordered potential, and to light propagation in a disordered nonlinear medium. Our main model is a discrete Anderson chain with a nonlinear energy shift, or, equivalently, a discrete nonlinear Schrödinger lattice with disorder. We discuss two problems for this model: (i) How an initially localized wave packet spreads [1] and (ii) How a regular wave is transmitted through a nonlinear disordered layer [2].

[1] A. S. Pikovsky and D. L. Shepelyansky. Destruction of Anderson localization by a weak nonlinearity. *Physical Review Letters*, 100(9):094101, 2008; [2] S. Tietsche and A. Pikovsky. Chaotic destruction of Anderson localization in a nonlinear lattice. *Europhysics Lett.*, 84(1):10006, 2008.

Modelling the dynamics and control of transmitted diseases

S. T. R. Pinho
Universidade Federal da Bahia, Salvador, Brazil

Some directly and vector-transmitted diseases are still not controlled in this century. In modern life, the intense flux of people increases the complexity of their propagation. The knowledge of spatiotemporal propagation is very important to provide early information to population about the risk of an epidemics. So, beside the usual system of cases notification, an internet based-system to monitor transmitted diseases (Influenza) is working in some countries in Europe [1]. We are developing a similar system for dengue in Salvador (Brazil) as a pilot project, whose data will be also useful for modeling the dynamics of dengue. In this talk, we present the main ideas of this project and focus on our proposal of periodically forced model that reproduce the epidemics time series and the complex spatiotemporal patterns observed in the transmission of dengue [2]. We analyze both the discrete and continuous versions of this model. Its discrete version is a two-dimensional cellular automata that comprises three population levels (the human, the adult and immature vector). The rules include seasonal forcing, human and mosquito mobilities, and vector control effects. Results are obtained by comparison with actual data retrieved from dengue epidemics. Different strategies and local action of vector control are relevant as well as its early action (at maximum slope of epidemics series), reinforcing the necessity of a fast system of cases notification. This work is a collaboration with researchers of Instituto de Física (UFBa), Instituto de Saúde Coletiva (UFBa) and Instituto Gulbenkian de Ciência (Fundação Calouste Gulbenkian - Portugal).

[1] S.P. van Noort, M. Muehlen, H. Rebelo de Andrade, C. Koppeschaar, J.M. Lima Loureno, M.G.M. Gomes; Eurosurveillance **12**, 7, 3 (2007); [2] L.B.L. Santos, M.C. Costa, S.T.R. Pinho, and R.F.S. Andrade, F.R. Barreto, M.G. Teixeira, and M.L. Barreto; Phys. Rev. E **80**, 016102 (2009).

Statistical mechanics' tools for quantum phase-entanglement transitions

A. Plastino
National University La Plata, Argentina

With reference to many-body systems we show how to use finite-temperature, statistical mechanic's methods to deal with zero-temperature quantum phase transitions that also involve sudden entanglement changes. Our considerations are illustrated by recourse to an exactly solvable, nuclear many-fermion model of Plastino and Moszkowski.

Intra-cluster percolation of calcium signals

G. Solovey, S. Ponce Dawson
Departamento de Fisica, FCEN-UBA, Argentina

Calcium signals are involved in a large variety of physiological processes. Their versatility relies on the diversity of spatio-temporal behaviors that the calcium concentration can display. Calcium entry through inositol 1,4,5-trisphosphate receptors (IP_3R's) is a key component of the calcium signaling toolkit. IP_3R's are usually organized in clusters on the membrane of the endoplasmic reticulum and their spatial distribution has important effects on the resulting signal. Recent high resolution observations give accurate estimates of the number of channels that open during localized release events offering a window to study intra-cluster organization. In this talk I will present a simple model with which we interpret the observations in terms of two stochastic effects: IP_3 binding and unbinding and Ca^{2+}-mediated inter-channel coupling. Depending on the parameters, one or the other process may be dominating. The transition between both limiting cases, a fingerprint of which can be encountered in the distribution of event sizes, is similar to percolation. By analyzing the distribution it is possible to infer properties of the interactions among channels from statistical information on the emergent behavior of the cluster as a whole.

Synchronization of optically coupled chaotic lasers

Jose R. Rios Leite
Departamento de Fisica, UFPE-Recife, Brazil

Semiconductor diode lasers under optical feedback have instabilities with Low Frequency Fluctuations in their power output. These chaotic instabilities can be synchronized by optical and electronic coupling of two or more laser units. We shall present experiments on the properties of the synchronization of chaos between two such lasers and their relation to complex system excitability. Synchronism with intermittent time leadership exchange was also observed and characterized using coupled single mode rate equations.

Conditions for the rise of a Brazil nut

Dino Risso
Departamento de Física, Universidad del Bío-Bío, Concepción, Chile; Departamento de Física, FCFM, Universidad de Chile, Santiago, Chile

Using molecular dynamics simulations we investigate the Brazil Nut effect (BNE) in a vertical bidimensional vibrated granular system consisting of a bed of many small hard spheres of a fixed size plus one large intruder. The collisions are inelastic and particles have translational and rotational degrees of freedom. The container consist on a box with lateral walls that do not move and a vibrating base with movement characterized by two dimensionless parameters Γ and ζ determining its frequency and amplitude. We systematically explore this parameter space (while keeping fixed all other possible parameters) looking for the conditions under which the intruder rises to the top of the vibrated system in less than a fixed number of cycles of the vibrating base. For each point of this parameter space a set of different initial conditions is simulated. In most of the points the simulations give the same result in the sense that the intruder rises to the top or it does not. There is a strip line of points however where not all the simulations give the same result. In the ζ versus Γ plane the BNE takes place only above this strip. A comparison with simulational and experimental results of other authors under similar conditions shows good consistency in spite that the dissipation coefficients (restitution and friction) and the geometry are not the same. The shape of the transition line is understood in connection with the friction of the system with the lateral walls and with the jamming.

Statistical dynamics at zero Lyapunov exponent

A. Robledo[1], L.G. Moyano[2], M.A. Fuentes[3]
[1]Instituto de Fsica, UNAM, México; [2]Telefonica I+D, Madrid, España; [3]Santa Fe Institute, Santa Fe, New Mexico, USA

We demonstrate [1] that the dynamics toward and within the Feigenbaum attractor combine to form a q-deformed statistical-mechanical construction. The rate at which ensemble trajectories converge to the attractor and to the repellor is described by a q-entropy obtained from a partition function generated by summing distances between neighboring positions of the attractor. The values of the q indices involved are given by the unimodal map universal constants, while the thermodynamic structure is closely related to that formerly developed for multifractals. We expose features of the dynamics of trajectories that either evolve toward the Feigenbaum attractor or are captured by its repellor, and make clear the dynamical origin of the anomalous thermodynamic framework existing at this attractor. We also look [2] at the limit distributions of sums of deterministic chaotic variables in unimodal maps and find a renormalization group structure associated to the operation of increment of summands. In this structure - where the only relevant variable is the difference in control parameter from its value at the transition to chaos - the trivial fixed point is the Gaussian distribution and a novel nontrivial fixed point is a multifractal distribution that bears a resemblance to the Feigenbaum attractor, and is universal in the sense of the latter. The crossover between the two fixed points is explained and the flow toward the trivial fixed point is seen to be comparable to the chaotic band merging sequence. We discuss the nature of the Central Limit Theorem for deterministic variables.

[1] A. Robledo, L.G. Moyano, Phys. Rev. E 77, 036213 (2008).
[2] M.A. Fuentes, A. Robledo, Phys. Rev. E (submitted).

Linear response for systems which do or do not satisfy the chaotic hypothesis

D. Ruelle
IHES, Bures sur Yvette, France

Classical chaos will here be described by a Nonequilibrium Steady State (or SRB measure) for a smooth dynamical system on a compact manifold. This misses some important physical features related to the thermodynamic limit. Nevertheless, it is instructive to study linear response in this setting. For uniformly hyperbolic dynamical systems the SRB measure depends differentiably on parameters, and linear response can be interpreted in terms of a susceptibility function with the expected analyticity properties. For systems that are not uniformly hyperbolic, however, nondifferentiable response arises, and also 'acausal' singularities of the susceptibility, for which we shall give a physical interpretation in terms of 'energy non-conservation'.

Statistical mechanics and dynamics of solvable models with long-range interactions

Stefano Ruffo
Dipartimento di Energetica "S. Stecco", Università di Firenze, and INFN, Italy

Systems with long-range interactions, like gravitational, charged and dipolar systems, can be made extensive, but are intrinsically non additive. The violation of this basic property of thermodynamics is the origin of ensemble inequivalence, which in turn implies that specific heat can be negative in the microcanonical ensemble, temperature jumps can appear at microcanonical first order phase transitions, ergodicity may be broken. Realizing that such features may be present for a wide class of systems has renewed the interest in long-range interactions. In this seminar, I will present a review of the recent advances on the statistical mechanics and out-of-equilibrium dynamics of solvable models with long-range interactions.

Open quantum maps: a view from quantum information theory

Marcos Saraceno
Departamento de Fisica - CNEA; Buenos Aires, Argentina

Open quantum maps are used to model physical quantum systems where probability is not conserved due to some leakage mechanism. Their classical dynamics, in the chaotic case, involves typically fractal invariant sets, the associated generalized dimensions, escape rates, Lyapounov exponents,etc. The quantum treatment of open maps is characterized by the lack of unitarity, and current interest deals with the distribution of resonances, the relationship with classical features and the appearence of fractal Weyl laws. In this contribution we use some techniques of quantum information to show that some models of open maps can be efficiently simulated by probabilistic quantum circuits.

Economic fluctuations and statistical physics

H. Eugene Stanley
Center for Polymer Studies and Department of Physics, Boston University, Boston, USA

Recent analysis of truly huge quantities of empirical data suggests that classic economic theories not only fail for a few outliers, but that there occur similar outliers of every possible size. In fact, if one analyzes only a small data set (say 10^4 data points), then outliers appear to occur as "rare events." However, when we analyze orders of magnitude more data (10^8 data points!), we find orders of magnitude more outliers—so ignoring them is not a responsible option, and studying their properties becomes a realistic goal. We find that the statistical properties of these "outliers" are identical to the statistical properties of everyday fluctuations. For example, a histogram giving the number of fluctuations of a given magnitude x for fluctuations ranging in magnitude from everyday fluctuations to extremely rare fluctuations that occur with a probability of only 10^{-8} is a perfect straight line in a double-log plot. Two unifying principles that underlie much of the finance analysis we will present are scale invariance and universality [R. N. Mantegna/HES, *Introduction to Econophysics: Correlations & Complexity in Finance* (Cambridge U. Press, 2000)]. Scale invariance is a property not about algebraic equations but rather about functional equations, which have as their solutions not numbers but rather functional forms—power laws. The key idea of universality is that the identical set of "scaling laws" hold across diverse markets, and over diverse time periods. We demonstrate the principles of scaling and universality by describing very recent unpublished work [HES/T. Preis/J. J. Schneider "New Laws Describing Trend Switching Processes in Financial Markets", submitted]. For an intriguing variety of switching processes in nature, the underlying complex system abruptly changes at a specific "phase transition" point from one state to another in a highly discontinuous fashion. Examples of phase transitions range from magnetism in statistical physics to physiology and macroscopic social phenomena. Financial market fluctuations are characterized by many abrupt switchings on very short time scales from increasing "microtrends" to decreasing "microtrends"—and vice versa. We ask whether these ubiquitous switching processes have quantifiable features analogous to those present in phase transitions, and find striking scale-free behavior of the time intervals between transactions both before and after the switching occurs. We interpret our findings as being consistent with time-dependent collective behavior of financial market participants. We test the possible universality of our result by performing a parallel analysis of transaction volume fluctuations. This work was carried out in collaboration with a number of colleagues, chief among whom are T. Preis (Mainz), J. J. Schneider (Mainz), X. Gabaix (MIT and Princeton) V. Plerou, and P. Gopikrishnan (Boston University).

Orientational order in systems with competing interactions at different scales

D. A. Stariolo[1], D. G. Barci[2]
[1]IF-UFRGS, Porto Alegre, Brazil; [2]UERJ, Rio de Janeiro, Brazil

We discuss orientational order in two dimensions in the context of systems with competing isotropic interactions at different scales. We analyze a Landau-Ginzburg model for such systems and show that the orientational symmetry present in the Hamiltonian induces a series of phase transitions with orientational order, giving rise to pattern formation. These phases have only quasi-long-range order for systems with perfect isotropic interactions in two dimensions. The characterization of a domain wall nematic phase in ultrathin ferromagnetic films is discussed in the context of the general phenomenological theory.

Fluctuation and work theorems of open quantum systems

Peter Talkner, Michele Campisi, Peter Hanggi
Institute of Physics, University of Augsburg, 86135 Augsburg, Germany

Fluctuation and work theorems have first been known as exact relations between equilibrium and non-equilibrium properties of isolated or open classical systems and have later been generalized to closed quantum systems [1] and quantum systems staying in weak interaction with their environment [2]. Only recently it was shown that fluctuation and work theorems also hold for quantum systems in strong contact with their environment [3]. This though requires a proper description of the thermodynamics of small open quantum systems which may show unusual properties such as negative specific heats [4].

[1] P. Talkner, E. Lutz, P. Hanggi, Phys. Rev E 75, 050102(R) (2007); [2] P. Talkner, M. Campisi, P. Hanggi, J. Stat. Mech. Theor. Exp. P02026 (2009); [3] M. Campisi, P. Talkner, P. Hanggi, Phys. Rev. Lett. 102, 210401 (2009); [4] G.-L. Ingold, P. Hanggi, P. Talkner, Phys. Rev. E 79, 0611505 (2009).

Non-linear screening of charged macromolecules

Gabriel Tellez
Departamento de Fisica, Universidad de los Andes, Bogota, Colombia

We present several aspects of the screening effect of cylindrical charged macromolecules, such as ADN, in an electrolyte. After a review of the basic mean field approach, based

on the linear Debye-Huckel theory, we consider the case of highly charged macromolecules, where the linear approximation breaks down and the system is described by full non-linear Poisson-Boltzmann equation. Some analytical results for this non-linear equation give some interesting insight on physical phenomena like the charge renormalization and the Manning counterion condensation. We will also present recent results valid beyond mean field theory, which take into account the effect of the correlations between microions. Some interesting properties arise due to the correlations, for instance the charge inversion phenomenon, where the screening cloud around a macromolecule is able to overscreen it, therefore inverting the natural tendency of the macromolecule to repel object with the same charge.

Linear dynamics on spaces with boundaries: almost linear systems

Stefan Thurner
Medical University of Vienna, Austria

We study high dimensional linear dynamical equations, which appear as e.g. in (linearized) catalytic reactions in gene or protein interaction networks. We impose a nonlinearity by enforcing a boundary condition which guarantees non-negativity of all components (non-negativity of concentrations substances). System stability under this constraint is then studied. We find that non-negativity leads to a drastic inflation of those regions in parameter space where the Lyapunov exponent exactly vanishes. The phenomenon can be fully explained as a result of a symmetry breaking mechanism induced by the positivity constraint. The robustness of this finding with respect to interaction network topologies and the role of intrinsic molecular and external noise is discussed. We argue that systems with inflated edges of chaos could be much more easily favored by natural selection than systems where the Lyapunov exponent vanishes only on a parameter set of measure zero.

Noisy continuous-opinion dynamics

R. Toral, M. Pineda, E. Hernandez-Garcia
IFISC (Instituto de Fisica Interdisciplinar y Sistemas Complejos), Universidad de Baleares-CSIC, Palma de Mallorca, Spain

I will presents results of a detailed study the Deffuant et al. model [G. Deffuant, D. Neu, F. Amblard and G. Weisbuch, Adv. Compl. Syst. 3, 87 (2000)] for continuous–opinion dynamics under the influence of noise. In the original version of this model, individuals meet in random pairwise encounters after which they compromise or not depending of a confidence parameter. Free will is introduced in the form of noisy perturbations: individuals are given the opportunity to change their opinion, with a given probability, to a randomly selected opinion inside the whole opinion space. We derive the master equation of this process. One of the main effects of noise is to induce an order-disorder transition. In the disordered state the opinion distribution tends to be uniform, while for the ordered state a set of well defined opinion clusters are formed, although with some opinion spread inside them. Using a linear stability analysis we can derive approximate conditions for the transition between opinion clusters and the disordered state. The master equation analysis is compared with direct Monte-Carlo simulations. We find that the master equation and the Monte-Carlo simulations do not always agree due to finite-size induced fluctuations that we analyze in some detail.

Why are there so many q-Gaussian-like distributions in Nature?

C. Tsallis
CBPF, Brazil

We shall focus on two important thermostatistical features which typically emerge in complex systems: (i) the extensivity of the nonadditive entropy Sq for a special value of q (which corresponds to universality classes), and (ii) the ubiquity (possibly due to a generalized form of the Central Limit Theorem) of q-Gaussian (or q-Gaussian-like) distributions in a variety of systems. Analytical, numerical and experimental evidence will be presented for both facets.

BIBLIOGRAPHY: (i) C. Tsallis, J Stat Phys 52, 479 (1988); (ii) M. Gell-Mann and C. Tsallis, eds., Nonextensive Entropy - Interdisciplinary Applications (Oxford University Press, New York, 2004); (iii) S. Umarov, C. Tsallis and S. Steinberg, Milan J Math 76, 307 (2008); (iv) A. Rodriguez, V. Schwammle and C. Tsallis, J Stat Mech P09006 (2008); (v) C. Tsallis, A.R. Plastino and R.F. Alvarez-Estrada, J Math Phys 50, 043303 (2009); (vi) C. Tsallis, Entropy, in Encyclopedia of Complexity and Systems Science (Springer, Berlin, 2009); (vii) C. Tsallis, Introduction to Nonextensive Statistical Mechanics - Approaching a Complex World (Springer, New York, 2009); (viii) http://tsallis.cat.cbpf.br/biblio.htm

Non-equilibrium dynamics of symmetry breaking phase transitions in copolymer thin films

D. A. Vega[1], L. R. Gomez[1], A. D. Pezzutti[1], M. A. Villar[2], E. M. Valles[2], A. E. Ciolino[2]
[1]Departamento de Fisica, IFISUR, Universidad Nacional del Sur, Conicet, 8000 - Bahia Blanca, Argentina; [2]Departamento de Ingenieria Quimica, Plapiqui, Universidad Nacional del Sur, Conicet, 8000 - Bahia Blanca, Argentina

Amphiphilic organic molecules will, under appropriate conditions, self-assemble into well ordered crystalline structures. Using these molecules as a model system, a great variety of problems of interest to statistical physics, material science and condensed matter physics have been investigated during the past decade [Ruzette and Leibler, Nat. Mat., 4, 31 (2005); Kramer, Nature, 437, 824 (2005)]. Particularly, these molecules are attractive templates for making ordered nanostructures, as they spontaneously form supramolecular aggregates with a tunable interaction. One prominent feature of these systems is the spontaneous formation of topological defects during a quench through the critical point. Since any addressable nanoscale device, such as an ultrahigh-density hard drive, requires well ordered structures, different strategies have been proposed to control the density of topological defects [Register, Nature, 424, 378, (2003)]. Although important advances have been made to obtain well ordered patterns, it has been found that the slow kinetics of defect annihilation prevents the use of thermal treatments to obtain systems with long range order [Gomez et al., Phys. Rev. Lett. 97, 188302 (2006)]. On the other hand, recently there has been an increasing interest in the study of 2D ordered phases on curved surfaces [D. R. Nelson, Nano Lett. 2, 1125 (2002); Santangelo et al., Phys Rev Lett. 99, 017801, 2007]. One of the main differences with planar systems is the nature of topological defects because the curvature of the substrates can impose a topological requirement that includes defects in the ground state [Gomez and Vega, Phys Rev. E, 79, 51607, 2009]. In this talk we will discuss the process of defect formation during a continuous symmetry breaking phase transition in thin films of block copolymers and additional features, such as the role of the curvature on the mechanism of self-organization and the coupling between defects and intrinsic curvature.

Fractal structures in nonlinear dynamics and plasma physics

R. L. Viana[1], J. Aguirre[2], M. A. F. Sanjuan[2], I. L. Caldas[3]
[1]Universidade Federal do Parana, Curitiba, Parana, Brazil; [2]Universidad Rey Juan Carlos, Madrid, Spain; [3]Universidade de São Paulo, São Paulo, Brazil

Besides the striking beauty inherent to their complex nature, fractals have become a fundamental ingredient of nonlinear dynamics and chaos theory since they were defined in the 1970s. Moreover, fractals have been detected in nature, in most fields of science, with even a certain influence in arts. Fractal structures appear naturally in dynamical systems, in particular associated to the phase space [1]. The analysis of these structures is especially useful for obtaining information about the future behavior of complex systems, since they provide fundamental knowledge about their relation with uncertainty and indeterminism. Dynamical systems are divided in two main groups, Hamiltonian and dissipative systems. The concepts of attractor and basin of attraction are related to dissipative systems. In the case of open Hamiltonian systems, there are no attractors, but we have the analogous concepts of exit and exit basin. Therefore, basins formed by initial conditions can be computed both in Hamiltonian and dissipative systems, being some of them smooth and some of them fractal. This fact has fundamental consequences in our ability to predict the future of the system. The existence of this deterministic unpredictability, usually known as final state sensitivity, is typical of chaotic systems, and makes deterministic systems become, in practice, random processes where only a probabilistic approach is possible. One application of exit basins in Hamiltonian systems of interest in plasma physics is the magnetic field line structure in a magnetic plasma confinement scheme like a tokamak. The external region of the plasma and the scrape-off layer near the tokamak inner wall have typically chaotic magnetic field lines (chaotic here should be intended in the Lagrangian sense, since the magnetic configurations are strictly static). The particle and heat diffusion along this chaotic region is not uniform but, due to the complex invariant manifold structure of the chaotic orbit, is characterized by escape channels. An observable manifestation of this phenomenon is the presence of magnetic footprints in the tokamak inner wall due to the localized heat and particle escape from the external plasma region [2]. These magnetic footprints have a remarkable fractal structure that can be qualitatively explained using nonlinear dynamics theory [3]. We aim to present an overview of the properties of the exit basin and some of the applications of exit basins in tokamak equilibria with destroyed magnetic surfaces and chaotic field lines at the plasma edge, in particular the formation of magnetic footprints and escape channels, as well as the occurrence of Wada basins [4].

[1] J. Aguirre, R. L. Viana, and M. A. F. Sanjuán, Rev. Mod. Phys. **81** (2009) 333-386; [2] T. Kroetz, M. Roberto, E. C. da Silva, I. L. Caldas, and R. L. Viana, Phys. Plasmas **15** (2008) 092310-1/12; [3] E. C. da Silva, I. L. Caldas, R. L. Viana, and M. A. F. Sanjuán, Phys. Plasmas **9** (2002) 4917-4928; [4] J. S. E. Portela, I. L. Caldas, R. L. Viana and M. A. F. Sanjuán, Int. J. Bifurcat. Chaos **17** (2007) 4067-4079.

Incompressible flows and random walks

G. M. Viswanathan[1,2] and T. M. Viswanathan[1,2]
[1]Universidade Federal de Alagoas, Maceió, Brazil; [2]Consortium of the Americas for Interdisciplinary Science, University of New Mexico, Albuquerque, USA

We study hyper-viscous incompressible flows in high dimensions that result from a dissipation term given by a fractional Laplacian of order α. By interpreting incompressible flows as non-local diffusion of energy density in the Fourier domain, we prove that in d dimensions, finite time singularities cannot form if $\alpha > (d+2)/4$. Our approach has its inspiration in the study of random walks, Lévy flights and anomalous diffusion.

Stochastic resonance in extended systems: the role of the coupling mechanism

Horacio S. Wio
Instituto de Fisica de Cantabria, Santander, Spain

We analyze the stochastic resonance response in extended systems, considering different transport mechanism: reaction-diffusion, non- local, KPZ. Our aim, as such mechanisms correspond to different forms of coupling of resonant units, leading to an extended systems, is to obtain information about the one that could optimize (increase) the system's response to weak signals. To reach such a goal we will exploit the knowledge of the so called "non-equilibrium potential" for the above indicated cases. Our results indicate that the "optimal" coupling mechanism seems to be the diffusive-like one.

Loschmidt echo and the local density of states

Diego A. Wisniacki, Natalia Ares
Departamento de Física "J. J. Giambiagi", FCEN, UBA, 1428 Buenos Aires, Argentina

Loschmidt echo (LE) is a measure of reversibility and sensitivity to perturbations of quantum evolutions. For weak perturbations its decay rate is given by the width of the local density of states (LDOS). When the perturbation is strong enough, it has been shown in chaotic systems that its decay is dictated by the classical Lyapunov exponent. However, several recent studies have shown an unexpected non-uniform decay rate as a function of the perturbation strength instead of that Lyapunov decay. Here we study the systematic behavior of this regime in perturbed cat maps. We show that some perturbations produce coherent oscillations in the width of LDOS that imprint clear signals of the perturbation in LE decay. We also show that if the perturbation acts in a small region of phase space (local perturbation) the effect is magnified and the decay is given by the width of the LDOS.

ORAL CONTRIBUTIONS

Network evolution based on minority game with herding behavior

R. F. S. Andrade[1,4], D. O. Cajueiro[2,4], V. Moura[1], B. A. Mello[3]
[1]Instituto de Física, Universidade Federal da Bahia, Salvador, Brazil; [2]Departamento de Economia, Universidade de Brasília, Brasília, Brazil; [3]Instituto de Física, Universidade de Brasília, Brasília, Brazil; [4]National Institute of Science and Technology for Complex Systems, Brazil

The minority game (MG) is used as a source of information to design complex networks where the nodes represent the playing agents. Differently from MG classical version consisting of independent agents, the current model rules that connections between nodes are dynamically inserted or removed from the network according to the most recent game outputs. This way, preferential attachment based on the concept of social distance is controlled by the agents wealth. The time evolution of the network topology, quantitatively measured by usual parameters, is characterized by a transient phase followed by a steady state, where the network properties remain constant. Changes in the local landscapes around individual nodes depend on the parameters used to control network links. If agents are allowed to access the strategies of their network neighbors, a feedback effect on the network structure and game outputs is observed. Such effect, known as herding behavior, considerably changes the dependence of volatility σ on memory size: it is shown that the absolute value of σ as well as the corresponding value of memory size depend both on the network topology and on the way along which the agents make their playing decisions in each game round.

Curvature-driven coarsening: new exact, numerical and experimental results

Jeferson J. Arenzon
Instituto de Fisica - UFRGS, Brazil

The classic scenario in coarsening dynamics concerns a system that in equilibrium exhibits a phase transition from a disordered high-temperature phase to an ordered low-temperature phase with a broken symmetry of the high-temperature phase. An example is the Ising ferromagnet: when the system is cooled rapidly through the transition temperature, domains of the two ordered phases form and grow with time under the influence of the interfacial surface tension, which acts as a driving force for the domain growth. A common feature of nearly all such coarsening systems is that they are well described by a dynamical scaling phenomenology in which there is a single characteristic length scale, $R(t)$, which grows with time. If dynamical scaling holds, the domain morphology is statistically the same at all times when all lengths are measured in units of $R(t)$. Despite the success of the scaling hypothesis, its validity has only been proved for very simple models. We consider the statistics of the areas enclosed by domain boundaries (hulls) during the curvature-driven coarsening dynamics of a two-dimensional nonconserved scalar field from a disordered initial state. We show that the hulls enclosed area distribution has, for large time t, the scaling form $n_h(A,t) = 2c/(A+\lambda t)^2$, demonstrating the validity of dynamical scaling in this system, where $c = 1/8\pi\sqrt{3}$ is a universal constant. Domain areas (regions of aligned spins) have a similar distribution up to very large values of $A/\lambda t$. These predictions are supported by extensive numerical simulations. We also present results of the domain morphology of weakly disordered ferromagnets, whose scaling functions have forms identical to those of the corresponding pure system ('super-universality'). These results are tested during the electric field driven deracemization in an achiral liquid crystal, where chiral domains are formed and coarsen. We show that this process is curvature-driven and that the experimental data are in very good agreement with the theory, this system thus belonging to the Allen-Cahn universality class. The statistics of domain sizes during coarsening can then be used as a strict test for this dynamic universality class.

[1] Arenzon, Bray, Cugliandolo and Sicilia, 2007 Phys. Rev. Lett. **98** 145701; [2] Sicilia, Arenzon, Bray and Cugliandolo, 2007 Phys. Rev. E **76** 061116; [3] Sicilia, Arenzon, Bray and Cugliandolo 2008 Europhys. Lett. **82** 10001; [4] Sicilia et al 2008 Phys. Rev. Lett. **101** 197801; [5] Sicilia, Sarrazin, Arenzon, Bray and Cugliandolo 2009 Phys. Rev. E (arXiv:0809.1792), submitted; [6] Loureiro, Arenzon, Sicilia and Cugliandolo, submitted

Predicting fluxes of metabolic reactions

A. Vazquez[1], M. Argollo de Menezes[2]
[1]IAS-Princeton, USA; [2]UFF, Niteroi, Brazil

The goal of systems biology is to organize biological knowledge and transform it into fundamental laws for living organisms. We present a method for the estimation of key quantities in the metabolism of E. Coli and Yeast such as metabolic rate, enzyme activities, and metabolite concentrations. Our method is based on the topology of the particular metabolic reaction network and on the assumption of intracellular crowding, which constrains enzyme production. We compare our predictions with experiments with both E. Coli and Yeast cells, showing that the limited solvent capacity is a relevant constraint acting on cells at physiological growth conditions.

Detecting focusing motion in nonintegrable Hamiltonian system

C. Manchein[1], M. W. Beims[1,2], J. M. Rost[2]
[1]UFPR, Curitiba, Brazil; [2]MPIPKS, Dresden, Germany

"Sticky" motion occuring in mixed phase space of nonintegrable conservative systems is difficult to detect and to characterize, in particular for high dimensional phase spaces. Here, we study systematically standard maps beginning with the uncoupled two-dimensional case up to coupled maps of dimension $d = 20$. For $d > 2$ dimensional systems "sticky" motion can be interpreted as focusing of chaotic trajectories which influences the distribution of the finite time Lyapunov exponents qualitatively in the quasi-regular regime. This influence is quantified here with four variables: the variance (and the higher cumulants, skewness and kurtosis) and the normalized number of occurencies of the most probable finite time Lyapunov exponent (P_Λ). Using these four variables we find that the effect of the focusing motion on the distributions of Lyapunov exponents is equal in different unstable directions above a threshold K_c of the nonlinearity parameter K for the high dimensional cases $d = 10, 20$. Moreover, as K increases we can clearly identify the transition from quasi-regular to totally chaotic motion which occurs simultaneously in all unstable directions. The results show that the four statistical variables are a sensitive probe for focusing motion in high dimensional systems.

Homoclinic quantum numbers

F. Borondo
Dep. Quimica e Instituto Mixto de CC. Matematicas Universidad Autonoma de Madrid, Cantoblanco-28049 Madrid, Spain

The pioneering work of Poincaré and others at the turn of the twentieth century unveiled the possibility of chaotic motion in dynamical systems. Moreover, he demonstrated the importance of periodic orbits (PO), and its homoclinic and heteroclinic connections, in the hierarchical organization of the associated tangle. In 1984, Heller published his seminal work [1] on scar theory, in which the importance of PO was also demonstrated for quantum dynamics. Recently, and using a technique previously developed by us to construct scarred functions [2], we have demonstrated that the information concerning the associated homoclinic and heteroclinic motions is also contained in the quantum mechanics of the system [3]. This completes Hellers work in the sense that cares about the fate of quantum probability not circulating along the main "scarring path" due to the PO, but pushed away, in the first instance by the Lyapunov dynamics, and moving along homoclinic and heteroclinic circuits reinforcing the scarring power of the PO. Moreover, in this way we are able to define homoclinic quantum numbers., at least in some specific cases. The procedure will be illustrated with results for the scar functions along the axes in the quartic oscillator.
[1] E. J. Heller, Phys. Rev. Lett. 53, 1515 (1984); [2] G. G. de Polavieja, F. Borondo, and R. M. Benito, Phys. Rev. Lett. 73, 1613 (1994); ibid. 80, 944 (1998); [3] D. A. Wisniacki, E. Vergini, R. M. Benito, and F. Borondo, Phys. Rev. Lett. 94, 054101 (2005); ibid. 97, 094101 (2006); E.L. Sibert III, E. Vergini, R.M. Benito and F. Borondo, New J. Phys. 10, 053016 (2008).

Dynamical characteristics of plasma turbulence in TCABR tokamak

I. L. Caldas[1], Z. O. Guimaraes-Filho[1], G. Z. dos Santos Lima[1], R. L. Viana[2], I. C. Nascimento[1], Yu. K. Kuznetsov[1]
[1]Institute of Physcis, University of São Paulo, São Paulo, Brazil; [2]Physics Departament, Federal University of Parana, Curitiba, Brazil

During TCABR tokamak discharges the magnetic fluctuations activity may increase and drive the plasma edge electrostatic turbulence. For these discharges, spectral linear analyzes of electrostatic turbulence and magnetic fluctuations present several common features with a noticeable dominant peak in the MHD frequency. Dynamical analyzes were applied to find other common characteristics between electrostatic and magnetic fluctuations. A spectral version of an order parameter revealed that the turbulence and magnetic fluctuations are synchronized in the MHD frequency. Moreover, the bicoherence spectra of these two kinds of fluctuations are similar with high values in the MHD frequency. These effects are concentrated inside the plasma, near the edge. Furthermore, the recurrence quantification analysis shows that the turbulence determinism radial profile is substantially changed, becoming more radially uniform, when the magnetic fluctuations increase. In contrast with the synchronization and bicoherence spectral changes, that are radially localized, the turbulence recurrence is broadly altered at the plasma edge and the scrape-off layer.

Dewetting of ultra-thin solid films

O. Pierre-Louis[1,2], A. Chame[3], Y. Saito[4]
[1]LSP, Univ. Joseph Fourier, Grenoble, France; [2]Rudolf Peierls Centre for Theoretical Physics, Oxford, UK; [3]UFF, Niteroi, Brazil; [4]Keio University, Kanagawa, Japan

The dewetting of crystalline films with thickness ranging from two to several atomic layers is investigated.In recent experiments it was observed that a solid thin film dewets by spontaneously retracting, forming a facetted rim at its edges,and in some situations holes may also form. In our model,the transport of matter occurs via surface diffusion, and the agglomeration of the film is driven by the ratio between adsorbate-substrate interface energy and bond energy. In this work, the evolution of the film is obtained through Kinetic Monte Carlo simulations for three initial conditions:i) the film covers completely the substrate; (ii) a stripe of the substrate is initially uncovered and the film has a straight edge; iii) there is a hole in the film. Using arguments involving the diffusion equation and mass conservation, the temporal evolution of the uncovered area is predicted and compared with the simulation results. For sufficiently high temperatures, we observe that: for initial condition i), holes exhibit multi-layer rims and the uncoverage obeys a scaling law; for ii) a facetted rim develops at the edges of the film; for iii) islands form on top of the film, and when an island is in the vicinity of the hole, a rim is nucleated, and then it closes around the hole.

Two exponent power law behavior of successive correlation products: A Peripheral Limit Theorem

G. Cocho[1], M. Beltran del Rio[1], R. Mansilla[2]
[1]Instituto de Fisica, Universidad Nacional Autonoma de Mexico, Distrito Federal, Mexico; [2]Centro de Investigaciones Interdisciplinarias en Ciencias y Humanidades, Universidad Nacional Autonoma de Mexico, Distrito federal, Mexico

The Central Limit Theorem is associated to convolution products, related to the sum of probability distributions: $X = X_1 + X_2$. If $p_3 = p_1 x p_2$, where x is the convolution product, Gauss and Levy distributions are stable under such a product and the successive products of arbitrary, equal, distributions have the Gaussian as an attractor. If instead of the convolution, we define the correlation as the product, then such a product corresponds to the difference of probability distributions: $D_{1,2} = X_1 - X_2$. Now, we look for stable representations of $p_3 = p_1 x p_2$, where now x is the correlation product. These representations are very well approximated by the beta distribution $f(r) = Ar^a(N-r)^b$ where N bounds the maximum value of r $(0 < r < N)$, A is a normalization constant and a and b are real numbers. It has been shown that the beta distribution fits extremely well a wealth of situations from physics, biology, lexicography, social networks and arts.

On-off intermittency in thin film electromigration

Eric Dalton[1], Ian Clancy[2], David Corcoran[2], George Gooberman[2], Arousian Arshak[2]
[1]CTVR Stokes Institute, University of Limerick, Ireland; [2]Department of Physics, University of Limerick, Ireland

In this paper we examine electromigration in thin film aluminum interconnects via high resolution resistometer methods to investigate the induced abrupt resistance changes (ARCs). The method of preparation of aluminum samples and the abrupt resistance measurement system are described in detail. These abrupt resistance changes are analyzed against a driven logistic map which exhibits on-off intermittency. Our principal result is that the ARCs exhibit behavior consistent with an on-off intermittent system; the probability density distributions of both the magnitude of the ARCs and the times between ARCs show power-laws with exponents of -0.8 and -3/2 respectively and the ARCs show a power spectral density exponent of -1.4. These three factors are consistent with an on-off intermittent system. Finally, analogues for the physical phenomena that occur within an interconnect undergoing electromigration have been identified in the parameters of a driven logistic map.

Diffusions in fluctuating geometries

F. Debbasch[1], C. Chevalier[2]
[1]ERGA-LERMA, Université Paris 6, Paris; [2]LPTMC, Université Paris 6, Paris, France

Lateral diffusions on interfaces are of great biological importance and can be modeled by stochastic motions on 2D surfaces. Though real interfaces present highly fluctuating geometries, usual models of lateral diffusions neglect these fluctuations altogether. It is shown here that geometry fluctuations couple non linearly to diffusions and, contrary to common belief, have a drastic influence on diffusions on all scales, including scales much larger than those on which the geometry fluctuates . Analytical and numerical results also indicate that, generically, the net large-scale effect of fluctuations cannot be taken into account by simply renormalizing the diffusion coefficient and that realistic mean field models are necessarily more complicated.

Patterns formation in optical parametric oscillator

K. Dechoum[1]
[1]UFF, Niteroi, Brazil

We study the light flows that come out from a optical parametric oscillator (a Fabry-Perot resonator with a nonlinear cristal inside that couples the cavity modes). These flows are associated with the dynamics of two noncommuting quadratures of each mode component of the light field. We show that manipulating two parameters, the pump intensity and cavity detuning, we can access a rich variety of phases of the light, among them a Lifshitz modulated phase and a Kosterlitz-Thouless type of phase transition, as found in superfluid and others bidimensional systems.

Many-body effects in the coalition formation process

M. Del Castillo-Mussot, F. Samaniego-Steta, G. G. Naumis
Instituto de Fisica, UNAM, Mexico

Two-body interactions in the process of coalition or block formation do not describe all features occurring in real world. Therefore, an study of the effects of three-body interactions in coalition formation is presented. The model can be used to study conflicts, political struggles, political parties, social networks, wars and organizational structures. As an application, we analyze a simplified model of the recent invasion of Iraq.

Synchronized release in sensory synapses

Manuel C. Eguia, Ramiro O. Vergara
Laboratorio de Acustica y Percepcion Sonora, Universidad Nacional de Quilmes, Argentina

Most of the information in our brains is conveyed by discrete events (action potentials) that can be interpreted as a digital code. However, our senses receive analog inputs from the environment. At some early stage of sensory processing a sort of conversion must be performed. Primary receptor cells generate graded potentials in response to stimuli. But their primary nerve afferents re-encode this information as a temporal pattern of action potentials. In auditory, visual and vestibular systems a highly specialized synapse (ribbon synapse) plays a chief role in such a conversion. The ribbon synapse has unique features: it can release neurotransmitter at high rates for sustained periods, it is extremely fast and reliable and it has little or no plastic behavior. It is thought to achieve this by means of coordinated multi-vesicular fusion; but the way it does remain unknown. In this work we propose a dynamical model of the ribbon synapse that is able to reproduce the main features of these units. Unlike previously reported models, the dynamics of the vesicles of neurotransmitter is strongly coupled. We use our model to compare two recently proposed underlying mechanisms of multi-vesicular release: compound fusion and coordinated release. For the case of the auditory system, we also show that these synapses are crucial to encode temporal information in the sub-millisecond range, a requirement for the localization of sound sources and the perception of pitch.

Fermi acceleration and dissipation on the annular billiard

R. Egydio de Carvalho, F.C. Souza, E.D. Leonel, C.V. Abud
UNESP-Rio Claro, São Paulo, Brazil

We study the phenomenon of unlimited energy growth for a particle moving in the annular billiard. The model is considered under two different scenarios: static and with breathing boundaries. We show that when the dynamics is chaotic for the static case, the introduction of a time-dependent perturbation allows that the particle experiences the phenomenon of Fermi acceleration even when the oscillations are periodic. On the other hand, some properties of the annular billiard under the presence of weak dissipation are also studied. We show that, when the colisions with the boundaries are inelastic, the average energy of a particle acquires higher values than its average energy of the conservative case. The creation of attractors, associated with a chaotic dynamics in the conservative regime constitute a generic mechanism to increase the average energy of a particle in a dissipative dynamical systems.

Nonlinear wave-vortex interaction

Claudio Falcón[1] and Stéphan Fauve[2]
[1]Departamento de Física, Facultad de Ciencias Físicas y Matemáticas, Universidad de Chile, Casilla 487-3, Santiago, Chile; [2]Laboratoire de Physique Statistique, Ecole Normale Supérieure, CNRS, UMR 8550, 24, rue Lhomond, 75005 Paris, France

We present an experimental study on the effect of a electromagneticaly generated vortex flow on parametrically amplified waves at the surface of a fluid. The underlying vortex flow, generated by a periodic Lorentz force, creates spatio-temporal fluctuations that interact nonlinearly with the standing surface waves. We characterize the bifurcation diagram and measure the power spectrum density (PSD) of the local surface wave amplitude. We show that the parametric instability threshold increases with increasing intensity of the vortex flow, as do the saturation exponents of the fluctuating wave amplitude. A theoretical model is proposed to describe the observed behavior as a quasi-reversible system in presence of noise.

Encoding and transmission of information in the brain: differences between fMRI and neurophysiological data

L. Franco[1], E.T. Rolls[2], F. Grabenhorst[3], I.A. Molina[1], J.M. Jerez[1]
[1]Universidad de Málaga, Spain; [2]Oxford Centre for Computational Neuroscience, U.K.; [3]University of Oxford, U.K.

We analyze using information theory the encoding and transmission of information in the brain from fMRI and neurophysiological recordings. The growth of the transmitted information is analyzed as recordings, from different voxels in one case and cells in the other, are grouped together. In the first case a subjective rating produced by warm and cold stimuli applied to humans is analyzed from functional magnetic resonance neuroimaging data on individual trials from the activations of groups of voxels in the orbitofrontal and medial prefrontal cortex pregenual cingulate cortex. The information available was typically in the range 0.10.2 (with a maximum of 0.6) bits. The prediction was typically a little better with multiple voxels than with one voxel, and the information increased sublinearly with the number of voxels up to typically seven voxels. For comparison, the activity of a single neuron in the orbitofrontal cortex of a macaque monkey can predict with 90% correct and encode 0.5 bits of information about whether an affectively positive or negative visual stimulus has been shown, and the information encoded by small numbers of neurons (2-4) is typically independent. We further analyze the pairwise stimulus-dependent correlations between voxels and cells, and found that in both cases (fMRI and neurophysiological data) this correlation measure does not encode significant amounts of information. Differences and similarities between both types of data are further discussed.

Relative efficiency of financial markets and the algorithmic complexity theory

R. Giglio[1], S. da Silva[1], R. Matsushita[2], A. Figueiredo[2], A. Ranciaro Neto[3], Iram Gleria[3]
[1]Federal University of Santa Catarina, Florianópolis, Brazil; [2]University of Brasília, Brasília, Brazil; [3]Federal University of Alagoas, Maceió, Brazil

Financial economists usually assess market efficiency in absolute terms. This is to be viewed as a shortcoming. One way of dealing with the relative efficiency of markets is to resort to the efficiency interpretation provided by algorithmic complexity theory. Algorithmic complexity theory makes a connection between the efficient market hypothesis and the unpredictable character of stock returns because a time series that has a dense amount of nonredundant information exhibits statistical features that are almost indistinguishable from those observed in a time series that is random. Measurements of the deviation from randomness provide a tool to assess the degree of efficiency of a given market. We employ such an approach in order to rank assets of the IBOVESPA index.

Optical modes in chaotic dielectric microcavities

Soo-Young Lee
Seoul National University, Seoul, South Korea

Optical modes in 2-D dielectric microcavities have some correspondence to eigenfunctions of open quantum billiards since they share the Helmholtz equation inside the cavities and billiards. Therefore, many quantum chaotic features can be found in the optical modes. We study localizations in optical modes based on ray dynamical analysis and husimi functions. We find that the scarred optical modes distorted by the openness can be understood by the ray distribution in phase space, called steady probability distribution, and there is another localized optical mode, called quasiscarred mode due to the absence of underlying unstable periodic orbit.

Analysing and controlling the tax evasion dynamics and flutuations via majority-vote model

F.W.S. Lima
UFPI, Teresina-Piau, Brazil

Within the context of agent-based Monte-Carlo simulations, we study the well-known Majority-vote model (MVM) with noise applied to tax evasion behavior on simple square lattice, Voronoi-Delaunay random lattice, Barabasi-Albert network, and Erdös-Rényi random graphs. In the order to analyze and to control the fluctuations in the evasion tax in the economics model proposed for Zaklan, in the neighborhood of the noise critical q_c. The Zaklan model had been studied recently using the equilibrium Ising model. Here we showed that Zaklan model is robust that can be reproduced also for nonequilibrium model MVM on various topologies.

Long-range elastic-mediated interaction between nanoparticles adsorbed on free-standing smectic films

I.N. de Oliveira[1], M.S.S. Pereira[1], M.L. Lyra[1], C. Filgueiras[2], C. Sátiro[2,3], and Fernando Moraes[2]
[1]Instituto de Física, Universidade Federal de Alagoas, Maceió-AL, Brazil; [2]Departamento de Física, Universidade Federal da Paraíba, João Pessoa-PB, Brazil; [3]Unidade Acadêmica de Garanhuns, Universidade Federal Rural de Pernambuco, Garanhuns-PE, Brazil

We determine the elastic-mediated interaction between colloidal nanoparticles adsorbed on the surface of free-standing smectic films. In contrast with the short-range character of the elastic mediated force between particles adsorbed on smectic films supported by a solid substrate, the effective force acquires a long-range character in free-standing films, decaying with the particles distance R as slow as $1/R$. We also discuss the dependence of the effective interaction potential on the surface tension γ and film thickness. We show that it decays as $1/\gamma$ in the regime of strong anchoring and becomes independent of the film thickness at a characteristic surface tension.

The architecture of mutualistic networks minimizes competition and increases biodiversity

Antonio Ferrera and Bartolo Luque
Departamento de Matematica Aplicada y Estadistica, ETSI Aeronauticos, Universidad Politecnica de Madrid, Plaza Cardenal Cisneros 3, Madrid 28040, Spain

The main theories of biodiversity either neglect species interactions or assume that species interact randomly with each other. However, recent empirical work has revealed that ecological networks are highly structured, and the lack of a theory that takes into account the structure of interactions precludes further assessment of the implications of such network patterns for biodiversity. Here we use a combination of analytical and empirical approaches to quantify the influence of network architecture on the number of coexisting species. As a case study we consider mutualistic networks between plants and their animal pollinators or seed dispersers. These networks have been found to be highly nested, with the more specialist species interacting only with proper subsets of the species that interact with the more generalist. We show that nestedness reduces effective interspecific competition and enhances the number of coexisting species. Furthermore, we show that a nested network will naturally emerge if new species are more likely to enter the community where they have minimal competitive load. Nested networks seem to occur in many biological and social contexts, suggesting that our results are relevant in a wide range of fields.

Interaction of a bouncing ball with a sinusoidally vibrating table

Elbert E. N. Macau, Marcus V. Carneiro, Joaquim J. Barroso
INPE - Instituto Nacional de Pesquisas Espaciais, São José dos Campos, Brazil

Exploring all its ramifications, this presentation gives an overview of the fundamental bouncing ball problem, which consists of a ball bouncing vertically on a sinusoidally vibrating table under the action of gravity. The dynamics is modeled on the basis of a discrete map of difference equations, which numerically solved fully reveals a rich variety of nonlinear behaviors, encompassing irregular non-periodic orbits, subharmonic and chaotic motions, chattering mechanisms, and also unbounded non-periodic orbits. For periodic motions, the corresponding conditions for stability and bifurcation are determined from analytical considerations of a reduced map. Through numerical examples, it is shown that a slight change in the initial conditions makes the ball motion switch from periodic to chaotic orbits bounded by a velocity strip $v = \pm s/(1-r)$, where s; is the non-dimensionalized shaking acceleration and r the coefficient of restitution which quantifies the amount of energy lost in the ball-table collision. Moreover, a detailed numerical discussion of the excitation of the unstable 1-periodic mode and the ensuing transition to its stable counterpart mode is also given.

Stability of polymer blends with free surfaces

S. Madruga[1], U. Thiele[2]
[1]Universidad Politécnica de Madrid, ETSI Aeronáuticos, Spain; [2]School of Mathematics, Loughborough University, UK

Films of polymer blends are used in advanced technological applications either as homogeneous coatings or as structured functional layers. Their stability and potential use is mostly determined by the wettability properties of the substrate and is well understood for single component liquids. However, in many relevant applications the film consists of a binary mixture such as a polymer blend. For such systems the dynamics of the decomposition within the film and of the dewetting of the film itself may couple. This allows for new pathways of structuring like decomposition induced dewetting. We present a model for thin films of binary mixtures, such as polymer blends, with free surfaces that allows the study of the coupling between profile evolution and decomposition. The model is based on model-H [1] describing the coupled transport of concentration (convective Cahn-Hilliard equation) and momentum (Navier-Stokes-Korteweg equations) fields supplemented by boundary conditions at the substrate and the free surface. We determine the homogeneous and vertically stratified base states of free surface films of polymer mixtures and analyse their linear stability with respect to lateral perturbations [2]. For purely diffusive transport, an increase in film thickness either exponentially decreases the lateral instability or entirely stabilizes the film. The inclusion of convective transport leads to a further destabilization as compared to the purely diffusive case. In some relevant cases the inclusion of convective transport changes the stability behavior qualitatively [3]. We furthermore present results regarding the dependence of the instability on several other parameters, namely, the Reynolds number, the Surface tension number and the ratio of the typical velocities of convective and diffusive transport. SM and UT acknowledge support by the EU via a FP7 Marie Curie Reintegration Grant (PERG04-GA-2008-234384) and ITN [PITN-GA-2008-214919 (MULTIFLOW)], respectively.

[1] D.M. Anderson, G.B. McFadden, and A.A. Wheeler. Ann. Rev. Fluid Mech. 30, 139-165 (1998); [2] U. Thiele, S. Madruga, and L. Frastia. Phys. of Fluids. 19, 122106, (2007); [3] S. Madruga and U. Thiele. To appear in Phys. of Fluids.

Fast, parallel and secure cryptography algorithm using Lorenz's attractor

A. G. Marco[1], A. S. Martinez[2,3] and O. M. Bruno[4]
[1]ICMC, USP, São Carlos, SP, Brazil; [2]FFCLRP, USP, Ribeirao Preto, SP, Brazil; [3]INCT-CS (National Institute of Sciece and Technology in Complex Systems); [3]IFSC, USP, São Carlos, SP, Brazil

A novel crypto method based on the Lorenz's attractor chaotic system is presented. The proposed algorithm is secure and fast, making it practical for general use. We introduce the chaotic operation mode, which provides an interation among the password, message and a chaotic system. It ensures that the algorithm yields a secure codification, even if the nature of the chaotic system is known. The algorithm has been implemented in two versions: one sequential and slow and the other, parallel and fast. Our algorithm garantees the integrity of the ciphertext (we know if it has been altered, which is not assured by traditional algorithms) and consequently its autenticity. Numerical experiments are presented, discussed and show the behavior of the method in terms of security and performance. The fast version of the algorithm has a performance comparable to AES, a popular crypto program used commercially nowadays, but it is more secure, which makes it immediately suitable for general purpose crypto applications. An internet page has been set up, which enables the readers to test the algorithm and also to try to break into the cipher in.

Learning to play Nash in deterministic uncoupled dynamics

Diana A. Mendes, Vivaldo M. Mendes, Orlando Gomes
IBS-ISCTE Business School and UNIDE, Lisbon University Institute, Avenida das Forcas Armadas, 1649-026 Lisbon, Portugal, diana.mendes@iscte.pt; Lisbon University Institute and UNIDE, Portugal; ESCS-IPL Lisbon and UNIDE, Portugal

This paper is concerned with the following problem. In a bounded rational game where players cannot be as superrational as in Kalai and Leher (1993), are there simple adaptive heuristics or rules that can be used in order to secure convergence to Nash equilibria, or convergence only to a larger set designated by correlated equilibria? Are there games with uncoupled deterministic dynamics in discrete time that converge to Nash equilibrium or not? Young (2008) argues that if an adaptive learning rule follows three conditions — (i) it is uncoupled, (ii) each player's choice of action depends solely on the frequency distribution of past play, and (iii) each player's choice of action, conditional on the state, is deterministic — no such rule leads the players' behavior to converge to Nash equilibrium. In this paper we present a counterexample, showing that there are simple adaptive rules that secure convergence, in fact fast convergence, in a fully deterministic and uncoupled game. We used the Cournot model with nonlinear costs and incomplete information for this purpose and also illustrate that this convergence can be achieved with or without any coordination of the players actions.

Kalai, E. and Lehrer, E. (1993). Rational learning leads to Nash equilibrium. Econometrica, 61:1019–1045; Young, H. P. (2008). Learning by Trial and Error, mimeo, University of Oxford.

Mass condensation on networks with pair-factorized steady states

B. Waclaw[1], J.Sopik[2], W.Janke[1], H.Meyer-Ortmanns[2]
[1]University of Leipzig, Germany; [2]Jacobs University Bremen, Germany

A variety of stochastic processes out-of-equilibrium is summarized under the name of stochastic mass transport models, mass transport in the sense of microscopic dynamics that involves stochastic transport of some conserved quantity, called "mass", from one point in space to another. Examples for such processes are traffic flow, in particular traffic in the cell, force propagation in granular media, aggregation and fragmentation of clusters, and others. We shall consider variations of mass transport models with interactions leading to steady states, which by construction of the hopping rates factorize over the links of arbitrary connected graphs. These states are called pair-factorized steady states. For systems in one and two dimensions we derive the phase structure from these states, in particular the transition from a liquid phase to a phase with a condensate. Condensation amounts to spontaneous symmetry breaking in these systems when the dynamical rules are symmetric. Mass condensation is frequently observed in natural systems, for example as jams in traffic phenomena. We derive the critical mass density above which a condensate forms. In one dimension we furthermore analytically predict the shape of the condensate, its scaling with the system size, its fluctuations and the single-site mass distribution. The shape of the condensate can be tuned from an extended to a localized one via the competition of local and ultralocal interactions that are implemented in the hopping rates. The scaling shows features familiar from first- and second order phase transitions. The system of anisotropic hopping that we consider in two dimensions can be dimensionally reduced to an effective zero-range process in one dimension. Here we predict the formation of a condensate that is extended in one direction and localized in the other direction. All analytical results are well confirmed via numerical simulations. We give an outlook to applications and generalizations to higher dimensions.

Nonlinear differential equations with a common type of solution

Fernando D. Nobre, Marco A. Rego-Monteiro, and Constantino Tsallis
Centro Brasileiro de Pesquisas Físicas, Rua Xavier Sigaud 150, 22290-180 - Rio de Janeiro - RJ - Brazil

Some linear and nonlinear differential equations presenting a common type of solution are presented. The nonlinear equations consist of generalizations, including nonlinear terms, of the standard Fokker-Planck, Schrödinger, and Klein-Gordon equations. General solutions for these equations are expressed in terms of q-exponentials, well-known within the formalism of nonextensive statistical mechanics. In some cases, the same dispersion relation associated with the corresponding linear equations holds for the nonlinear equations.

Imbalance of synchronous activity in epilepsy

G. J. Ortega[1], I. Herrera Peco[1], R. Garcia de Sola[1], J. Pastor[2]
[1]Servicio de neurocirugia, Hospital Universitario de la Princesa, Madrid, Spain; [2]Servicio de neurofisiologia, Hospital Universitarioo de la Princesa, Madrid, Spain

Epilepsy is associated with dramatic changes in synchronization activity during the entire process of seizure development. Recent finding suggest that asynchronous activity is present at the first stage of the seizure initiation. We shall present here a methodological procedure to quantify the synchronous activity in the mesial area of temporal lobe epileptic patients. By using elements from complex network theory and information tools we show that asynchornous activity seems to be essential in favouring the appearance of clinical seizures. Our results are also contrasted with pseudo-seizure caused by using a seizure inducer agent, as it is the etomidate. Our results are import from the physician point of view allowing a fast and clear lateralization of the epileptogenic hemisphere. Standard EEG and Foramen Ovale Electrodes has been used for the time series analysis.

Time series segmentation based on entropy and fluctuations

O.F. de Sousa[1,2], P.J. Marinho[1,2], T.J.P. Penna[1,2], A.C. Bicharra Garcia[3,2]
[1]Instituto de Fisica, Universidade Federal Fluminense, Niteroi, Brazil; [2]Instituto de Computaao, Universidade Federal Fluminense,Niteroi, Brazil; [3]ADDLabs, Universidade Federal Fluminense, Niteroi, Brazil

Time-series segmentation is an important processing procedure for analyzing a time series. Some domains such as bioinformatics, medical treatment, finance and data mining especially emphasize it for making good prediction and decision. One of the most commonly used representations is piecewise linear approximation. This representation has been used by various researchers to support clustering, classification, indexing and association rule mining of time series data. A variety of algorithms have been proposed to obtain this representation, with several algorithms having been independently rediscovered several times. Here, we present a new approach for segmentation of highly non-stationary time series based on the analysis of the fluctuations rather than the value of the series themselves. We applied our method for synthetic time series as well as real data from the petroleum industry. Our approach is rather very general compared to the previous ones since it works for any size of the segments and do not depend on previous knowledge of the number of segments. Another advantage is that our method is more robust concerning the sensitivity to outliers.

Chaotic properties of three-dimensional billiards

Jorge Hernandez-Tahuilan, David P. Sanders
Departamento de Fisica, Facultad de Ciencias, Universidad Nacional Autonoma de Mexico, Mexico

We study the chaotic properties of three-dimensional and higher-dimensional billiards. Numerical results for the spectrum of Lyapunov exponents indicate that they are completely chaotic. We also study the application of other numerical techniques to exclude the presence of elliptic islands.

The physics of the random telegraph signals - decreasing the noise in semiconductor devices: An analytical and computational approach

R. da Silva[1], G.I. Wirth[2]
[1]Informatics Institute - UFRGS; [2]Engineering School - UFRGS, Brazil

Random telegraph signals are fluctuations in the drain current in semiconductor devices, for example, CMOS transistors, generated by successive capture and emission of electrons by traps distributed in the random interface between Si and SiO2. Such transitions depend on Fermi Level of the system and density of states of the traps spatially distributed according to a Poisson distribution. Experimental results suggest that the noise caused by these transitions can be decreased using appropriate cyclo-stationary time functions to evolve the Fermi Level. Such phenomenon has an important technological impact because is directly related to flash memory failures. In this work we show several different theoretical approaches for modeling this phenomenon in time and frequency dominion. Our results not only shows that the noise can be reduced by a factor of 10 but also shows a complete modeling that exhibits approximated formulas for different regimes: small and large oscillation periods for square and sinusoidal input functions.

Periodic-orbit analysis and intermingled basins in biological systems

S.E. de Souza Pinto[1], R.F. Pereira[1], S. Camargo[2], R.L. Viana[3], S.R. Lopes[3]
[1]Universidade Estadual de Ponta Grossa; [2]Universidade de São Paulo; [3]Universidade Federal do Paraná, Brazil

Chaotic dynamical systems with two or more attractors lying on invariant subspaces may, provided certain mathematical conditions are fulfilled, exhibit intermingled basins of attraction: Each basin is riddled with holes belonging to basins of the other attractors. In order to investigate the occurrence of such phenomenon in a bilogical dynamical systems – two-species competition with extinction – we have characterized quantitatively the intermingled basins using periodic-orbit theory and scaling laws. The latter results agree with a theoretical prediction from a stochastic model, and also with an exact result for the scaling exponent we derived for the specific class of models investigated. We discuss the consequences of the scaling laws in terms of the predictability of a final state (extinction of either species) in an ecological experiment.

Solution of a lattice gas model with orientational degrees of freedom on a Husimi lattice

Tiago J. Oliveira[1], Jürgen F. Stilck[1], Marco Aurélio A. Barbosa[2]
[1]Inst. de Fisica-UFF, Niteroi, RJ, Brazil; [2]Inst. de Fisica-UNB, Brasilia, DF, Brazil

We study a lattice gas in which particles interact with a soft core potential combined with orientational degrees of freedom which resemble the formation od hydrogen bonds. The model was originally proposed and studied with simulations on a triangular lattice (1), and here its thermodynamic properties on a Husimi lattice built with hexagons are obtained. Besides a gas phase, two liquid phases are found, with different densities (HDL-high density liquid and LDL-low density liquid). The density anomaly is also present in our solution, which display loci of maximum and minimum density. However, the phase diagram we found shows some qualitative differences when compared to the simulational results. In the simulations, the G-LDL and LDL-HDL coexistence lines end at critical points, whereas all transitions in the Husimi lattice phase diagram are discontinuous. The three coexistence lines (G-LDL, LDL-HDL, and G-HDL) meet at a triple point.

[1] V. B. Henriques and M. C. Barbosa, Phys. Rev. E 71, 031504 (2005); A. L. Balladares, V. B. Henriques, and M. C. Barbosa1, J. Phys.: Condens. Matter 19,116105 (2007).

Analysis of self-organized criticality in complex systems

Ugur Tirnakli
Department of Physics, Faculty of Science, Ege University, 35100 Izmir, Turkey

Recently Caruso *et al.* performed an analysis on two-dimensional earthquake model (Olami-Feder-Christensen model) considering avalanche size differences and they showed that, if the system is in criticality, the probability density function of avalanche size differences has q-Gaussian shape [1]. Then, the same type of analysis has been performed for one of the prototype models of self-organized criticality, Ehrenfest dog-flea model [2], and it is found that the relation between the exponent τ of avalanche size distribution and the q value of the appropriate q-Gaussian obeys the analytical result obtained in [1]. Here, we will discuss the generality of these results making use of two more model systems.

[1] F. Caruso et al., Phys. Rev. E 75 (2007) 055101(R); [2] B. Bakar and U. Tirnakli, Phys. Rev. E 79 (2009) 040103(R).

Superdiffusive dynamics in Hamiltonian systems

R. Venegeroles
Universidade Federal do ABC, Santo André, Brazil

Hamiltonian mixed system are typically characterized by two asymptotic algebraic laws: superdiffusion and decay of recurrence time statistics, described by their characteristic exponents β and γ, respectively. In this work I will discuss some recent analytical results that point towards the universality of these exponents. Some perspectives for billiards also will be discussed.

Properties of memory dynamics with Generalized Simulated Annealing for modeling mental processes

R. S. Wedemann[1], R. Donangelo[2], L. A. V. de Carvalho[3]
[1]Instituto de Matemática e Estatistica, UERJ, Rio de Janeiro, Brazil; [2]Instituto de Fisica, UFRJ, Rio de Janeiro, Brazil; [3]COPPE, UFRJ, Rio de Janeiro, Brazil

We have explored different memory retrieval mechanisms in neural network models for memory functioning in mental processes. In our models, we describe pathologies such as neurosis, as associative memory processes. Complex network modules, corresponding to sensorial and symbolic memories, are constructed with self-organizing mechanisms, inspired in known biological microscopic mechanisms. These modules interact representing unconscious and conscious mental processes. The topologies which result from this self-organization have a power-law and q-exponential behavior for the node degree distributions. We have thus modeled memory access dynamics by a generalization of the Boltzman Machine (BM) called Generalized Simulated Annealing (GSA), derived from the nonextensive formalism. We will show some properties of the BM and GSA, when used to model memory dynamics, for the topologies of the neural network substrata of our models.

Clustering parasitemia time series of malaria patients

Priscila C. Albuquerque da Silva, Rita M. Zorzenon dos Santos
Departamento de Física - UFPE Recife, PE, Brazil

Despite of all the efforts in the last decades to develop better control and surveillance strategies, malaria is one of the most fatal infectious diseases worldwide killings on average two individuals per minute. The anti-malarial drugs to control mosquito population or parasite proliferation and malaria symptoms have shown limited efficiency due to the ability of both, mosquito and parasite, to develop drug resistance. To improve the control of malaria it is important to understand the dynamics of interaction between the parasite and the human host and why infected individuals living in endemic areas do not develop immunity. In this work we search for common patterns on the daily parasitemia time series obtained from 193 malaria patients that were treated with different drugs. Since these series have different lengths we use a set of parameters to reduce uniformly the dimension of the parameter space for all series. Then we use the clustering technique SPC (Super-paramagnetic Clustering) to group the patients according to their similarities. This clustering technique maps the patients into spins of a ferromagnetic Potts model (q10) and studies its phase transitions throughout Monte Carlo simulations. The analysis of the super-paramagnetic phase allows grouping the patients in an unsupervised way. Surprisingly the patients were grouped according to the similarities of their responses to different treatments.

POSTER CONTRIBUTIONS

Unstable periodic orbits and chaos in standard map

S. A. Abdulack[1], S. E. S. Pinto
Universidade Estadual de Ponta Grossa, Paraná, Brazil

Conservative dynamical systems are a special class of systems that present importants features, some of them are not all known. Hamiltonian systems may exhibit complex motion. Two basic features of those systems is that they are area-preserving and Lyapunov exponents ocurr in pairs. We analyze the Chirikov-Taylor map, or standard map $f(x_n, y_n) = (x_n + y_{n+1}, K \cdot sin(x_n))$ $(mod\ 2\pi)$ which have periodic and chaotic regions in the same phase space for certain values of control parameter K. We analyzed unstable periodic orbits (UPOs) and finite-time Lyapunov exponents (FTLE) for some values of K. The unstable periodic orbits are one of the fundamental building blocks of invariant sets in chaotic systems. In this way we can obtain important quantities related to UPOs. For $K = 0$, the system is hyperbolic and integrable, and chaos can be ruled out. On the other hand, when the control parameter is about $K \approx 0.971635$ the last KAM surface is broken and some regions of space are filled with chaotic trajectory. Although the map become nonhyperbolic for great K the shadowing procedure can be done for long time. Finally for K greater than unity the islands of stability disappear giving rise to the chaotic motion. There is a K for which chaotic trajectories fill entire phase space.

Fill factor and efficiency characteristics of dye sensitized nanocrystalline TiO_2 photoelectrochemical cell

J. S. Agnaldo[1], J. G. Silva[1], J. C. Cresssoni[1], G. M. Viswanathan[2]
[1]UFAL-Maceio, Alagoas, Brasil; [2]Consortium of the Americas for Interdisciplinary Science, University of New Mexico, Albuquerque, NM, USA

An important feature in semiconductor physics and optic-electronic devices is the current-voltage relationship. In this work we propose a new linearizable model for the nonlinear photocurrent-voltage characteristics of nanocrystalline TiO_2 dye sensitized solar cells (DSSC) and the predicted values for fill factors and efficiency. These nanoporous photoelectrochemical cells have a TiO_2 surface, a wide band gap semiconductor. Light is used to excite electrons of the dye anchored on the surface which are then injected in the conduction band of the TiO_2 film. This electrochemical process is regenerative with part of the energy produced being lost due to charge recombination within the electrolyte. The injected electrons diffuse through the small crystals of TiO_2 and produce a current in an external circuit. The cycle is completed with the electrons returning to the platinum backelectrode. We show that photovoltaic DSSC has a universal behavior producing a data collapse onto a single curve. This allows for a complete characterization of the cell by making only three experimental measurements. The knowledge of the short circuit current, the open circuit voltage, and an intermediate current-voltage value, makes it possible to determine the full current-voltage curve of the cell, besides with the fill factor and efficiency.

From closed to open chaotic systems: the case of optical cavities

E. G. Altmann
IF-UFRGS, Porto Alegre, Brazil

Recently, the effect of oppeness on the dynamics of chaotic systems experienced a renewed interest. Part of this interest comes from experimental and theoretical developments which started to consider the effect of measurement devices, absorption, and other forms of leaks in a variety of otherwise closed systems. After a general introduction to the problem, I will illustrate the benefits of a theoretical treatment that combines tools designed for open and closed systems independently[1]. I will then focus on optical dielectric cavities whose ray dynamics shows coexistence of regular and chaotic trajectories. Two effects of oppeness will be investigated. (i) The specular reflection of rays is modified in open dielectric cavities due to wave corrections. I show that a modified ray dynamics explain previous observations and predicts the appearance of non-Hamiltonian dynamics[2]. (ii) The escape of rays is described in terms of the theory of transient chaos. I show why despite the dramatic effect of non-hyperbolicities on the temporal decay of energy inside the cavity (from exponential to power law) the far-field emission changes only slightly in time[3].

[1] E. G. Altmann and T. Tel, "Poincare recurrences from the perspective of transient chaos" Phys. Rev. Lett. 100, 174101 (2008); [2] E. G. Altmann, G. Del Magno, and M. Hentschel, "Non-Hamiltonian dynamics in optical microcavities resulting from wave-inspired corrections to geometric optics", EPL 84, 10008 (2008); [3] E. G. Altmann, "Emission from dielectric cavities in terms of invariant sets of the chaotic ray dynamics", Phys. Rev. A 79, 013830 (2009).

Scaling laws for aggregation process of wandering particles with correlated walks

I. N. Barbosa, S. G. Alves
UFSJ, Minas Gerais, Brazil

In a recent paper, Huang *et al.* investigated a diffusion limited aggregation like model where a new step of the walker is done inside an angle $\delta\theta$ around the last step direction[1]. The author found that the clusters exhibit a fractal dimension given by $D = \frac{d^2+d_w+1}{d+d_w+1}$, where d is the dimension of the space, in this case $d = 2$, and d_w is the particle trajectory dimension. This result suggest a dependency of the fractal dimension of the cluster with the parameter $\delta\theta$, that controls the particle trajectory dimension. However, these results were obtained using clusters with 25000 particles, a very small number to investigate scaling laws in aggregation process. In the present work, we extend this investigation considering large scale simulation. Scaling laws are obtained using careful simulations where the obtained clusters have up to 10^7 particles. The preliminary results show that the aggregates obtained with this model exhibit a crossover from BA-like behavior to the DLA-like characterized by the fractal dimensions $D \approx 2$ and $D \approx 1.7$, respectively. The point separating these two scaling behaviors depends on the parameter $\delta\theta$. A scaling function is depicted with two scaling exponents characterizing the mass-radium and peripheral particles.

[1] Sheng-You Huang, Xian-Wu Zou, Zhi-Jie Tan and Zhun-Zhi Jin, Phys. Lett. A **292**, 141 (2001).

A model of partial diferential equations for the propagation of HIV in $TCD4^+$ cells

R. F. S. Andrade[1,3], E. B. S. Marinho[1], F. S. Bacelar[2]
[1]Instituto de Física, Universidade Federal da Bahia, 40210-340 Salvador Brazil; [2]Instituto de Fisica Interdisciplinar y Sistemas Complejos - Universitat de les Illes Balears, Spain; [3]National Institute of Science and Technology for Complex Systems, Brazil

The acquired immunodeficiency syndrome (AIDS) is caused by virus human immunodeficiency (HIV). By attacking the cells of the immune system, especially the $TCD4^+$

cells, the virus causes a decrease of the immune defenses, facilitating the emergence of opportunistic diseases. Although the virus is found in the blood, the infection of the $TCD4^+$ cells occurs mainly in the thymus tissue, where the defense cells are matured and differentiated. In this work we use a model of partial differential equations (PDE) to describe the proliferation of HIV that takes into account such aspect. The model is based on a description of the elementary steps of the $TCD4^+$ infection, but do to consider explicitly the presence of the virus. The variables describe the density of $TCD4^+$ cells in a region of the thymus, which can be found in healthy, infected (A and B) and dead states. The dead $TCD4^+$ are continuously replaced by the new cells produced by the body. The model is a generalization of a model of ordinary differential equations (ODE), with the presence of a term of delay time, to which a diffusion term is added. The results show that presence of the diffusion term alter the predicted results of the ODE model. For the same parameter set, the diffusion coefficient causes a noticeable change in the latency time, one of the main dynamical features of the system. As in the ODE model, this time is associated with the flow of trajectories in a region of very slow dynamics in the phase space. Therefore, understanding the dynamics provided by the PDE model profits from the ODE description. The role of the diffusion term is to couple different trajectories corresponding the evolution of $TCD4^+$ cells located in nearby regions of the thymus. Starting from initial conditions where the fraction of infected cells is described by a random distribution over on a constant value, it is possible to show that the coefficient of diffusion is directly related to the latency time.

Discrete-time predator-prey model for blowfly populations

G. Andreguetto[1], R. A. Kraenkel[1], R. M. Coutinho[1], W. A. C. Godoy[2]
[1]IFT-UNESP, São Paulo, Brazil; [2]ESALQ-USP-Piracibaba, Piracicaba, Brazil

In this study we present a discrete-time model for two interacting species of blowflies, one being a prey and another a predator. Two stages of blowfly life history are considered, larvae/egg and adults. Some species of blowflies are facultative predators and intraguild predation only occurs during larval stage. The predator gain with predation is both in survival and fertility. There are also effects of depletion in the survival and fecundity due to competition among immatures in these populations. Taking these effects into account our model was built considering transferring rates from larvae to adults, which is the survival of population, and from adults to larvae, which is the fecundity of the females. These rates are dependent on the population of immatures and, based on earlier models, this dependence was modeled using exponential functions, in a Ricker-like functional response. In this way, we have a nonlinear discrete-time model for these intra- and inter-specific interactions. Earlier models for these individuals considered the dynamics of only one population. Then we show that the model can be rewritten in terms of the adults only, therefore reducing the order of the system of equations. This system presents a dynamics which goes through bifurcations for both prey and predator evolution. These occur when parameters related to maximum survival and fecundity are varied. When maximum survival and fertility is increased above a certain critical value complex behavior is found. Also, we note that prey can be eliminated when predation pressure is increased above a threshold.

Network analysis of Folksonomies: creating a recommendation engine

M. Argollo de Menezes[1], C.E.C. Galhardo[1]
[1]UFF, Niteroi, Brasil

We analyse the hypergraph structure of CiteULike*, an archiving system for scientific articles and books and the social bookmarking site Delicious**. These "Folksonomies" have the property that information about content (articles, books, hyperlinks) is provided by users by means of tags (or keywords). We create knowledge networks, where tag sharing symbolizes semantic proximity of contents and links are added according to this proximity. We apply statistical analysis and community detection algorithms to such networks to provide means for efficient information retrieval and show that content is efficiently organized in such networks, with distinct topics arranged in separate clusters. Finally, we propose the development of a recommendation engine for CiteULike.

* http://www.citeulike.org ** http://delicious.com

Finding alternative representations of formal languages: theorem proving with random walks

E.F. Galvão, M. Argollo de Menezes
UFF, Niteroi, Brasil

Formal grammars are means of representing knowledge by means of relations between elements in a systematic, recursive way. Examples of its wide range of application include Euclid's axiomatization of Geometry, the phrase structure of natural and computer languages and the artificial design of genetic constructs from biological parts. We construct formal grammars with axioms in the form of string substitution rules. Given a postulate (initial string from a two-letter alphabet) and the axioms one can recursively generate the correspondent formal language, with the formation of a phrase in a natural language being equivalent to proving a theorem in mathematics. We generate alternative formal grammars that generate the same formal language as their original counterparts by systematic creation of axiom sets and with theorem proving by means of a random walk in the network of derivations. We find alternative grammars that generate theorems more efficiently, as measured by the entropy generation per iterative step of recursive string creation.

Frequency jumps and source-tract coupling in birdsong

E. Arneodo, G. Mindlin
DF-UBA, Buenos Aires, Argentina

Oscine birds are capable of generating complex sounds by coordinating the activities of the nervous system and a highly nonlinear peripheral biomechanical system. The sound source (the syrinx) and the upper vocal tract are important parts of this peripheral system, yet the understanding of the dynamics emerging from their interaction remains most elusive. In this work we study a highly dissipative limit of a minimalistic model of the syrinx. We describe its interaction with the tract mathematically in terms of a delay differential equation (DDE), whose periodic solutions can be studied analytically. Close in parameter space to the point where the resonances of the tract match the frequencies of the uncoupled source solutions, we find coexistence of periodic limit cycles. This hysteresis phenomenon allows us to interpret recently reported features found in the vocalization of some songbirds, in particular, "frequency jumps".

Evidence of dynamic in the vocal tract of suboscines birds

A. Amador, F. Assaneo, G. Mindlin, M. Trevisan
UBA, Universidad de Buenos Aires, Argentina

The vocal system of the birds consists of two blocks: the vocal organ, called syrinx, where the sound is generated; and the group of cavities located from the syrinx exit to the peak (vocal tract), responsible for the spectral filtering of the sound. In the last years, important progress has been made in the understanding of the syrinx dynamics, while little is known about the importance of a tunable vocal tract coupled to the bird's vocal organ. This lack of attention could be due in part to the fact that many species are characterized by the tonality of their songs, with minimal, if any, spectral richness. However, precise matching of the vocal tract resonances to syringeal frequencies has been recently reported for some species of songbirds, characterized by spectrally poor songs. Here we investigated the role of the vocal tract in the spectrally rich calls of a non-oscine bird, reconstructed the dynamics of its vocal tract, and synthesized complete vocalizations from air sac pressure measurements.

Nonlinearly pulse-coupled stochastic excitable elements: collective excitability and discontinuous phase transitions

Vladimir R. V. Assis, Mauro Copelli
UFPE, Recife, Brazil

Stable global oscillations in Markovian continuous-time lattice models of excitable elements are rare. In order to try to observe it, we investigate a modified version of the stochastic susceptible-infected-refractory-susceptible (SIRS) model with a nonlinear rate which can be considered a *pulse-coupled excitable* version of the original *phase-coupled oscillator* model of Wood *et al.* [Phys. Rev. Lett. **96**, 145701 (2006)]. Contrary to what was observed by Wood *et al.* in their work, on the one hand, this extension of the SIRS model is apparently insufficient for the generation of stable collective oscillations. On the other hand, the model presents phase transitions into an absorbing state which can be continuous (if weakly nonlinear) or discontinuous (if nonlinear enough and for $d \geq 2$). Furthermore, the model can also exhibit a different bifurcation scenario from what is usually observed in nonequilibrium lattice models, showing collective excitability and unstable global oscillations.

Lotka-Volterra model of finite domains

Franciane Silva de Azevedo, Roberto Andre Kraenkel, Daniel Juliano Pamplona da Silva
Instituto de Fisica Teoria-UNESP, São Paulo, Brazil

This work presents a study of interact population and how limitation of the available habitat sizes affects the beha- vior of these population. We can suppose the Lotka-Volterra equations for one population that matches against other:

$$\frac{\partial\theta_1}{\partial t} = \nabla^2\theta_1 + \theta_1[1 - \theta_1 - \gamma_1\theta_2]$$
$$\frac{\partial\theta_2}{\partial t} = \kappa\nabla^2\theta_2 + \alpha\theta_2[1 - \theta_2 - \gamma_2\theta_1],$$

where the two equations have a dependence of the parameters. We consider the hypothesis $\kappa = \alpha = 1$, which means that the diffusivities and the intrinsic grow taxes of both populations are the same. Our idea is then to know what is the effect of the competition over the populations dynamics. For solve this question we start choosing $\gamma_1 < 1$ and $\gamma_2 < 1$ with $\gamma_1 < \gamma_2$. Where the population θ_1 has competitive advantage over the population θ_2. It was worked out a numerical solution for the Lotka-Volterra equations with diffusion. Also was considerate a square fragment and the differential equation were integrated for θ_1 and θ_2 and we obtained the maximum for this solution for long times. In the case when the areas were small the considered species vanish. On the other hand, for large areas,in the density of competitively superior species is much greater than the density of the competitively inferior species with coexistence of two species. The results of this work can be confronted with field data: In limited fragments species that will be eliminated by competition can survivor and coexist with a competitor. We will call this phenomenon as coexistence mediate by shortage of space.

The evolution of male-biased parasitism

Flora S. Bacelar[1], Andrew White[2], Mike Boots[3], Emlio Hernández-Garca[1]
[1]IFISC(CISIC-UIB), Palma de Mallorca, Spain; [2]Heriot-Watt University, Edinburgh, UK; [3]University of Sheffield, Sheffield, England, UK

In a range of ecological systems, there is evidence that the level of infection from parasites is higher in males than in females. Previous theoretical studies have shown that this has implication for the population dynamics of the host (Miller et al 2007). In this study we use modern game theoretical approaches (adaptive dynamics, Geritz et al 1997) to examine the circumstances under which male-biased parasitism would evolve. We examine a system of ordinary differential equations that represents a host-parasite system and also distinguishes between males and females. We examine the evolution of resistance to infection when males and females have a trade-off between the level of host resistance and the birth rate. When only the males evolve, male-baised parasitism occurs for polyandric mating systems (when one female has more than one male mate) or when males have a shorter life-span than females. When both species evolves male-biased parasitism is not affected by mating system but is observed when males have a short life span. When there is a trade-off between the level of male and female resistance, male-biased parasitism again occurs for polyandric mating systems and when male life span is less that females. The results indicate how host mating system and differences between male and female life history characteristics can lead to a reduced level of resistance to infectious disease in males.

Superdiffusion of massive particles induced by multi-scale flows

R. M. Baram[1,2], P. G. Lind[2], J. S. Andrade[3], H. J. Herrmann[1]
[1]IfB, HIF E12, ETH Hoenggerberg, CH-8093 Zurich, Switzerland; [2]CFTC, Universidade de Lisboa, Av. Prof. Gama Pinto 2, 1649-003 Lisbon, Portugal; [3]Departamento de Fisica, Universidade Federal do Ceara, 60451-970 Fortaleza, Brazil

We study the statistics of diffusion of massive particles in scale-free velocity fields. We show that the key feature underlying superdiffusive nature of the transport of the particles is the multi-scale vortical structure. However, other mechanisms such as dissipation are needed to account for preferential concentration in the distribution of the particles.

A parametrically-driven magnetic pendulum

E. P. Oliveira, C.E. Precker, and Adriano A. Batista
Universidade Federal de Campina Grande, Campina Grande-PB, Brazil

Here we describe an experiment that investigates the dynamical behavior of a parametrically driven magnetic pendulum. The apparatus used in the experiment consists basically of two Helmholtz coils (aligned along the same axis and concentrically located), and a freely rotating axially magnetized rod placed in the center of the coils. The outer coils generate the dc field, while the inner coils generate the ac field. The ac field is a square wave with a duty cycle of 50%, which is controlled by a desktop computer via its parallel port. The oscillating current signal generated by a function generator or the computer is amplified by an integrated circuit. The oscillations are detected optically by using a coding wheel and a pair of led photodetectors commonly found in old computer mouses; the transduced signal is sent back to the computer via the PS2 port. Initially, we investigate, numerically (by integrating the equations of motion) and experimentally, the boundaries of the unstable regions of motion, which are known as Arnold tongues. We also study the bifurcations of the stationary points of oscillations (obtained from Poincare maps) and the route to chaos as the drive amplitude is increased. We further investigate the control of the magnet in the unstable position and how to flip it by 360 ^{o} with carefully-designed pulses.

The 1/t algorithm: Fast method to calculate the joint density state function for the adsorbed phase with multisite occupancy

Rolando Belardinelli, Sergio Manzi, Victor Pereyra
Departamento de Fisica, Instituto de Fisica Aplicada (INFAP) - CONICET, Universidad Nacional de San Luis, Chacabuco 917, 5700, San Luis, Argentina

We present a modified 1/t algorithm for calculate the properties of the adsorbed phase with multisite occupation. We demonstrate this algorithm with the calculation of the joint density of state of dimer adsorbed on square lattices with anisotropic interactions. The joint density of states contains more information than the density of states of a single variable-energy, but is also much more time consuming to calculate. Different interaction energies are proposed depending on the orientation respect of the symmetry axes of the dimers, i.e., JL(JT) are the interaction energy parallel (perpendicular) respect to the principal symmetry axes of the molecule. The adsorption is monitored by the behavior of equilibrium observable as the adsorption isotherms, internal energy, specific heat of adsorption, order parameter, etc. Different phases are observed and critical points as well as the characterization of the phase transitions are presented.

On the topology of optical transport networks

R.M. Benito[1], J.P. CardenasS[1], M.L. MouronteO[2], L. Moyano[2], A. Santiago[1]
[1]Grupo de Sistemas Complejos, Departamento de Fisica y Mecanica, E.T.S.I.A., Universidad Politécnica de Madrid, 28040, Madrid, Spain; [2]Telefónica I+D. Emilio Vargas 6, 28043, Madrid, Spain

In this communication we present a study of the topology of the SDH telecommunication network operated by Telefónica in Spain. SDH (Synchronous Digital Hierarchy) network is the standard technology for the information transmission in broadband optical networks. The system transports different traffic types, such as voice, video, multimedia, and data packets (as those generated by IP) over the same fiber wire. We observe that the SDH network shows emergent complexity in all the Spanish provincial networks analyzed, despite being largely dependent on strict planning policies [1,2]. Particularly, we found power-law scaling in the degree distribution and properties of small-world networks, signs of self-organization in the evolution of complex systems. These complex topological properties have been related to the robustness of systems. Thus, complex networks are considered robust against random failures but sensitive to planned attacks in highly connected nodes. Under this perspective, we study the robustness of the Spanish SDH systems by the simulation of direct attacks to those equipments that control the flow of information. We have found that the robustness depends not only on the connectivity of equipments but also on the capacity and type of links associated to those equipments. Consequently we have also observed that the robustness of SDH networks depends on the particular initial design and evolution of each Spanish province. Considering the results obtained by the empirical study, we developed an ad hoc model to describe the topological structure of the networks. The model, that considers real planning directives and geographical and technological variables, generates networks in good agreement with the real Spanish SDH systems [2].

[1] J. P. Cárdenas, M. L. Mouronte, A. Santiago, V. Feliu and R. M. Benito, IJBC. (2009) in press; [2] A. Santiago, J. P. Cárdenas, M. L. Mouronte, V. Feliu and R. M. Benito. IJMPC 19 (2008) 1809-1820.

Multifractal analysis from vertical total electron content obtained in two different locations in Brazil

M.J.A. Bolzan[1], A. Tardelli[1], R.R. Rosa[2]
[1]UNIVAP, São José dos Campos, Brazil; [2] INPE, São José dos Campos, Brazil

In this paper, we have analyzed the Vertical Total Electron Content (VTEC) obtained in two different locations in Brazil, Belém (PA) and São José dos Campos (SP). The characterization of the VTEC fluctuations was performed using the singular power spectra deviations obtained from a wavelet transform modulus maxima (WTMM) approach. The results suggest the existence of different multifractal processes driving the intermittent in two different geographic coordinates on the VTEC time series. The characteristic time scales found, using the WTMM, a simple simulation approach, and possible related physical mechanisms are discussed in the context of nonlinear geomagnetic field response.

Dynamic behavior of a social model for opinion formation

Clelia M. Bordogna[1,2] and Ezequiel V. Albano[2]
[1]IMApEC, Facultad de Ingeniera, UNLP, Calle 115 Esquina 50, (1900) La Plata, Argentina; [2]Instituto de Investigaciones Fisicoqumicas Teóricas y Aplicadas (INIFTA), UNLP, CCT La Plata, CONICET, Casilla de Correo 16, Sucursal 4, (1900) La Plata, Argentina

A model of opinion formation of a social group influenced by both a strong leader and the mass media, which is modeled according to the social impact theory developed by Latané, exhibits sharp (first-order like) transitions between a leader-dominated regime and a mass media dominated state. The dynamic behavior of the model is studied when the strong leader changes his/her state of opinion periodically while the mass media are not considered. Under this condition, the leader is capable of driving the group between a dynamically ordered state with a weak leader-group coupling (high-frequency regime) and a dynamically disordered state where the group follows the opinion of the leader (low-frequency regime). On view of these results, we conclude that the dynamic behavior characteristic of the studied social opinion model shares many features of physical systems that are relevant in the fields of statistical mechanics and condensed matter, such as the dynamic phase transitions of the Ising model under the influence of an oscillatory magnetic field, electrochemically deposited monolayers in the presence of an oscillatory chemical potential, etc.

Continuous and discrete models for pattern formation in a predator-prey system with a finite-range interaction

E. Brigatti[1], M. Oliva[2], M.Nuñez-Lopez[3], R. Oliveros-Ramos[4], J. Benavides[5]
[1]Centro Brasileiro de Pesquisas Físicas, Rio de Janeiro, Brasil; [2]Universidad de La Habana, La Habana, Cuba; [3]Instituto Mexicano del Petróleo, DF, México; [4]Instituto del Mar del Perú, Callao, Perú; [5]Institut des Sciences de l'Evolution, Montpellier, France

We describe pattern formation in predator-prey ecological systems using a spatial version of the classical Lotka-Volterra model with a finite-range interaction. In the continuous implementation, a couple of differential equations, one for each species, describes diffusion in real space. Mortality and fecundity are density dependent and the strength of the interaction is a function of individuals' proximity. The discrete implementation of the system is obtained performing individual based simulations. Analytical and simulational results show that patterns can emerge in some regions of the parameters space where the instability is driven by the range of the interaction.

Study of flow through porous media using lattice-Boltzmann method

D. Müller[1], A. D'Onofrio[1,2], M. Cachile[1,2]
[1]Grupo de Medios Porosos, Facultad de Ingeniería, Universidad de Buenos Aires, Buenos Aires, Argentina; [2]CONICET

Numerical simulations using Lattice-Boltzmann method of the flow through 2D porous media were performed in order to characterize the relation between the porosity and permeability as well as local behaviors inside the media. The lattice-Boltzmann method has been proved to be a valuable method in solving the incompressible Navier-Stokes equation. It is well suited where complex boundaries are present because of the local character of the collision operator. The porous media used in these simulations were produced as a distribution of obstacles of uniform size. The boundary conditions at the inlet and outlet were controlled by fixing the velocity profile and the pressure. The results of the simulations were compared to experiments in similar conditions, where a very good agreement has been obtained.

Learning paths in complex networks

D. O. Cajueiro[1], R. F. S. Andrade[2]
[1]Universidade de Brasilia, Brasilia, Brazil; [2]Universidade Federal da Bahia, Salvador, Brazil

This work addresses the issue of learning shortest paths in complex networks, which is of utmost importance in real life navigation. The approach has been partially motivated by recent progress in characterizing navigation problems in networks, having as extreme situations the completely ignorant (random) walker and the rich directed walker, that which can pay for information that will guide to the target node along the shortest path. A learning framework based on a first-visit Monte Carlo algorithm is implemented, together with four independent measures that characterize the learning process. The methodology is applied to a number of network classes, as well as to networks constructed from actual data. The results indicate that the navigation difficulty and learning velocity are strongly related to the network topology.

Riddled basins of attraction in a mechanical system

S. Camargo[1], S. R. Lopes[2], R. L. Viana[2]
[1]USP, São Paulo, Brazil; [2]UFPR, Curitiba, Brazil

Riddling is an intrinsic phenomenum of dynamical systems which fulfill specific conditions and leads to basins of attraction that never exhibit a disk in the phase space. We say that a dynamical system has a chaotic attractor whose basin of attraction is riddled with "holes" belonging to the basin of another (non necessarily chaotic) attractor. Verifying conditions for the existence of riddling includes the Lyapunov exponents computation. Ott and co-workers have developed a stochastic model for explaining the fluctuations of the finite time exponents. There are a large number of examples of riddling in dynamical systems of physical and biological interest. We choose a system driven by the forced damped pendulum to study the phenomenon of riddling in a mechanical system.

A molecular dynamics simulation of a suspension of ferroelectric nanoparticles in a nematic liquid crystal

A.A. Canabarro[1], M.S.S. Pereira[1], I.N. de Oliveira[1], L.V. Mirantsev[1,2], M.L. Lyra[1]
[1]Instituto de Fisica, UFAL, Maceio, Brazil; [2]Institute of the Problems of Mechanical Engineering, Academy of Sciences of Russia, St. Petersburg, Russia

A large number of interesting phenomena related to the insertion of colloidal particles in liquid crystals (LC) has recently been reported. Here, we investigate effects caused by the addition of spherically shaped ferroelectric nanoparticles into a nematic liquid crystal. Using molecular dynamics (MD) simulations, the density of LC molecules, the orientational order parameter, as well as the polar and azimuthal angles profiles are calculated as functions of the distance to the center of the suspended nanoparticle for different temperatures of the system. We observe that the assembly of ferroelectric nanoparticles enhances the nematic order in the LC medium changing many properties of its host above the nematic-isotropic transition temperature T^*_{NI}, which is in qualitative agreement with recent experimental findings.

Missing ordinal patterns and stochastic processes

Laura C. Carpi[1], Patricia M. Saco[1] and Osvaldo A. Rosso[2,3]
[1]Civil, Surveying and Environmental Engineering, The University of Newcastle, University Drive, Callaghan NSW 2308, Australia; [2]Centre for Bioinformatics, Biomarker Discovery and Information-Based Medicine and Hunter Medical Research Institute, School of Electrical Engineering and Computer Science, The University of Newcastle, University Drive, Callaghan NSW 2308, Australia; [3]Instituto de Cálculo, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, 1428 Ciudad Universitaria, Buenos Aires, Argentina

Recent research aiming at the classification of theoretical and observational time series using Information Theory has looked at the determination of the probability distribution using ordinal patterns. In particular, new insight has been obtained using the Bandt and Pompe's methodology [Bandt and Pompe, Phys. Rev. Lett. 88, 174102-1 (2002)] and considering the emergence of the so-called "forbidden patterns" [Amigo et al., Europhys. Lett. 79, 50001 (2007)]. This research has shown that in the case of a deterministic one-dimensional maps not all ordinal patterns can be effectively materialized into orbits, which in a sense makes these "virtual" patterns "forbidden". However, in stochastic time series when the data set is long enough to exclude statistical fluctuations all the initially missing ordinal patters will appear (that is, in this case there are no forbidden patterns). We analyze the mean rate of decay of missing ordinal patterns as function of time series length for stochastic processes with different degrees of correlation: fractional Brownian motion, fractional Gaussian

noise and, noises with f^{-k} power spectrum. We show that for a fixed embedding dimension, the decay rates are much lower for processes with higher correlation structures. We discuss the implications of the present results for the use of missing ordinal patterns as a tool for distinguishing deterministic from stochastic processes.

Noisy and damped quantum ratchets

M.F. Carusela, A.J. Fendrik, L. Romanelli
Instituto de Ciencias, Universidad Nacional de General Sarmiento, Buenos Aires, Argentina; CONICET, Argentina

We study numerically a noisy quantum ratchet with dissipation and externally forced in the underdamped regime. We discuss about the adequate formalism (ie. the specific functional form of the Lindblad operators) and necessary conditions to establish transport consistent with the classical limit.

Deformed Gaussian-orthogonal-ensemble description of small-world networks

J. X. de Carvalho[1,2], Sarika Jalan[1] and M. S. Hussein[3]
[1]MPIPKS, Dresden, Germany; [2]PUC-Rio, Rio de Janeiro, Brazil; [3]IFUSP, São Paulo, Brazil

The study of spectral behavior of networks has gained enthusiasm over the last few years. In particular, random matrix theory (RMT) concepts have proven to be useful. In discussing transition from regular behavior to fully chaotic behavior it has been found that an extrapolation formula of the Brody type can be used. In the present paper we analyze the regular to chaotic behavior of small world (SW) networks using an extension of the Gaussian orthogonal ensemble. This RMT ensemble, coined the deformed Gaussian orthogonal ensemble (DGOE), supplies a natural foundation of the Brody formula. SW networks follow GOE statistics until a certain range of eigenvalue correlations depending upon the strength of random connections. We show that for these regimes of SW networks where spectral correlations do not follow GOE beyond a certain range, DGOE statistics models the correlations very well. The analysis performed in this paper proves the utility of the DGOE in network physics, as much as it has been useful in other physical systems.

Exact corrections to finite-time drift and diffusion coefficients

A.A.G. Cortines[1,3], R. Riera[1,2], C. Anteneodo[1,2]
[1]PUC-Rio, Rio de Janeiro, Brazil; [2]National Institute of Science and Technology for Complex Systems, Rio de Janeiro, Brazil; [3]IF Fluminense, Cabo Frio, Brazil

Many fluctuating processes in physics and other fields can be described by univariate Itô-stochastic differential equations. Due to the limited rate of acquisition of real data, the correction to finite-time estimations is mandatory in many situations where the time interval between consecutive data is of the order of characteristic timescales. It was shown that the error caused by the use of a finite time-scale can be estimated from a stochastic Itô-Taylor expansion. Although the first-order correction is commonly considered sufficient, there are frequent situations where this correction is not appropriate, mainly because of the slow convergence of the entire series. For the most commonly observed case, we obtain the exact correction to the finite-time Kramers-Moyal coefficients directly computed from empirical data. We illustrate our findings with real timeseries.

A multi-layer model for the global intermittency in the nocturnal atmospheric boundary layer

F.D. Costa[1], O.C. Acevedo[1], J.C. Mombach[1]
[1]Universidade Federal de Santa Maria, Santa Maria, Brazil

During clear nights with strong radiative cooling and weak winds, often occurs the phenomenon of the global intermittency in the nocturnal atmospheric boundary layer (ABL). There are, in the literature, many models to describe this phenomenon, but generally, the results do not reproduce properly the global intermittency, which has a very complex behavior. The models are based in prognostic equations for the mean quantities of the turbulent field. However, the solutions are in most of the cases periodic. In this work, we present a model which consists, firstly, in two-equations for a stratified fluid, one for the turbulent kinetics energy (TKE) and another for the Richardson number. This model is much similar to the classical Lotka-Volterra equations for the dynamics of biological systems in which two species interact, like predator-prey. The Richardson number acts as a predator, so that when the stability grows, the Richardson number increases and tends to extinguish the turbulence (TKE, which acts as a prey). In this context, the solutions of the model are periodic. The complexity of the solutions arises by the addition of a third prognostic equation for the wind shear, and through the interactions between different vertical levels of the stratified nocturnal ABL, in the form of a TKE exchange term. Under these conditions, the solutions can reproduce the bursts of turbulence that occur during the global intermittency, with good agreement with experimental data.

Unification of Ito and Stratonovich procedures and its consequences in the power-law-decaying probability densities

B. Coutinho dos Santos and C. Tsallis
Centro Brasileiro de Pesquisas Fisicas, Brazil

In this work we propose an unification of the two well establish stochastic calculus, Ito and Stratonovich procedures, and investigate its consequences in the power-law-decaying probability densities. We will show that our proposal allow us to recover Ito or Stratonovich calculus by suitable choices of the unification parameter. Using this unified procedure, we derive an unified Langevin equation in which the so called noise-induced drift appear as a function of the unification parameter. From this Langevin equation a unified Fokker-Planck equation is also derived by the means of the Kramers-Moyal expansion. If the deterministic drift is proportional to the noise amplitude, the stationary solution is shown to be a q-exponential. The effect of the unification parameter in the the q-moments of the distribution will be investigated in the temporal regime. This kind of information can be of great value to understand how such density distribution functions evolves towards its stationary states.

Resonance analysis of Hutchinson's delay differential equation

R. Coutinho, R. Kraenkel
IFT - Unesp, São Paulo, Brazil

The delayed logistic equation, also known as Hutchinson's equation, given by $\frac{du}{dt} = ru(t)(1 - u(t-\tau)/K)$, was used by May (1975) as a model for Nicholson's sheep-blowflies (1957) and since then delay differential equations were found to be very useful in modelling biological populations that show retarded growth responses. This equation shows growth and saturation, like in the non-delayed version, for parameters' product $r\tau < \pi/2$. Above that point, the constant solution becomes unstable, and oscillating, periodic solutions appear, with characteristic amplitude and period determined by the parameters r and τ. In this work we study a non-autonomous variant, with the carrying capacity $K(t)$ performing small, periodic oscillations. We show that resonance occurs between the carrying capacity oscillation frequency and the natural frequency of the system above the bifurcation point. We perform numerical simulation as well as an asymptotic analysis using a multiple-scales perturbation method around the bifurcation point to obtain an expression for the amplitude of the solution's envelope.

Geometrical phase transitions in growing networks: competition between aging and preferential attachment

Nuno Crokidakis, Marcio Argollo de Menezes
Instituto de Fisica - Universidade Federal Fluminense Niteroi, Rio de Janeiro - Brazil

We study numerically a model of nonequilibrium networks where nodes and links are added at each time step with aging of nodes and connectivity- and age-dependent attachment of links. In other words, the probability that a node receives a link is $\Pi(k,a,t) \propto (1+k)^{\delta} e^{-\alpha(t-a)}$, where k is the connectivity of a node that was added at a certain instant a. This probability depends on two parameters, α, that controls the effects of aging of nodes on the network, and δ, that is related to the connectivity. The simplest case $\delta = 1$ (linear preferential attachment) was analyzed in [1], and interesting critical phenomena were found, with the emergence of a giant cluster at a first-order critical point and a exponential tail of the distribution of cluster sizes below this critical point. We have studied the system for various values of the parameters α and δ by means of numerical simulations, and we have found that the giant cluster emerges at a specific critical point $\alpha_c(\delta)$, for each value of δ. This transition is followed by a change in the giant cluster's topology from tree-like to quasi-linear, as inferred from measurements of the average shortest-path length, which scales logarithmically with system size in one phase and linearly in the other. We show a sketch of the phase diagram of the model, in the plane α versus δ, separating a phase where the network presents small-world topology and another phase where we have a linear structure. A finite-size scaling analysis is performed, and we show that for $\delta \leq 1$ the transition is of first-order type, but become continuous for $\delta > 1$.

[1] Nuno Crokidakis and Marcio Argollo de Menezes, Journ. of Stat. Mech. P04018 (2009).

Solitary waves on carbon nanotubes

C.E. Cordeiro[1] and S. Dias[2]
[1]Instituto de Fisica- Universidade Federal Fluminense-Niteroi-RJ; [2]Instituto de Fisica- Universidade de Brasilia-Brasilia- DF, Brazil

Using the nearly-free electron effective model[1] for metallic single -walled carbon nanotubes(SWCNTs), we obtain a non-linear Schrdinger equation for the fields which may admit soliton-type solution.We investigate the stability of these solitary waves.

[1] C.E.Cordeiro, A.Delfino and T.Frederico, PRB 79,1 (2009); C.E.Cordeiro, A.Delfino and T.Frederico, Carbon 47, 690 (2009).

Influence of the finite precision on calculations

S. P. Dias[2], L. Longa[1,3], E. Curado[4]
[1]Centro Internacional de Física da Matéria Condensada, Universidade de Brasília, Campus Universitário Darcy Ribeiro, Brasília -DF, Brasil; [2]Instituto de Física, Universidade de Brasília, Campus Universitário Darcy Ribeiro, Brasília - DF, Brasil; [3]Department of Statistical of Physics, Jagiellonian University, Reymonta 4, Krakow, Poland; [4]Centro Brasileiro de Pesquisas Físicas, Rua Dr. Xavier Sigaud, Rio de Janeiro, RJ, Brazil

The effect of numerical precision on the mean distance and on the mean coalescence time between trajectories of two random maps is investigated. It is shown that the mean coalescence time between trajectories can be used as a identical synchronization criterium. The mean coalescence time between trajectories scales as a power law as a function of the numerical precision of the calculations in the contracting and transitions regions of the maps. In the contracting regions the exponent of the power law is approximated 1 for both maps and it is approximated 2 in the transition regions for both maps. In the chaotic regions the mean coalescence time between trajectories scales as an exponential law as a function of the numerical precision of the calculations for the maps. For both maps the exponents are of the same order of magnitude in the chaotic regions.

Model for the transmission of malaria: mean-field approximation

M.E.S. Nunes, A.G. Dickman
PUC Minas, Belo Horizonte, Brazil

We study a mathematical model describing the transmission of malaria in a population. Each lattice site can be occupied by a human, a mosquito or both. The individuals can be either healthy or infected. We allow infected humans to be isolated for a short period of time, after what they can recover, die or continue infected. The mosquitoes can diffuse through the lattice, raising the probability of spreading the disease. The transmission of the disease to humans occurs through the bite of an infected mosquito. A healthy mosquito becomes infected after biting an infected human. Recovered individuals are susceptible to re-infection. We show the phase diagram of the model obtained via cluster approximations (site level). We also compare our results with data from reported malaria cases collected from the World Malaria Report 2008.

Phase diagram and critical exponents for the pair annihilation model in one and two dimensions

A.G. Dickman[1], R. Dickman[2]
[1]PUC Minas, Belo Horizonte, Brazil; [2]UFMG, Belo Horizonte, Brazil

In this work we study the critical behavior of the one and two-dimensional pair annihilation model (PAM) with particle diffusion using the pair approximation (PA) and Monte Carlo simulation. The active and absorbing phases are separated by a continuous phase transition at $\lambda_c(D)$. We describe the phase diagram for the model, obtaining the critical parameter as a function of the diffusion rate. As expected, the critical exponents we obtain confirm that PAM belongs to the directed percolation (DP) universality class. The exponents satisfy the hyperscaling relation $4\delta + 2\eta = dz$ in $d \leq 4$ dimensions. The PA for the one and two-dimensional PAM indicates that for a diffusion rate greater than a certain value, defined as D^*, the critical parameter $\lambda_c = 0$. On the other hand, Katori and Konno [Katori, K., and Konno, N. (1992). Physica A **186**, 578] showed rigorously that $\lambda_c > 0$ for any diffusion rate, in one and two dimensions. They claim that a finite region of extinction exists for any finite D. Our simulation results are consistent with this theorem, although for the two dimensional case the extinction region we find is extremely narrow.

Noise induces partial annihilation of colliding dissipative solitons

Orazio Descalzi[1,2],* Jaime Cisternas[1], Daniel Escaff[1], and Helmut R. Brand[2]
[1]Complex Systems Group, Facultad de Ingenieria, Universidad de los Andes, Santiago, Chile; [2]Department of Physics, University of Bayreuth, Bayreuth, Germany

Partial annihilation of two counter propagating dissipative solitons, with only one pulse surviving the collision, has been widely observed in different experimental contexts, over a large range of parameters, from hydrodynamics to chemical reactions. However, a generic picture accounting for partial annihilation is missing. Based on our results for coupled complex cubic-quintic Ginzburg-Landau equations as well as for the FitzHugh-Nagumo equation we conjecture that noise induces partial annihilation of colliding dissipative solitons in many systems.

Capillary wave turbulence

Gustavo Düring[1] and Claudio Falcón[2]
[1]Laboratoire de Physique Statistique, Ecole Normale Supérieure, CNRS, UMR 8550, 24, rue Lhomond, 75005 Paris, France; [2]Departamento de Física, Facultad de Ciencias Físicas y Matemáticas, Universidad de Chile, Casilla 487-3, Santiago, Chile

We report theoretical and experimental results on 4-wave capillary wave turbulence. A system consisting of two inmiscible and incompressible fluids of the same density can be written in a Hamiltonian way for the conjugated pair (η, Ψ). When given the symmetry $z \to -z$, the set of weakly non-linear interacting waves display a Kolmogorov-Zakharov (KZ) spectrum $n_k \sim k^{-4}$ in wave vector space. The wave system was studied experimentally with two inmiscible fluids of almost equal densities (water and silicon oil) where the capillary surface waves are excited by a low frequency random forcing. The power spectral density (PSD) and probability density function (PDF) of the local wave amplitude are studied. Both theoretical and experimental results are in fairly good agreement with each other.

Statistical aspects of search dynamics in scarce environments

C. L. Faustino[1], E. P. Raposo[2], G. M. Viswanathan[3], M. L. Lyra[3], M. G. E. da Luz[1]
[1]Department of Physics - UFPR - Curitiba, Brazil; [2]Department of Physics - UFPE - Recife, Brazil; [3]Institute of Physics - UFAL - Maceió, Brazil

In this work, we analyze search dynamics and the statistical properties of an organism in search of a target of interest. In general terms, there are many interesting aspects of studies of this nature. For example, in the biological context, organisms in Nature constantly interact one with another, both of the same as well as of different species. The general objectives of random searches are diverse, ranging from searches for food, reproductive partners, etc. of living organisms to socio-economically relevant processes, such as searches for missing children, fugitive terrorists, or searches for petroleum. In our special model, we consider the searcher and the target moving randomly in a one dimensional lattice of size λ, with periodic boundary conditions. The type of diffusion in the system is determined by the choice of the probability distribution function for the steps sizes for the individual walkers. We assume a power law distribution, characteristic of Levy processes, $P(\ell) \sim \ell^{-\mu}$. Considering an initial energy ξ_0 for the searcher, an energetic expenditure for the walk and an energetic gain g for each target found, we discuss relevant physical quantities, such as energy fluctuations, the fraction of survival searchers and the cumulative energy for N time steps, as a function of the parameters, e.g., the lattice size λ. We find that searches with ballistic diffusion are more efficient than Brownian ones, allowing the survival of the searcher in situations of ultra-low target density. This extreme behavior guarantees the differential survival of such searchers. We also find strong evidence of a continuous phase transition, in which one phase has survival and the other phase has extinction. We calculate the critical densities which depend on the parameters of diffusion adopted by the organisms. We also obtain the critical exponents for the transition. Our results suggest a universality of the critical exponents, which independent of the type of diffusion of the organisms.

Correlated Lévy walk

M. L. Felisberto[1], M. G. E. da Luz[2], F. Bartumeus[3,4], E. P. Raposo[5], G. M. Viswanathan[1,6]
[1]Instituto de Fisica, Universidade Federal de Alagoas, 57072-970 Maceio-AL, BR; [2]Departamento de Fisica, Univ. Federal do Parana, 81531-990 Curitiba-PR, Brazil; [3]Department of Ecology and Evolutionary Biology, Princeton Environmental Institute, Princeton, NJ 08544, USA; [4]Institut Catala de Ciencies del Clima (IC3), Baldiri Reixac 2, 08028 Barcelona, Catalonia, Spain; [5]Departamento de Fisica, Universidade Federal de Pernambuco, 50670-901 Recife-PE, Brazil; [6]Consortium of the Americas for Interdisciplinary Science, University of New Mexico, Albuquerque, NM, EUA

Random walks and diffusion theory pervaded ecological sciences as methods to analyze and describe animal movement. Beyond the quantification of movement, we study random walk models with the aim of mechanistically link movement patterns with animal behavioral processes. Organisms, can be treated as self-propelled particles that move to increase the rate of encounters of other organisms of the same or different species, as well as useful or necessary inaminate objects. Currently known, two main kinds of random walk models have been used to describe the characteristic search patterns of foraging animals. Correlated Random Walk (CRW) describe the events of re-orientation via a non-uniform angular distribution, where the directional persistence is controlled by the probability density function of the angle of re-orientation. Typically, CRW models use the Wrapped Cauchy Distribution (WCD). Unlike the CRW, another model known as the Lvy Walk (LW) involves a uniform distribution for the angles of re-orientation and a power law tailed distribution for the size of the jumps. Here, we study and discuss, in the context of foraging, some relevant statistical features of a recently proposed new model, a hybrid model combining the main elements of both CRWs as well as LWs, which we call Correlated Lvy Walks (CLW). This model possesses both a non-uniform distribution of turning angles as well as a power law tailed distribution for distances.

Boundary induced phase transitions in automata reaction diffusion model

R.A. Krankel, A.A. Ferreira
IFT-Instituto de Física Teórica-UNESP, Brazil

We present a unidimensional model of reaction diffusion on lattice with open boundary conditions. At each site the lattice is allowed to contain a particle or a hole. The dynamics is characterized by the diffusion of particles with empty adjacent sites and the creation of particles at empty sites, induced by particles on neighboring sites. The number of particles in the sites on the boundary of lattice is setting to zero. Thus, a competition between the process of destruition of particles in the boundary and the creation on the lattice can the particle density in the lattice reach the value zero. This suggests a transition phase to an active state to a frozen state (absorbing state), since the state with zero particles in the lattice is an absorbing state.

Nonlinearity analysis in international stock markets

D.A. Mendes[1], Rui Menezes[1,2], Nuno B. Ferreira[3]
Department of Quantitative Methods, ISCTE - University Institute of Lisbon, Lisbon, Portugal

Several empirical evidence has been gathered for both nonlinearity and structural changes in the dynamic properties of many observed time series. In particular, in economics and financial markets, the nonlinearities have been found in many important variables, such as unemployment rate, production variables like GNP, GDP, and industrial production, consumption, nominal and real exchange rates, stock prices, etc. There are several possible nonlinear models but only few of them are commonly used in finance and economics. Several statistics have been applied, like the general dependence test (the BDS test). However, we prefer to not adopt directly the statistical time series analysis in favour of the dynamical systems approach. For those systems, there is a deterministic way, in which future states are determined by the present state. This phenomenon well known as chaos, was already known to Poincaré at the turn of the twentieth century. This study attempts to investigate the nonlinear behavior in seven international stock price indices (Portugal, Spain, Italy, France, UK, Canada and US). For each selected market, daily prices on the corresponding stock price indices were considered during the sample between 2005 and 2009. Using some invariants from nonlinear dynamics theory, such as the correlation dimension, the Lyapunov Exponent test and the phase space reconstruction (surrogate data method), we analyze the underlaying dynamics of the time series. The empirical results indicate that the stock market series have a nonlinear structure and that linear noise models are insufficient to explain dynamic variability in day-by-day returns. These findings have important implications for empirical finance, investment decisions, pricing of financial derivatives, portfolio optimization, and cross-market transmission of volatility.

Thresholds, critical exponents, and spreading patterns of the contact process on Watts-Strogatz and Barabási-Albert networks

R. S. Ferreira[1], S. C. Ferreira
Universidade Federal de Viçosa, Viçosa, Brazil

The contact process (CP) is a standard model for describing nonequilibrium phase transitions to absorbing states. The model dynamics involves the local disease spreading among connected individuals and spontaneous cure in a population. Varying the infection rate, a transition from a state free from disease to one where the epidemics persists is observed. We studied this transition for the CP on a complex network scenario, in which each individual is represented by a graph node, while their contacts are represented by links among them. We performed the computational implementation of the CP on different network topologies in order to compare the criticality of the phase transitions with results predicted by mean field (MF) approaches. Actually, this subject have generated frequent discussions concerning on the validity of MF predictions for phase transitions. We applied a finite size scaling theory for the CP on the Watts-Strogatz (WS) network and Barabsi-Albert (BA) network. In particular, on WS network we report on two different topologies, namely with high and low clustering. The MF approaches failed for determining the critical rates of phase transition, but the critical exponents obtained are in agreement with the MF predictions, in contrast with recent reports on CP in scale free topologies. Space-time patterns were used to identify the role of the network topology on the spreading dynamics. For WS model, the clustering coefficient, which does not appears explicitly in MF field calculations, is identified as the main feature in determining of the threshold and patterns of disease spreading. For all cases, the small word property is pointed out as factor ruling the MF critical exponents.

Liquid polymorphism, order-disorder transitions and anomalous behavior: A Monte Carlo study of the Bell-Lavis model for water

C. E. Fiore[1], M. M. Szortyka[2], M. C. Barbosa[2] and V. B. Henriques[3]
[1]Departamento de Física, Universidade Federal do Paraná, Curitiba, PR, Brazil; [2]Instituto de Física, Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil; [3]Instituto de Física, Universidade de São Paulo, São Paulo, SP, Brazil

We investigate, through numerical simulations, the Bell-Lavis lattice-gas model that reproduces some water-like anomalies. It is known to present a highly bonded low density phase (HDL) and a loosely bonded high density phase (LDL). We show that the model liquid-liquid transition is continuous, in contradiction with mean-field results on the Husimi cactus and from the cluster variational method. We define an order parameter which allows interpretation of the transition as an order-disorder transition of the bond-network. Our results indicate that the order-disorder transition is in the Ising universality class. Previous proposal of an Ehrenfest second order transition is discarded. A detailed investigation of anomalous properties has also been undertaken. The line of density maxima in the HDL phase is stabilized by fluctuations, absent in the mean-field solution.

Excitonic effects on the nonlinear optical rectification in one-dimensional quantum dots

J. Florez, A. Camacho
Universidad de los Andes, Bogota, Colombia

We study the excitonic effects on the nonlinear optical rectification in quantum dots considering the Coulomb interaction between the pair electron-hole. The exciton is confined in a one-dimensional semiparabolic potential, where the electron and the hole are confined with the same oscillator frecuency. We use numeric methods to find the exciton states and with these results we calculate the nonlinear optical susceptibility associated with the nonlinear optical rectification. The numerical results are presented for GaAs/AlGaAs quantum dots. We observe that the nonlinear optical rectification susceptibility is enhancement due to the quantum confinement of the exciton, according with the result obtained for small quantum dots where the Coulomb interaction is neglected. Finally, we look for a relation between the susceptibilities with and without the excitonic effect.

Symmetry and dissipation in coupled Huygens pendula

Josue S. Fonseca and J. R. Rios Leite
Departamento de Fisica, Universidade Federal de Pernambuco, Recife PE, Brasil

The behavior of two coupled pendula, as described originally by C. Huygens, will be presented in their nonlinear regime of oscillations. The observations in a real system shall be presented and compared with numerical solutions of the classical equations of motion, including frictional dissipation terms. Within chaotic and quasiperiodic conditions we find stable periodic non-linear solutions. The role of symmetry on the existence of these solutions will be discussed. The conection between energy dissipation and symmetry will be exploited. The physics of this classical system will be put in the analogy with that of coupled quantum systems [1,2].

[1] S. H. Strogatz, "Non Linear Dynamics and Chaos", Addison Wesley Pub Co, 1997; [2] E. Altshuler and R. Garcia, Am. J. of Phys. 71, 405-408 (2003)

Do Arnold tongues really constitute a fractal set?

A.L. Gama[1], M.S.T. Freitas[2]
[1]UTFPR, Curitiba, Brazil; [2]Department of Physics, UTFPR, Curitiba, Brazil

In this work in progress, we review and analyze the main features of fractal sets, arguing that the geometric property called fractality deserves a more careful discussion, in order to fulfill the lack of a rigorous definition in the modern bibliography. We exemplify with the mode locking phenomenon exhibited by the Sine Circle Map, concerning those sets in parameter space called Arnold Tongues and Devil's Staircase (more exactly, their complements). As we demonstrate, well-known results for the fat fractal exponent of the ergodic region reveal to be valid just in a tiny region of parameter space: interpretation of the involved procedure in geometrical terms makes clear that a misleading simplification was responsible for a loss of information that obstructs any relevant conclusion. Alternatively, we propose a broader and more rigorous method, selecting a generic interval from to the whole domain, that excludes the mentioned restrict region. Our results reveal that the measure exhibits a different dependence on tongue widths, so we argue that such a discrepancy is only possible if we assume that the analyzed set does not satisfy a scale-free property. Since there is no invariant exponent for the complementary set of Arnold Tongues (and consequently for that of Devil's Staircase), we conclude that such statistical criteria are not appropriated to characterize those sets as true fractals. We also suggest that a future definition of fractals may take in account the topological process responsible for generating the set, and not only the usual procedures of calculated dimensions or statistical properties.

Extended Gaussian ensemble for the mean-field Blume-Capel model

Rafael B. Frigori, Leandro G. Rizzi, Nelson A. Alves
DFM/FFCLRP, Universidade de São Paulo, Brazil

Examples of ensemble inequivalence are known to appear in small systems or even in thermodynamic systems with long-range interactions. The gaussian ensemble, proposed by Hetherington et al. in 1988, and its extended version (EGE) theoretically play the important role of an interpolating ensemble between the microcanonical and canonical ensembles (however, without making use of the Laplace transform). Here, we consider the extended gaussian ensemble to study the thermodynamic properties of the mean-field Blume-Capel (BC) model. This model was originally devised to explain phase transitions on He3/He4 mixtures, or analogously, magnetic spin-1 systems with competitive interactions. This model exhibits a rich phase diagram whose region associated with first-order phase transition is not equivalently described by the microcanonical and canonical approaches. In this sense, we analyze how this interpolating approach behaves for such systems. For instance, we show that some unusual features of this model (as temperature jumps, negative specific-heat and negative susceptibility), which emerge just when a microcanonical description is employed, can be smoothly recovered by EGE in some regimes. Also, the effects of fluctuations due to couplings with a finite thermal-reservoir can be straightforward observed. Thus, we show its role in stabilizing (from a canonical perspective) some out-of-equilibrium states.

Cell differentiation on scale-free networks

H.F. Fumiã, H.S. Silva, M.L. Martins
UFV, Minas Gerais, Brazil

A multicellular organism consists of many diferent cell types that were generated from a single fertilized egg in an order process of development in space and time. All cells contain the same genome and exhibit complex metabolic networks, which are differentiated by their patterns of gene expression. In this work, a cellular automata model for cell differentiation is proposed. It takes into account the temporal evolution of a gene network representing each cell (intracellular dynamics), cell-cell interactions through coupling (intercellular level) and cell division, in which mutations can be introduced into the cell daughter. The interactions between the genes in the intracellular dynamics are supported by a scale-free topology [1] as suggested by recent biological data [2]. Our computer simulations show that the exponente of power law degree distribution of the genome determine the nature of the intracellular dynamics, which can be frozen, marginal or chaotic. The main feature observed in biological morphogenesis occurs in genes scale-free networks on the edges of chaos, the marginal regime. The cells differentiation observed in the model is qualitatively in accord with the experimental data.

[1] Réka Albert and Albert-Lászl Barabási. Statistical mechanics of complex networks, Reviews of Modern Physics, VOL 74 (2002). [2] P. Provero. Gene networks from DNA microarray data: centrality and lethality arXiv:cond-mat/0207345 (2002).

Detrended fluctuation analysis of systolic blood pressure control loop

C.E.C. Galhardo[1], T.J.P. Penna[1], M. Argollo de Menezes[1], P.P.S. Soares[2]
[1]Instituto de Física, Universidade Federal Fluminense, Av. Litoranea, s/n, 24210-340, Niteroi, RJ, Brazil; [2]Instituto Biomédico, Universidade Federal Fluminense, R. Prof. Hernani Melo, n. 101, 24210-130, Niteroi, RJ, Brazil

We use detrended fluctuation analysis (DFA) to study the non-stationary dynamics of blood pressure oscillations and its feedback control in rats by analyzing systolic pressure time series, in different physiological conditions, before and after a surgical procedure that interrupts its control loop. We found, for each situation, a crossover between two scaling regions characterized by exponents that reflect the nature of the feedback control and its range of operation. In addition, we found evidences of adaptation in the dynamics of blood pressure regulation a few days after surgical disruption of its main feedback circuit. Based on the paradigm of antagonistic, bipartite (vagal and sympathetic) action of the central nerve system, we propose a simple model for pressure homeostasis as the balance between two nonlinear opposing forces, successfully reproducing the crossover observed in the DFA of actual pressure signals. A comparative study using wavelet variance analysis corroborate with the DFA results.

A framework for complex systems by using multi-agent and complex networks: application to the evolution of Chagas disease

Viviane Galvao[1,2], Alex N. Santana[3], Antonio S. A. Terceiro[3], José G. V. Miranda[2]
[1]Departamento de Ciencias Biologicas, Universidade Estadual de Feira de Santana, Feira de Santana, Bahia, Brazil; [2]Instituto de Fisica, Universidade Federal da Bahia, Salvador, Bahia, Brazil; [3]Departamento de Ciencias da Computacao, Universidade Federal da Bahia, Salvador, Bahia, Brazil

A complex system can be described by a composed system of interconnected parts in which the analysis of individual parts cannot exhibit the behavior of the whole. The increase of interest in understanding the general principles of complex systems is related to the evolution of computers, because a more powerful computer can develop more complex models. In the construction of theoretical models, there are parts of the code with similar characteristics that can be reused. The code reuse saves time, cost and energy by reducing redundant work. A framework is used to develop applications that allow the creation of highly reusable code. This type of software is composed by classes that provide the skeleton to construct a new model. The computational models for Chagas disease include a two-dimensional [1] and three-dimensional [2] agent-based model for the Chagas disease after stem cell transplantation. In this way, we propose a framework for complex systems by using multi-agent and complex networks and apply our framework to analyze the evolution of Chagas disease. This disease is caused by the protozoan Trypanosoma cruzi and affects millions of people in the world. It has the acute and chronic phases. In the acute phase, the number of parasites and inflammatory cells are elevated. In the chronic phase, most people remain in the indeterminate form without any clinical symptoms. This computational model includes five different types of agents: inflammatory cell, fibrosis, cardiomyocyte, fibroblast and T.cruzi. Fibrosis is fixed and the other types of agents can move through the network. Our model results were compared with this experimental data giving a fairly fit.

[1] Galvão et al., Bioinformatics 24, 2051 - 2056 (2008); [2] Galvão and Miranda, Physica A 388, 1747-1754 (2009).

Fractal formation process in the Mandelbrot set

A. L. Gama, M. S. T. Freitas
UTFPR, Curitiba, Brazil

In previous works by our research group, we have introduced the possibility of analyzing a fractal attractive set using its topological formation process. Two graphical methods were developed, in order to reveal topological transformation in invariant sets. The present work extends the principles of such methods for fractal sets in parameter space, using as example the Classical Mandelbrot set. Through the analysis of the bifurcation of periodic components it was possible to identify some fractal structures present the Mandelbrot set. It also reveals a mapping, which converge to the quasi-periodic region. However, this was only possible because such mapping produces an infinite number of copies in every iteration. This indicate that some aspects of the Mandelbrot set are not completely fractal. In addiction, we calculate the map's Similarity Dimension and found $D \approx 1.28$. That value contrasts with the Hausdorff Dimension equal to 2 for the hole boundary. This is explained by the chaotic region, which connects the several disconnect parts generated by the mapping. We argue that this work is important because it introduces the possibility of identifying the topological formation process of a set in parameter space. It also illustrates how the study of a geometric set through its topological formation process can lead us to a better understanding of the fractal structure: even being a fractal, not all complexity present in Mandelbrot set can be explained by fractal patters.

Building robust barriers to control chaotic magnetic field lines in tokamaks

Caroline Gameiro Lopes Martins[1], Ricardo Egydio de Carvalho[1], Iberé Luiz Caldas[2], Marisa Roberto[3]
[1]UNESP, Rio Claro, Brazil; [2]USP, São Paulo, Brazil; [3]ITA, São José dos Campos, Brazil

Progress achieved in plasma heating and magnetic confinement during the past decade has brought to the fore a number of problems which have to be solved if controlled thermonuclear fusion is to become an economically and environmentally acceptable energy source. Among them, the interactions of plasmas with solid surfaces represent a very serious obstacle to the achievement of a positive energy balance in the next generation of magnetic fusion devices. In present devices, plasma energy losses are dominated by radiation due to impurities released from the vacuum vessel wall. We investigate the influence that a robust barrier cause when we include them in a Hamiltonian derived from the problem of plasma's confinement in tokamaks with ergodic magnetic limiter. We focus on the dimerization of magnetic islands chains in the presence of this robust barrier, called Robust Torus, which trap all chaotic magnetic field lines that approach them, preventing thus its impact with tokamak's wall.

Complex network analysis of a semantic memory system

E. Russo[1], P. M. Gleiser[2,3]
[1]SISSA, Cognitive Neuroscience, via Beirut, 34014 Trieste, Italy; [2]Instituto Balseiro, Bustillo 9500, 8400 Bariloche, Argentina; [3]Centro Atómico Bariloche, Bustillo 9500, 8400 Bariloche, Argentina

In this work we consider a simplified model of a semantic memory system. The model is an associative Potts network. The units, representing local subnetworks, are connected to one another through tensor sets of weights, which represent long-range synaptic connections between distant patches of cortex. By setting different threshold values on the weights we extract the underlying complex networks of connections. Through the analysis of the clustering coefficient and the mean path length we show that for a wide range of threshold values these are robust small world networks. We also present a k-core analysis, that measures the connected maximal induced subgraph which has minimum degree greater than or equal to k. This study reveals a non trivial hierarchical structure characterized by a k-coreness dependence on the degrees of the nodes. By incorporating neuronal adaptation and correlation among attractors the model allows for the emergence of a latching dynamics, as a simplified model of a recursive process. We analyze the latching transitions as complex networks, using a similar approach where thresholds are set to the transition matrices. We show that these networks also present a small world hierarchical structure.

Emergent hierarchical structure in a dynamical network with chaotic units

I. Gomez Portillo, P. M. Gleiser
Instituto Balseiro, Bariloche, Argentina; Centro Atómico Bariloche, Bariloche, Argentina

In order to study the evolution of complex networks with dynamical units, Gong & van Leeuwen (Physica A 321 (2003) 679 688) considered a growing network model with chaotic units. They observed the emergence of scale free networks using an adaptive algorithm where the nodes can rewire their connections according to their coherence. This algorithm allows each node to compare its state with the state of all the other nodes in the system in order to rewire its links. However, in most real systems the nodes do not have such a global view. We present a simple modification of the algorithm by restricting the information available to the nodes to second neighbors. We show that this local version of the model allows for the emergence of scale-free hierarchical networks, with characteristics that are not present in the global version of the model. In particular, we analyzed the clustering coefficient C, that allows for the quantification of the fraction of neighbors of a node that are connected between themselves. Hierarchical networks are characterized by a clustering coefficient that is independent of system size, and that decays as a power law as a function of the degree of the nodes. We show that these characteristic are present (absent) in the local (global) version of the model. Finally, we compare the results of the model with chaotic units with a similar version where phase oscillators are used as dynamical units. We point out similarities and differences between the models, that suggests that local rules are a necessary ingredient for the emergence of hierarchical structures.

Stability of breathers in simple mechanical models for DNA

Gabriel Gouvéia Slade, José Roberto Ruggiero
UNESP-IBILCE, São José do Rio Preto, Brazil

Since the discovery of the double helix structure of DNA done by Watson and Crick in 1953, it has been carried out many studies in several areas of the knowledge, like physics, mathematics and biology, to describe its dynamic and functional aspects. Even at its biological temperature the DNA shows fluctuations of great amplitude and highly localized, that is capable to open a single base pair. This "breath" made by the molecule is called breathers, among the biologist, and it was found by experiments of proton exchange. In nonlinear systems breathers are time periodic spatially localized solutions. This kind of solution is generated by the combination of two factors: the discreteness and the nonlinearity of the system. The first one does the dispersion band (linear modes of vibration) to be limited, while the second one makes the frequency of vibration to be dependent of the movement amplitude. In this work, we revisited the problem of formation and stability of breathers in simple mechanical models for the DNA, like the Peyrard-Bishop model and its extensions. We used the anti-continuous limit and the Floquet theory for the formation and stability studies of the breather. The results were analyzed using the Floquet multipliers and the energetic dynamic of the system. Tests for different breathers frequency and coupling range were done; these parameters are intrinsically related to the system energy. In the range of the coupling parameters where there is stability, the energetic dynamics show a well defined localized structure and periodic, so the breather persists along the time. For instability regions, there are two different behaviors: the breather can travel inside the chain or the localized structure can be completely lost characterizing the energy dispersion.

Transport properties in a open square billiard

M. Heckler, S. D. Prado
UFRGS, Porto Alegre, Brazil

Billiards are two-dimensinal systems with a constant inner potential and hard wall confinement. In general the confinement defines the classical dynamics to be regular (circle or square) or chaotic (Bunimovich stadium or Sinai). However, a uniform magnetic field perpendicular to the surface can make the system undergoes a transition from regular or integrable regimes to chaotic dynamics or vice-versa. These bounded systems have been extensively studied since it can be used as toy model to more realistic physical situations. Structures with a geometry similar to billiards can be fabricated in the two-dimensional electron gas (2DEG) which forms at the interface of a GaAs/AlGaAs heterostructure. Such electron billiards have dimensions L of the order of $1 - 10\mu$m, while the Fermi wave length $\lambda_F \approx 60$nm is much smaller than L. These are mesoscopic systems for which semiclassical approximations are useful tools. In this work we study the open quantum square billiard immersed in an uniform magnetic field to simulate situations where electrons can enter and exit the structure through point contacts or leads. Particles are injected into the system by the leads and evolves accordingly to the evolution operator of the system. Some of the particles will escape rapidly while others can remain for longer times depending on the contacts dimensions or on the magnetic field strength. Our numerical results indicate a strong relation between the conductance and the underlying classical dynamics.

Specific heat and compactivity of the parking lot model

K. Hernandez, L.I. Reyes
Universidad Simon Bolivar, Caracas, Venezuela

Granular media are many-particle systems with dissipative nonlinear interactions. Managing these systems is a fundamental part of many industrial processes but, to the date, they're poorly understood at a fundamental level even in the static state. In 1989, Edwards and Oakeshott proposed a statistical mechanics for granular packings. In this approach, the volume plays the role of the energy in classical thermodynamics, and a state variable, called compactivity, plays the role of the temperature. The parking lot model (PLM) is an stochastic one-dimensional system where particles of length l are thrown to a line of length L. Particles are adsorbed with a rate p_+ (restricted to volume exclusion) and are desorbed with a rate p_-. Other than absorption and desorption, particles cannot move within the line. This system has shown many qualitative behaviors seen in granular media. The statistical mechanics proposed by Edwards and Oakeshott has been adapted to the PLM by Tarjus and Viot (2004). Within this approach, we found a criteria to choose the random loose packing fraction for the PLM. We also found a packing fraction ϕ_m from which virtually all accessible states are blocked configurations. For this system, we calculated the compactivity and a parameter k analog to the specific heat introduced by Aste and co-workers in 2007. k can be used to estimate ϕ_m.

Linear viscoelasticity of a single semiflexible polymer chain

T. Hiraiwa, T. Ohta
Department of Physics, Kyoto University, Kyoto, Japan

We study the dynamic properties of a single semiflexible polymer chain based on the theory for the wormlike-chain model developed by Hallatschek et al.[1]. In our presentation, firstly, we will talk about the viscoelastic response of a normal wormlike-chain under oscillatory forces acting at the two chain ends. The complex compliance and complex modulus are obtained analytically as functions of the oscillation frequency[2]. The real part of the complex compliance in the low frequency limit is consistent with the static result of Marko and Siggia[3] whereas the imaginary part in the low frequency regime exhibits the power-law dependence $(fleq.)^{+1/2}$. On the other hand, these compliances decrease as $(fleq.)^{-7/8}$ in the high frequency limit. Secondly, the linear viscoelasticity of a wormlike-chain with dissipation induced by the deformation is investigated. We found that the viscoelatic behavior is similar to that of Rouse model with internal friction examined by Khatri et al.[4]. Lastly, we present the linear viscoelasticity of a wormlike-chain with intramolecular interaction. Especially, we investigate the case of attractive interaction and consider this viscoelastic behavior as that near a collapse transition.

[1] O. Hallatschek, E. Frey and K. Kroy, Phys.Rev.E 75, 031905,(2007); [2] T. Hiraiwa and T. Ohta, J. Phys. Soc. Jpn. 77, 023001,(2008); [3] J.F. Marko and E.D. Siggia, Macromolecules 28, 8759,(1995); [4] B.S. Khatri and T.C.B. McLeish, Macromolecules 40, 6770,(2007).

Delay tuned phase-locking in a pair of coupled limit cycle oscillators

T. Kalmar-Nagy, A. Halder, S. Zhao
Texas A & M University

Coupled limit cycle oscillators have been studied in the context of many different disciplines including but not limited to physics, chemistry and biology. In particular, dynamical behavior of a pair of coupled limit cycle oscillators has been studied quite extensively for coupled van der Pol oscillators, both for the case of strong and weak coupling, with and without time delay. Our study is motivated by the dynamics of the central pattern generator of primitive vertebrate like lamprey. The mathematical model considered in this paper is a proposed scaled version for traveling wave generation mechanism in lamprey spinal cord assuming uniform immediate neighbor coupling. Hence, the time delay originates either due to signal transmission (communication delay) or due to segmental processing (inevitable for a robotic implementation with distributed computing). In particular, we study the dynamics of two delay-coupled limit cycle oscillators. The mathematical model considered here involves time delay in the state as well as in the derivative of the state, both of which constitute the coupling. The equations for the pair of coupled oscillators have the form:

$$\ddot{x}_1 + (x_1^2 + \frac{\dot{x}_1^2}{\omega^2} - A_1^2)\dot{x}_1 + \omega^2 x_1 = \alpha x_2(t-\tau) + \beta \dot{x}_2(t-\tau),$$

$$\ddot{x}_2 + (x_2^2 + \frac{\dot{x}_2^2}{\omega^2} - A_2^2)\dot{x}_2 + \omega^2 x_2 = \alpha x_1(t-\tau) + \beta \dot{x}_1(t-\tau),$$

where α and β are the coupling strengths, A_1 and A_2 are the amplitudes of each uncoupled oscillator, ω is the common angular frequency, and τ denotes the time delay in coupling. First, the equilibria of the actual system are found and linear stability analysis is performed. Next, we analyze the system for the case of weak coupling by the averaging method. It is shown that the weakly coupled oscillators can achieve phase-locked solutions only at the expense of delay tuning. All such "delay-driven equilibria" were computed and their stability were characterized. Numerical simulations of the original as well as the averaged system matches the analytical predictions. Further, the numerics reveal some more qualitative behavior of the system dynamics including the destruction of the four dimensional tori with the variation of parameters. One important result revealed was the dynamics of the phase locking as the time delay was varied. It was shown that only two cases may result stable equilibria, one of them for the case of in-phase locking and the other one for out-of-phase locking. The global dynamics exhibits dependence on the intersegmental coupling strength.

Cellular automata with inertia

K. Kramer, M.G.E. Luz, M. Koehler
UFPR-Curitiba, Paraná, Brazil

There are several models of cellular automata, with different applications that range from the modeling of physical, chemical or biological systems to applications in industries. The cellular automaton used in this work has two dimensions, the Moore neighborhood and three states (0, +1, -1). The deterministic rule that is applied to each iteration in the entire automaton establishes that the state to which each cell will change in the next generation depends on the number of neighbors that have the same state as this cell and, also, the cells inertia. This study is being conducted to better understand the systems dynamics, and the system was first analyzed with inertia equal to zero. After the end of this analysis the inertia will be increased and the new systems dynamics will be studied. This is a statistical analysis and it uses a large set of initial data, since more than 30,000 random lattices were generated and, taking these lattices as a base, some major aspects were analyzed, such as: clustering, both total and for each state, the total quantity of elements in a given state and the convergence time. Both the clustering and the number of elements were compared between the lattices initial and final configurations, the latter being the one in which the lattice, after the number of iterations determined by its initial configuration, no longer changes the configuration of its elements.

Investigation of multistability and transport on the bouncing ball problem

T. Kroetz[1], M. Roberto[1], I. L. Caldas[2]
[1]ITA, São José dos Campos, Brazil; [2]IFUSP, São Paulo, Brazil

The bouncing ball problem consists of a particle under action of a uniform gravitational field which suffers repeated inelastic impacts on a sinusoidally vibrating plate at the floor. The particle motion between consecutive impacts is integrable, however the instant of the impacts can not be obtained analytically. As a consequence, the whole dynamics of the system is non-integrable. This simple unidimensional problem exhibits very rich dynamics, such as: period-doubling route to chaos, coexistence of many periodic and chaotic attractors, crisis and Fermi acceleration. In this work it was investigated the multistability of attractors considering a weak dissipation regime. Poincar maps were obtained for the conservative case and as the system becomes gradually dissipative the behavior of the KAM islands were also analyzed. The basins of attraction and bifurcation diagrams for some values of dissipation parameter provide physical analyses which allow us to explain the coexistence of chaotic and periodic attractors. The transport on Poincaré map is also studied and related to the Fermi acceleration phenomenon.

Competition between suppression and production of Fermi acceleration

D. G. Ladeira[1], E. D. Leonel[2]
[1]Universidade Federal de São João del-Rei, Ouro Branco - MG, Brazil; [2]Universidade Estadual Paulista, Rio Claro - SP, Brazil

The behavior of the average velocity for a classical particle in the one-dimensional Fermi accelerator model under saw-tooth external force is considered. For elastic collisions, it is known that the average velocity of the particle grows unlimitedely because of the discontinuities of the derivative of the moving wall's position with respect to the time. However, and contrary to what was expected to be observed, the introduction of a friction force generated from a slip of a body against a rough surface leads to a *boundary* separating different regions of the phase space that yields the particle to either experience unlimited energy growth or suppression of Fermi acceleration. The Fermi acceleration is described by using scaling arguments. The formalism presented can be extended to two-dimensional time-dependent billiards as well as to higher order mappings.

Tokamak equilibria with toroidal-current reversal

F. Leoncio[1], M. Roberto[1], Caroline G.L. Martins [2] , I.L. Caldas[3], R.E. Carvalho[2]
[1]Departamento de Fisica, Instituto Tecnologico de Aeronautica, S. Jose dos Campos, São Paulo, 12228-900 Brazil; [2]Departamento de Estatistica, Matematica Aplicada e Computação, Universidade Estadual Paulista, Rio Claro, Brazil; [3]Instituto de Fisica, Universidade de São Paulo, São Paulo, 05315-970, Brazil

Numerical Grad-Shafranov equilibria with negative toroidal-current-density distribution in the plasma core are computed. The shape of this distribution sets the pitch with which magnetic-field lines wind themselves around the flux surfaces. We choose current density profiles with an inversion near the center of the magnetic axis and we use these profiles to solve the Grad-Shafranov equation. These profiles are related to a non-monotonic safety factor i.e. tokamak discharges with reversed magnetic shear. Stability analysis of this unusual plasma equilibria are characterized by the presence of axisymmetric magnetic islands with low mode numbers that appear in the hole of the plasma column. These modes affect tokamak confinement properties, as it has been observed experimentally. Understanding their stability properties is essential to an improvement of the actual confinement devices, but it is quite a challenging issue because the numerical integration of Grad-Shafranov equation takes a long computing time and presents a lot of numerical errors, making this study more difficult and inaccurate. We treat this problem with Hamiltonian Formalism since we have ordinary differential equations that describe the trace of field lines. After obtaining the Hamiltonian function, we discretize the system and to develop a new simpletic map that describes the behavior of magnetic field lines in tokamaks with toroidal-current reversal.

Scaling investigation of Fermi acceleration on a dissipative bouncer model

A.L.P. Livorati[1], D.G. Ladeira[2], E.D. Leonel[1]
[1]Unesp, Rio Claro, Brazil; [2]UFSJ, São João del Rey, Brazil

The phenomenon of Fermi acceleration is addressed for the problem of a classical and dissipative bouncer model, using a scaling description. The model consists of a classical particle of mass m, bouncing inelastically from a periodically time-moving wall in the presence of a constant gravitacional field g. Our main goal is to understand and describe a phase transition present in this problem. The dynamics of the model, in both the complete and simplified versions, is obtained by use of a two-dimensional nonlinear area-contracting mapping, in the variables velocity of the particle and time, immediately after a collision with the moving wall. The dissipation is introduced using a restitution coefficient on the periodically moving wall. Using scaling arguments, we describe the behavior of the average chaotic velocities on the model both as a function of the number of collisions with the moving wall and as a function of the time. We consider variations of the two control parameters; therefore critical exponents are obtained. We show that the formalism can be used to describe the occurrence of a transition from limited to unlimited energy growth as the restitution coefficient approaches unity. The formalism can be used to characterize the same transition in two-dimensional time-varying billiard problems.

Curvature-driven coarsening in the two dimensional Potts model

M.P.O. Loureiro[1], J.J. Arenzon[1], L.F. Cugliandolo[2], A. Sicilia[2]
[1]Instituto de Fsica, Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil; [2]LPTHE, Université Pierre et Marie Curie, Paris, France

Domains formed during the evolution of mixtures are of great theoretical and experimental importance, and examples range from foams to cellular tissues, superconductors, magnetic systems, etc. Particularly, in metallurgy, understanding the formation of polycrystalline microstructures and their development time is important to determine the properties of the material. Models that show a transition between ordered and disordered phases are widely used to study the dynamics of domain growth. When a system is cooled, going suddenly from the disordered phase to the ordered one (where all q states are likewise available), domains begin to be formed mainly due to local interactions. The temporal evolution of each domain is governed by the curvature of its interface and, generally, the growth law depends on factors such as the conservation (or not) of the order parameter, the presence of disorder or the existence of topological defects. We analyzed the distribution of the domains and hull enclosed areas in the q-state Potts model on the $2d$ square lattice, with non conserved order parameter after a quench in temperature either from infinite or from the critical temperature. For not so low temperatures the system presents dynamical scaling and the characteristic length grows in time as $t^{1/2}$, thus belonging to the Allen-Cahn law universality class. Nevertheless, the above area distributions may differ from those of the Ising model even when the transition is continuous, as in the $q = 3$ case. We describe those distributions for several values of q both in the pure Potts model as in the case where weak disorder is present.

Instabilities in reaction-diffusion systems modify by porosity changes

L. Macias, D. Muller, A. DOnofrio
Grupo de Medios Porosos, FIUBA, Argentina

We analyze the effect of porosity in a porous medium on hydrodynamic instabilities in reactiondiffusion fronts. We use an experimental device to create an effective two dimensional porous medium which is vertically orientated. In this system the molecular diffusion coefficients and the acid autocatalysis of the chlorite-tetrathionate reaction satisfy the appropriate conditions to produce a chemical front that advances through the cell leading to the products overlaying the reactants. The reactants have a lower density than the products and therefore a buoyantly unstable front develops. To evaluate the influence of the porosity on the formation and propagation of such instabilities, media with different porosities were used in the experiments. The amplitude of the instability is found to reduce as the porosity of the medium is decreased. For sufficiently small porosity, the instability can almost disappear leading to a planar front.

Dynamics of defects in the Swift-Hohenberg equation

F. Magalhães, R. Dickman
UFMG, Belo Horizonte, Brazil.

The Swift-Hohenberg equation is a reduced representation of pattern dynamics, such as in Rayleigh-Bénard convection. The equation describes the bifurcation from a uniform steady state to one modulated by a pattern with a characteristic wave vector. For positive values of the control parameter a range of wave vectors are instable. In this work, we study pattern formation in the one-dimensional Swift-Hohenberg via numerical integration. In a system with periodic boundaries, the equation is readily integrated using a spectral method. Starting from a random initial configuration, we follow the process by which a dominant pattern emerges. At intermediate times the system is characterized by a pattern with a well defined wave vector, but with a number of defects. For larger values of the critical wave vector k_c, the number of defects decays to zero at long times, while for smaller values the number appears to attain a nonzero limiting value. In both cases the mean defect number N_d approaches its limiting value via a power-law decay, $\Delta N_d \propto t^{-\gamma}$. The exponent γ appears to vary with k_c. We also study pattern switching (from an initial wave vector to one that grows more rapidly) in the presence of noise.

Evolution and drug resistance: a computational study

L. P. Maia
IFSC-USP, São Carlos, Brazil

I will describe the results of stochastic simulations of an idealized population of microorganisms subject to four types of mutations (deleterious, beneficial, resistance-activating and mutator-activating) and to the eventual introduction of a drug that kills every nonresistant strain. The first two kinds of mutation are usually studied in population dynamics research and directly affect fitness of individuals. The mutator-activating mutations activate idealized mutator alleles that increase the genomic mutation rate (on which depend all mutation rates) of their owners. There is also a carrying capacity to keep bounded the population size, since, depending on its fitness, each strain leaves a Poisson-distributed number of descendents to the next generation, what could lead to explosive growth. This model was originally described in "PJ Gerrish, JG Garcia-Lerma, Lancet Infect Dis 2003; 3: 28-32" and displays nontrivial dynamics. That authors described preliminary results that, under specific conditions, revealed mutator enrichment (i.e., an increase of relative frequency of mutator alleles) at the moment of drug introduction and suggested this could be related to efficient pathogen suppression, but promised further study to confirm this hypothesis and to systematically search for optimal control strategies. To the best of my knowledge, they never did such research and that is the aim of this work. Some of my results seem to be at odds with that article. I kept detailed records of dynamical characteristics of the populations not described in the original work that help understanding the phenomenon of mutator enrichment and searching for optimal pathogen suppression strategies. Besides that, by exploiting the flexibility of the computational model, I also studied the effects of horizontal transmission (in contrast with the vertical one, defined by heredity) and of some alternative dynamics.

Instability statistics and mixing rates

Roberto Artuso[1,2], Cesar Manchein[1,3]
[1]Center for Nonlinear and Complex Systems and Dipartimento di Fisica e Matematica, Università degli Studi dell'Insubria, Via Valleggio 11, 22100 Como, Italy; [2]I.N.F.N. Sezione di Milano, Via Celoria 16, 20133 Milano, Italy; [3]Departamento de Física, Universidade Federal do Paraná, 81531-980 Curitiba, Paraná, Brazil

In last years, there has been considerable interest in understanding of how finite order estimates of time or space averages converge to their asymptotic limit. In this work we claim that looking at probability distributions of *finite time* largest Lyapunov exponents, and more precisely studying their large deviation properties, yields an extremely powerful technique to get quantitative estimates of polynomial decay rates of time correlations and Poincaré recurrences in the -quite delicate- case of dynamical systems with weak chaotic properties.

The morphogenesis of color patterns in reptiles as a variational problem

R. Mansilla[1], L. Caballero[2], P. Miramontes[3], G. Cocho[2]
[1]Centro de Investigaciones Interdisciplinarias, UNAM, México; [2]Instituto de Física, UNAM. México; [3]Facultad de Ciencias, UNAM, México

There is good information concerning the embryogenesis of color patterns of reptiles and thanks to the fact that snakes are almost one dimensional, it is possible to model the development of their color patterns using an approach of similar to the formation of patterns of charged liquid drops subjet to the following dynamics: 1. Short-range attractive interactions among drops, 2. Long-range repulsive interactions, 3. Surface tension and 4. The interaction ("wetting") of the drops with the support background. These points have their biological counterpart: 1. Cell-to-cell interaction, 2. Long range interaction associated to interactions between the cells and the background, 3. Linear tension and 4. Interaction between the cells and the mesenchyma background. It is possible to elaborate a variational problem as a model for the pigmentation of reptiles. Most of the color patterns of snakes are reproduced with this model.

One-dimensional diffusion: range of validity of the kinetic jump

S. J. Manzi, G. A. Ranzuglia, R. E. Belardinelli, V. D. Pereyra
Departamento de Fisica, Instituto de Fisica Aplicada (INFAP) - CONICET, Universidad Nacional de San Luis, Chacabuco 917, 5700, San Luis, Argentina

The coverage dependence of the one-dimensional collective diffusion coefficient is analyzed by using the gradient expansion of the local density. The transition probabilities are written as an expansion of the occupation configurations. Due to that, the detail balance principle determine part of the diffusion terms in the expansion, different functional relation are proposed for this terms. The diffusion coefficient is obtained for various choices of the functional relation. It is shown that, with the exception of Transition State Theory, all the jump schemes proposed here present weakness. Particularly, there are values of the lateral interaction, V, for which the diffusion coefficient presents inconsistencies or un-physical behavior. The range of validity of the kinetic jump processes is determined and phase diagrams for the allowed regions are also shown.

Epidemic processes in complex networks

Angélica S. da Mata, Silvio C. Ferreira Jr., Marcelo L. Martins
Universidade Federal de Viçosa, Minas Gerais, Brazil

Complex networks describe a wide variety of systems of high technological and intellectual importance like the Internet, scientific collaborations, cellular networks, epidemic spreading and others. From these examples, we can emphasize the dissemination of disease in scale-free networks, whose dynamics can be studied through the SIS model. This kind of network exhibit a power law connectivity distribution, $P(k) \sim k^{-\gamma}$. In the SIS model, the nodes represent the individuals that can be susceptible or infected. Susceptible nodes get sick at a rate λ, if at least one of their neighbors is infected and infected nodes are cured and become again susceptible at a unitary rate. The main emphasis of our work was the implementation of this model in mixed networks which are composed of regular lattices connected through a scale-free network. These networks have a local dissemination component inside regular chains and a global one associated with the exchange of individuals among different chains. The phase transition to the absorbing state (free of the disease) was studied considering different strategies of immunization. Ours results show that an immunization targeted to hubs is more efficient than a uniform one. Besides, we analyzed the temporal series for the density of infected sites and observed that in the cases without or with a uniform immunization the power spectrum has two different regimes: for long periods the spectrum has characteristic peaks and, for short periods, the serie follows a $1/\omega^{\alpha}$ noise. In turn, using the immunization targeted to hubs, we found the vanishing of the long period component. We associate this feature with the infection recurrence in the hubs which produces waves of infection throughout the whole network.

Multiple difference-frequency generation in nonlinear acoustics

Anderson B. Melo and Glauber T. Silva
Instituto de Física, Universidade Federal de Alagoas, Maceió AL

Difference-frequency (DF) generation in acoustics is produced by the interaction of two or more continuous-waves (CW). The DF-signal can be adjusted to have the wavelength much larger than that of the fundamental CW-waves. This feature has opened applications of DF-waves to novel ultrasound imaging methods. Ultrasound images synthesized from DF-signals do not exhibit speckle noise, which is seen in conventional ultrasound images. Multifrequency vibro-acoustography is an ultrasound imaging technique, which uses multiple DF-waves tuned at the kilohertz range. However, DF-signals are weak compared to the fundamental and even some harmonic components of the interacting CW-waves. Hence, methods to enhance the generation of single and multiple DF-waves are desired. Here, we study the generation of multiple DF-signals. Our approach is based on the approximate solution of the Westervelt nonlinear wave equation and numerical solvers of the fluid conservation equations. Models are limited to 1D wave propagation. The numerical solver is based on the semi-Lagrangian numerical method. The acoustic source is formed by N CW-waves. The wave frequencies are ordered in a stair-like manner having fixed difference-frequency between two successive waves. Simulation shows the generation of one DF-signal and its harmonics. By solving the Westervelt equation in the second-order approximation, we find the amplitude of nth-harmonic of the DF-signal proportional to $(N-n)/N^2$. Therefore, this method yields multiple DF-wave whose amplitudes of the first harmonics ($N < 5$) are of the same order of that for a DF-wave produced by two CW-waves. Furthermore, this method can be employed to improve multi-frequency vibro-acoustography imaging technique.

Hausdorff dimension of the attractors of baker's transformations with holes

Diana A. Mendes, J. Leonel Rocha
Department of Quantitative Methods, Lisbon University Institute, ISCTE-IUL and UNIDE, Avenida das Forcas Armadas, 1649-026 Lisbon, Portugal; ISEL Lisbon, Rua Conselheiro Emdio Navarro, 1949-014 Lisbon, Portugal

The notion of Hausdorff dimension plays an important role in describing the concept of "size" of sets in the plane and is particularly useful in analyzing sets of Lebesgue measure zero. A situation that is relatively well understood is that of Cantor sets in the real line that are constructed dynamically from simple Markov transformations. The situation becomes more complicated when non-conformal and higher dimensional analogues are considered. The main purpose of this paper concentrates on computing explicit formulae for Hausdorff dimension in as many specific cases as possible. The techniques of previous authors and ours are quite different but confirm the same results. In order to obtain this algorithm we construct a weighted kneading theory for triangular maps of the plane and as a first consequence of this theory we obtain the Hausdorff dimension of the limit set of these maps. We consider piecewise linear triangular maps of the real plane, where the basis map is expansive and the fiber map admits holes. It is of interest to concentrate on particular invariant sets, and here we concentrate on those that are Cartesian product of two Cantor sets, associated to Baker's transformations with holes and product systems.

Terrorism, power laws and long-range correlations

K. A. P. Prudêncio, R. S. Mendes, S. Picoli Jr.
Universidade Estadual de Maringá, Brazil

The dynamics of terrorism is analyzed via concepts and methods from statistical physics. Specifically, we have investigated the data number of dead, wounded and victims. We compare the cumulative distributions of dead/attack, wounded/attack and victms/attack with power laws. In addition, we study the time series of events, dead, wounded and victims. From these series, we obtain the probability distributions of fluctuations as well as we analyze the existence of long-range correlations.

Nonlinear asymmetric co-movements in globalised stock markets: evidence from the U.S. and the E.U.

R. Menezes
ISCTE-IUL, Lisboa, Portugal

Nonlinear economic phenomena have been widely recognised by economists and, e.g., Granger and Tersvirta (1993) have dedicated a whole book to the subject. Such relationships are present in many aspects of the economic activity, and particularly so in the context of financial markets. Examples of this include the attitude of investors towards the risk and the process of generating financial variables such as stock returns, dividends, interest rates, and so on. On the other hand, the performance of an economy also presents signs of nonlinear behaviour: e.g. business cycles, production functions, growth rates, unemployment, etc. The shape of nonlinearity in these relationships may be rather complex, of which a particular case involves regime switching. This is so when one studies the co-movements between stock returns volatility and some relevant macroeconomic factors. One obvious question that we may pose in this context is whether the magnitude of positive and negative responses differs for similar positive and negative variations in the predictors, in which case we can say that the underlying variables display asymmetric adjustment. Markets characterised by higher supply elasticity are likely to show less asymmetry than their counterparts due to in-creased security of supply. Financial market models have incorporated asymmetry using GARCH-type methodologies. An alternative way is to use threshold autoregressive models to address the problem of multivariate asymmetry. These methodologies are essential when the asymmetric variables are non-stationary (but not only), because of the low power of unit roots and cointegration tests in such cases. In a non-stationary framework, asymmetric cointegration tests were developed by Enders and Siklos (2001) using a modified error correction model derived from the original EG testing procedure. We apply this methodology to the U.S. and some European stock markets using monthly data collected from Datastream.

Walking patterns in termites

O. Miramontes[1], O. de Souza[2]
[1]UNAM, DF, Mexico; [2]UFV, Viçosa, Brazil

In this contribution we present the analysis of time series from observations of termites walking in confined spaces. We show the existence of scale-free statistics of the distances traveled and show subtle fractal structures in the walking process.

Arch generated shear bands in granular systems

A. LaierL. Sigaud, G. Tavares, H. Lopes, T. Lewiner, W.A.M. Morgado
PUC-Rio, Rio de Janeiro, Brazil

We propose an arch based model, on cubic and square lattices, to simulate the internal mobility of grains, in a dense granular system under shear. In this model, the role of the arches in granular transport presents a non-linear dependence on the local values of the stress components that can be modeled geometrically. The model mimics the behavior of the actual granular mobility inside the system and is consistent with the minimal dissipation hypothesis associated with the internal shear bands. In special, we study a modified Couette flow and find the appearance of shear-bands in accordance with the literature.

Dynamical thermalization of disordered nonlinear lattices

Mario Mulansky[1], Karsten Ahnert[1], Arkady Pikovsky[1,2], Dima L. Shepelyansky[2,3]
[1]Department of Physics and Astronomy, Potsdam University, Karl-Liebknecht-Str 24, D-14476, Potsdam-Golm, Germany; [2]Université de Toulouse, UPS, Laboratoire de Physique Théorique (IRSAMC), F-31062 Toulouse, France; [3]CNRS, LPT (IRSAMC), F-31062 Toulouse, France

We study numerically how the energy spreads over a finite disordered nonlinear one-dimensional lattice, where all linear modes are exponentially localized by disorder. We establish mergence of dynamical thermalization, characterized as an ergodic chaotic dynamical state with a Gibbs distribution over the modes. Our results show that the fraction of thermalizing modes is finite and grows with the nonlinearity strength.

Multifractal properties of time series and the Levy sections theorem

C. M. Nascimento[1], I. M. Gléria[2], F. S. Passos[2], A. Figueiredo[3], P. C. Assis Jr[4], M. Serva[5], G. M. Viswanathan[2,6]
[1]Universidade Federal de Sergipe, São Cristóvão, Brazil; [2]Universidade Federal de Alagoas, Maceió, Brazil; [3]Universidade de Brasília, Brasília, Brazil; [4]Universidade Estadual da Paraíba, Patos, Brazil; [5]Università dell' Aquila, L' Aquila, Italy; [6]Consortium of the Americas for Interdisciplinary Science, University of New Mexico, Albuquerque, USA

Within the econophysics community, the stylized facts such as self-affinity, fat tails, multifractality and leverage effect are still considered to be open problems. One believes that the stylized facts are responsible for the ultraslow convergence to the Gaussian distribution observed, among other effects. Also of interest in this work is the Levy sections theorem, which was recently revisited to encompass empirical time series. The sections theorem guarantees a fast convergence to Gaussian distribution regardless the presence of correlations. This fast convergence is probable related to the fact that the sections theorem is focused on a fixed variance, rather than fixed time lag, as usual. Our goal is to analyze the multifractal properties of time series obtained with the help of the sections theorem, in order to understand the fast convergence to Gaussian distribution observed within this approach.

Orientational order of modulated phases in Langevin simulations of a scalar model with competing interactions

L. Nicolao, D. A. Stariolo
Departamento de Fisica, Universidade Federal do Rio Grande do Sul, Brazil

In this work we study the phenomena observed in a large number of physical, chemical and biological systems, where stripe pattern formation results from the presence of interactions competing in different spacial scales. Here we focus on the competition between the exchange and dipolar interactions, as to model the magnetic stripe domains observed in ultrathin magnetic films with perpendicular anisotropy. In this case, as well as in other scalar order parameter systems in two dimensions, the competing interactions stabilize stripe domain structures with reasonable regularity that have both translational anisotropic and orientational orders, similar to those found in liquid crystal films. Through a scalar Landau Ginzburg model that captures the stripe domain formation in ultrathin magnetic films with perpendicular anisotropy, we study the effect of thermal fluctuations acting in the length scales introduced by the competition of the interactions, that, together with the low dimensionality of the problem, estabilize low temperature ordered phases with quasi-long-range order, where topological defects play a fundamental role. We introduce here a Langevin simulation technique to the Landau Ginzburg model, through which we obtain equilibrium results determining the nature of the low temperature phases. We confirm, in agreement with experimental observations, the stability of a smectic phase, related to the break of translational symmetry. Between this phase and the isotropic phase, we find results that point to the stability of the nematic phase, related to the break of orientational symmetry, that is predicted theoretically but was not observed experimentally. The Langevin simulation introduced here is capable to reproduce some of the phenomena, like the stripe domain width temperature dependence and the domain wall profile, as well as stripe thermal fluctuations and topological defects, very close to those observed experimentally.

Dynamics of deformable self-propelled particles

T. Ohkuma and T. Ohta
Department of Physics, Kyoto University, Japan

A self-propelled motion is widely seen in nature such as biological systems, an excitable reaction diffusion system, and a system of oil droplets in a surfactant solution. In this poster,

we present a phenomenological equation of motion of a deformable self-propelled particle and investigate the dynamics of assembly by introducing a global interaction in two-dimension [1]. It is assumed that the particle can deform into an elliptical shape by increasing the propagating velocity. A coupled set of equations in terms of the velocity and a tensor variable that describes the deformation is introduced to represent the motion of a deformed particle by considering the lowest order couplings. It is shown that there is a bifurcation from a straight motion to a circular motion of a single particle depending on the propagating velocity and the relaxation time of the deformation. The clockwise and counterclockwise motions are possible by the isotropic symmetry of the system. The collective dynamics of deformable particles has also been numerically studied by applying a global coupling such that the particles tend to cause an orientational order. In our simulation, several synchronized states and chaotic behaviors have been found depending on the strength of the interaction and the parameters of the individual particles. The phase reduction method reveals the bifurcations between in and out-of phase synchronization phenomena and between a scattered state and a ballistic procession state. We estimate the boundaries of the chaotic region where the synchronized states become unstable by using linear stability analysis.
[1] T.Ohta and T. Ohkuma, Phys. Rev. Lett. vol. 102, 154101 (2009)

Dynamics of two interacting particles in a 1D soft billiard

H. A. Oliveira, M. W. Beims
Departamento de Física, Universidade Federal do Paraná, 81531-990 Curitiba, PR, Brazil

Since physically realizable potentials are inherently soft, it is the purpose of the present work to study the effect of soft walls on the dynamics of interacting particles in a 1D billiard [1]. It has been shown recently [2] that the origin of chaotic motion of two interacting particles in a one-dimensional box is due *double collisions* which occur *very close* to the hard walls. These double collisions occur when one particle is colliding with the 1D wall and almost *simultaneously* collides with the other particle. As a consequence, the kind of motion generated close to the 1D walls is essential for the whole dynamics inside the billiard. Therefore we expect that the softness of the 1D walls will strongly affect the dynamics of the interacting particles. The 1D billiard used here has n potential steps with height V_n and represents the discrete version of a soft wall potential ($n \to \infty$). Due to the simplicity of the model, analytical results for the dynamics in the tangent space can be obtained. Consequently the Lyapunov exponents are calculated and the transition from hard to soft walls is studied.
[1] Oliveira, H., A.; Manchein, C.; Beims, M. W., *Phys. Rev. E*, v. 78, p. 46208, 2008; [2] Manchein, C.; Beims, M. W.; Rost, J. M., *Phys. Rev. E*, v. 76, p. 56203, 2007.

Universality of the contact process with random dilution

Marcelo M. de Oliveira[1,2], S. C. Ferreira[2]
[1]UFSJ, Ouro Branco, Brazil; [2]UFV, Viçosa, Brazil

We present quasistationary simulations of the two-dimensional contact process with quenched disorder included through the random dilution of a fraction of the lattice sites (these sites are not susceptible to infection). Our results strongly indicate that the static exponents are independent of the immunization fraction. In addition, the critical moment ratios $m = \langle\rho^2\rangle/\langle\rho\rangle^2$ deviate from the universal ratio $m = 1.328$, observed for the non-diluted system, to smaller values due to rare favorable regions which dominate the statistics.

Multiscale modelling for the virotherapy of avascular papillary tumors

L. R. Paiva, M.L. Martins, S. C. Ferreira, Jr.
Universidade Federal de Viçosa, Brazil

One of the most promising strategies to treat cancer is attacking it with viruses. Oncolytic viruses are biological nanomachines that can be programmed to kill tumor cells specifically or induce anti-cancer immune response. The new viruses released from the lysed cells can subsequently infect adjacent or distant tumor cells and trigger multiple cycles of infection. Clinically-significant systemic antitumoural activity has now been demonstrated with oncolytic virotherapy. An extended multiscale model for virotherapy of cancer based on those proposed by Ferreira *et al.*[1] and Paiva *et al.*[2] is investigated. This nutrient-limited model combines macroscopic reaction-diffusion equations, describing the nutrient fields concentration, with microscopic stochastic rules governing the actions of individual cells. Uninfected tumor cells can undergo division, migration, infection and death by necrosis, while the infected ones can only die by lysis. The free virus particles, whose sources are infected cancer cells, undergo random walks. Virotherapy begins when the tumour attains N_0 cells and it consists of a single virus injection. The case of highly invasive papillary tumors (e.g. glioblastoma multiform or trichoblastoma) is considered. In the intratumoral administration, viruses are uniformly supplied over the circle that circumscripts the tumour. In the present work, the temporal evolution of the numbers of cancer cells and oncolytic viruses are studied. Also, the dominant therapeutic responses and their corresponding probabilities are determined for the different regions in the model parameter space.
[1]S. C. Ferreira, Jr., M.L. Martins and M.J. Vilela, Fighting cancer with viruses. *Physica A* **345** : 591, (2005); [2]L. R. Paiva, C. Binny, S. C. Ferreira, Jr. and M.L. Martins, A Multiscale Mathematical Model for Oncolytic Virotherapy. *Cancer Res* **69** : 3, (2009).

Analysis of persistance during intracellular actin-based transport mediated by molecular motors

C. Pallavicini[1], V. Levi[1,2], L. Bruno[1], M.A. Desposito[1]
[1]Depto. de Fisica, FCEyN, UBA, Buenos Aires, Argentina; [2]Depto. de Quimica Biologica, FCEyN, UBA, Buenos Aires, Argentina

Intracellular transport of large cargoes, such as organelles, vesicles or large proteins, is a complex dynamical process that involves the interplay of ATP-consuming molecular motors, cytoskeleton filaments and the viscoelastic cytoplasm. The displacements of particles or probes in the cell cytoplasm as a function of time are characterized by different (anomalous) diffusion regimes. We investigate the motion of pigment organelles (melanosomes) driven by myosin-V motors in *Xenopus laevis* melanocytes using a high spatio-temporal resolution tracking technique. By analyzing the turning angles (*phi*) of the obtained trajectories as a function of the time lag, we found the critical time of the transition between anticorrelated and directed motion which was paralleled by a crossover from subdiffusive to superdiffusive behavior in the mean square displacement. Using a stochastic theoretical model that starts from a generalized Langevin equation that explicitly considers the collective action of the molecular motors, we derive an analytical expression for *cos*(*phi*) as a function of the time lag, which also takes into account the experimental noise. By fitting our model to the experimental data we were able to obtain a quantitative description of active transport in living cells with a reduced number of parameters.

A simple heterogeneus agent-based model for traders systems

F. S. Passos[1], C. M. Nascimento[2], Iram Gleria[1], Sergio da Silva[3], G. M. Viswanathan[1,4]
[1]Universidade Federal de Alagoas, Maceió, Brazil; [2]Universidade Federal de Sergipe, São Cristóvão, Brazil; [3]Universidade Federal de Santa Catarina, Florianópolis, Brazil; [4]Consortium of the Americas for Interdisciplinary Science, University of New Mexico, Albuquerque, USA

The financial market is a complex system in which a large number of traders interact non-linearly among them. They also react to external information to determine the price of a chosen financial share. Any agents decision of buying or selling alters the price, and the new price provokes another decision, in such a way that a characteristic pattern of correlation arises. In recent years physicists proposed an efficient tool to understand the economical system, the Agent-based model approach. Instead of modeling the evolution of prices, we create a community of traders (agents) that follow simple rules to decide whetter to buy or sell a given financial share. In this work we present a simple heterogeneous agent-based model to describe a financial market which displays several of the well established stylized facts. We have observed multifractal properties, long range correlation of the volatility, short range correlation of the returns and other typical properties of financial markets presents.

Correlation and multifractality in climatological time series

Isabel Tamara Pedron
Universidade Estadual do Oeste do Paraná, Brazil

The atmospheric behavior is not linear and the complexity of its dynamics can be studied by several approaches. Climate can be described by statistical analysis of mean values of atmospheric variables over a period. Another way is to address the joint evolution of individual values in a succession of atmospheric states. Data obtained in meteorological stations or satellites constitute a time series and techniques for time series analysis offer very important information about climatogical series and therefore, about the clima. It is possible to detect correlations in the data series and to classify its behavior. In this work the Hurst exponent, which can characterize correlation and fractality in time series, is obtained by using the Detrended Fluctuation Analysis (DFA) method. This method has proven useful in revealing the existence of long-range correlations in time series. Data series of temperature, humidity, precipitation, solar radiation and wind speed are analyzed. Furthermore, the multifractality of such series is analyzed applying the Multifractal Detrended Fluctuation Analysis (MDFA) method.

Quantum chaotic resonances from short periodic orbits

M. Novaes[1], 2, J.M. Pedrosa[3], D.A. Wisniacki[4], G.G. Carlo[3], J.P. Keating[1]
[1]University of Bristol, Bristol, UK; [2]Universidade Federal de São Carlos, São Carlos, Brazil; [3]CNEA, Buenos Aires, Argentina; [4]Universidad de Buenos Aires, Buenos Aires, Argentina

We present an approach to calculating the quantum resonances and resonance wave functions of chaotic scattering systems, based on the construction of states localized on classical periodic orbits and adapted to the dynamics. Typically only a few of such states are necessary for constructing a resonance. Using only short orbits (with periods up to the Ehrenfest time), we obtain approximations to the longest living states, avoiding computation of the background of short living states. This makes our approach considerably more efficient than previous ones. The number of long lived states produced within our formulation is in agreement with the fractal Weyl law conjectured recently in this setting. We confirm the accuracy of the approximations using the open quantum baker map as an example.

Non-extensivity index as an indicator of non-classicality

F. Pennini[1,2], A. Plastino[1], G.L Ferri[3]
[1]Instituto de Física La Plata–CCT-CONICET, Fac. de Ciencias Exactas, Universidad Nacional de La Plata, C.C. 727, 1900 La Plata, Argentina; [2]Departamento de Física, Universidad Católica del Norte, Av. Angamos 0610, Antofagasta, Chile; [3]Facultad de Ciencias Exactas, Universidad Nacional de La Pampa, Peru y Uruguay, Santa Rosa, La Pampa, Argentina

Finding marks of the classical-quantum border is a very important task of perennial interest. We show that the frontier between the classical and quantum domains can be characterized by recourse to a delimiter parameter q associated with non-extensive scenarios. A convenient indicator of non-classical field is the so-called Mandel parameter. We calculate the dependence of the Mandel parameter with the index q.

Bifurcations in normal random matrix ensembles

T. Pereira[1], A.M. Veneziani[2], D.H.U. Marchetti[2]
[1]UFABC, Centro de Matematica, Brazil; [2]USP, Instituto de Fisica, Brazil

In a recent work Elbau and Felder established a one-to-one connection between simple analytic curves and normal random matrix ensembles. However, their results are no longer valid when the exterior of the simple analytic curve $\gamma(s)$ tends to the slit domain $\mathbb{C}/[-2r, 2r]$. We generalize Elbau-Felder's results by applying the constructive bifurcation theory from a simple eigenvalue. We construct the bifurcating curves show how to keep the one-to-one relation between the simple analytic curves and normal matrix ensembles.

Topological approach to synchronization times in coupled chaotic maps lattices

Rodrigo Frehse Pereira[1], Sandro Ely de Souza Pinto[1], Sergio Roberto Lopes[2], Ricardo Luiz Viana[2]
[1]State University of Ponta Grossa, Ponta Grossa, Brazil; [2]Federal University of Paraná, Cuitiba, Brazil

We analyze the synchronization times of a spatially extended system composed by Bernoulli shift maps which interact in non-local fashion. It was observed that, even when the synchronized state is globally and uniformly stable, typical trajectories can be apparently repelled from it. We show the existence of an infinite denumerable set of unstable periodic orbits outside of synchronized state. The erratic behavior of typical trajectories is then associated to a chaotic saddle and, consequently, its average lifetime (obtained by the reciprocal of the escape rate) gives the observed mean synchronization time.

Classifying graphs by spectra of neighborhood matrix and higher order adjacency matrices

T. C. Petit Lobao, A. D. Bessa, S. T. R. Pinho, R. F. S. Andrade
Universidade Federal da Bahia, Salvador, Brazil

Classification of graphs is an important issue in Graph Theory, and so in the study of complex networks. Spectral graph analysis identifies sets of invariants for isomorphic graphs. Recently, a detailed study of cospectral graphs enumerates and analyzes the spectra of all graphs with respect to several matrices, such as the Adjacency, Laplacian and the sign-less Laplacian matrices [1]. In this work, we address the quoted problem and consider the eigenvalue spectra of two classes of matrices that emerge from the study of the neighborhood properties of graphs: the set of higher order adjacency matrices M_ℓ's and the neighborhood matrix noted by $\hat{M}$ and defined as a linear combination of M_ℓ's whose coefficients correspond to the order ℓ [2]. We perform a complete study of their cospectrality rates for all non-isomorphic graphs with at most $n = 9$ vertices (274,668 non-isomorphic graphs). The results show that these matrix sets differentiate non-isomorphic graphs by their spectra better than the Adjacency and Laplacian matrices. Considering the set of M_ℓ's and $\hat{M}$, there are no graphs with cospectral mates when $n < 7$. They also present a better performance than the sign-less Laplacian $|L|$ matrix for graphs when $n < 9$. The set of M_ℓ's is more accurate than $\hat{M}$ in differentiating the non-isomorphic graphs for $7 < n < 10$. Finally, changing the coefficients of $\hat{M}$ to prime numbers, the results are more efficient than $\hat{M}$ for higher values of n. Based on our results, we point out that such matrices may be appropriate for applications that depend on very low cospectrality rates as, for instance, pattern recognition.

[1] W. H. Haemers, E. Spence, Enumeration of Cospectral Graphs, Eur. J. Combin. **25** (2004) 199-211; [2] R. F. S. Andrade, J. G. V. Miranda, T. P. Lobão, Neighborhood Properties of Complex Networks, Phys. Rev. E **73** (2006) 046101.

Height fluctuations in plant monoculture: non-Gaussian behavior and anti-correlations

S. Picoli, R. S. Mendes, A. A. Bonacin, L. C. Malacarne
Universidade Estadual de Maringá, Maringá, Paraná, Brazil

The variability of plant size has been related to several factors, including age differences, genetic differences, environmental heterogeneity, differential effects of herbivores, parasites or pathogens and competition. Competition effects may be focused by analyzing size variability in even-aged plant monocultures. Here, we analyse four databases containing the height of individual plants in monospecific stands. Specifically, we study *Zea Mays* since it has an erect and robust stem and is suitable for measurements. We find evidence of non-Gaussian behavior and anti-correlations in height increments between successive plants. These findings are similar to those found in other complex systems where competition between elements is strong. This similarity suggests that competition between plants may be the origin of the observed behavior.

Solutions of the Fokker-Planck equation for Morse isospectral potential

F. Polotto, M. T. Araújo, E. Drigo Filho
IBILCE/UNESP - São José do Rio Preto, São Paulo, Brazil

The Fokker-Planck equation was first applied to the problem related to the Brownian motion. This kind of movement clearly shows the statistical fluctuations in a system. There are several examples of applications of the Fokker-Planck equation in physic, chemistry and biology [1]. This equation can be used to describe processes involving biological systems [2]. In particular, processes involving protein folding can be described for this equation [3]. In many cases, the potential to be treated is bistable and asymmetric, i.e, it involves two minimums with distinct values of energy. This work is addressed to study statistical fluctuations in a particular case. Specifically, it is studied the Fokker-Planck equation related to Morse isospectral potential. The starting point is the study of the Schrodinger equation for Morse potential. The next step is to determine the isospectral potential by using the formalism of Supersymmetric Quantum Mechanics [4]. Quantum isospectral potential have the same energy spectrum of the original Morse potential, but the wave functions are different [5]. Then, the probability resulting from the Fokker-Planck equation, written as an expansion of the wave functions [1], is different in both cases. The results obtained for the class of new potentials can be useful to refine models used to describe biological systems. In the present work, the solutions of the Fokker-Planck equation are found in terms of the like-Schrodinger equation. The graphics of probability versus position for different times are analyzed. It is observed that, for very large values of time, the term dependent of the time can be negligible and that the probability distribution becomes to a stationary one.

[1] Risken, H., The Fokker-Planck Equation: Method of Solution and Applications, Berlin, Springer, (1989); [2] Rosu, H. C., Morn-Mirabal, J.M., Cornejo, O., Phys. Rev. A, 310 (2003) 353; [3] Onuchic, J. N., Luthey-Schulten, Z., Wolynes, P. G., Ann. Rev. Phys. Chem., 48 (1997) 545; [4] Drigo Filho, E., J. Phys. A: Math. Gen., 21 (1988) L1025; [5] Rubio-Ponce, A.; Pea, J. J.; Morales, J., Phys. A, 339 (2004) 285.

Duration models of independent competing risks: An application to the customer churn

Sofia Portela[1], Rui Menezes[2]
[1]ISCTE Business School, Lisbon, Portugal; [2]ISCTE Business School, Lisbon, Portugal

The fixed telecommunications industry in Portugal has presented high customer churn rates (i.e., the customer's decision to terminate the relationship with a provider) for the last decade, which may be mainly due to the considerable competition in this industry. The aim of this study is to do a longitudinal analysis of the customer lifetime and the multiple causes of churn. Specifically, this study intends to estimate the probability (risk) of a given customer to cancel the relationship with the service provider, for each cause of churn. In this way, an independent competing risks duration model is used. The model is developed by using large-scale data from an internal database of a Portuguese company which presents bundled offers of ADSL, fixed line telephone, pay-TV and home-video. The model is estimated with a large number of covariates, which includes customer's basic information, demographics, churn flag, customer historical information about usage, billing, subscription, credit, and other.

Propagation of optical solitons in semiconductor quantum dot ensembles

M. Ramirez, A. Camacho
Universidad de los Andes, Bogota, Colombia

Ever since its discovery, the optical properties of quantum dots have been studied with great interest. Quantum dots, also known as artificial atoms, show several properties absent in atomic systems. For example, spontaneous emission which depends on quantum dot size, interactions with many electron systems, interactions between excitons and biexcitons with electromagnetic waves and propagation of optical solitons in quantum dot ensembles. The purpose of this work is to study theoretically the nonlinear coupling between light and matter, analyzing, in particular, the propagation of electromagnetic waves in non interacting quantum dot ensembles. We studied the interaction of an electromagnetic wave with a three level system by solving the nonlinear wave equation under the condition of self-induced transparency. This equation was solved numerically taking into account the nonlinear polarization of the quantum dot. The ideal initial conditions were obtained using a variational method for a test solution of the nonlinear wave equation. Finally, we obtained optical solitons that propagates through the medium without suffering significative losses.

Nonlinear response and dynamical transitions in a phase field crystal model for adsorbed overlayers

J.A.P. Ramos[1,2], E. Granato[2,4], C.V. Achim[3], S.C. Ying[4], K.R. Elder[5], and T. Ala-Nissila[3,4]
[1]Departamento de Ciências Exatas, Universidade Estadual do Sudoeste da Bahia, 45000-000 Vitória da Conquista, BA, Brasil; [2]Laboratório Associado de Sensores e Materiais, Instituto Nacional de Pesquisas Espaciais,12245-970 São José dos Campos, SP, Brazil; [3]Department of Engineering Physics, P.O. Box 1100, Helsinki University of Technology, FIN-02015 TKK, Espoo, Finland; [4]Department of Physics, P.O. Box 1843, Brown University, Providence, RI 02912-1843, USA; [5]Department of Physics, Oakland University, Rochester, Michigan 48309-4487, USA

We study numerically the nonlinear response and sliding friction behavior in a phase field crystal model for adsorbed layers in presence of thermal fluctuations [1,2]. The model describes the layer as a continuous density field in presence of a pinning potential and external driving force allowing for both elastic and plastic deformation, and inertial effects. At low temperatures and in presence of inertial effects we find that the velocity response of an initially commensurate layer shows hysteresis with dynamical melting and freezing transitions for increasing and decreasing applied forces at different critical values. The main features of the nonlinear response are similar to the results obtained previously with molecular dynamics simulations of particles [3,4]. However, the dynamical melting and freezing mechanisms are significantly different corresponding to nucleations of stripes rather than closed domains.

[1]J.A.P. Ramos, E. Granato, C.V. Achim, S.C. Ying, K.R. Elder, T. Ala-Nissila, Phys. Rev. E **78**, 031109 (2008); [2]C.V. Achim, J.A.P. Ramos, M. Karttunen, K.R. Elder, E. Granato, T. Ala-Nissila, and S.C. Ying, Phys. Rev. E **79**, 011606 (2009); [3]B.N.J. Persson, Phys. Rev. Lett. **71**, 1212 (1993); [4]E. Granato and S.C. Ying, Phys. Rev. Lett. **85**, 5368 (2000).

Work supported by Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP) under Grant No. 07/08492-9. S.C.Y. also acknowledges the support from FAPESP (Grant No. 09/ 01942-4).

Semiclassical many-body density of states of a Bose gas

A. D. Ribeiro[1], J. Roccia[2], P. Leboeuf[3]
[1]UFPR, Curitiba, Brazil; [2]University of Regensburg, Regensburg, Germany; [3]LPTMS, Orsay, France

The present article is concerned with the use of semiclassical approximations in the calculation of the many-body density of levels $\rho_{\rm mb}(E,N)$ of a system with total energy E, composed by N bosons. We restrict ourselves to cases where a mean-field approximation can be used, which implies that the fundamental ingredient used to calculate $\rho_{\rm mb}$ is the single-particle density of states $\rho_{\rm sp}(\epsilon)$. We derive a uniform formula for $\rho_{\rm mb}$ as function of $\rho_{\rm sp}$ which is potentially able to deal with regimes that go from the quantum-degenerate limit to the Maxwell-Boltzmann limit. We, then, replace the exact single-particle spectrum by a smooth semiclassical function $\bar{\rho}_{\rm sp}(\epsilon)$, which basically contains information about the average spacing between two neighboring levels around the single-particle energy ϵ. This approach obviously disregards details in the distribution of levels. By demanding more accuracy, we include a correction to $\bar{\rho}_{\rm sp}$, the oscillating term $\tilde{\rho}_{\rm sp}$, which can be semiclassically achieved through trace formulas.

Anomalous diffusion and symbolic sequences

H. V. Ribeiro, E. K. Lenzi and R. S. Mendes
Departamento de Física, Universidade Estadual de Maringá, Av. Colombo 5790, 87020-900, Maringá, PR, Brazil

We address this work to analyze the nonusual behavior of a symbolic model with an adjustable long-range behavior. More precisely, we investigated one dimensional symbolic sequences with long-range correlations. The sequence was generated using the numerical procedure presented by Buiatti [Physica A **268**, 214 (1999)]. We considered the sequence as a random walk-like process and this approach enabled us to characterize the diffusive process. The results indicated that the diffusion regime is superdiffusive when there are long-range correlations.

Off-lattice model for neuron outgrowth

M. Ribeiro, M. Martins
Universidade Federal de Viçosa, UFV, Viçosa, Brazil

Far from equilibrium growth and pattern formation phenomena are widespread in nature and many science branches. For try to understand these processes, computational models are created and investigated. Like example we can cite the neuronal outgrowth. Is known that neurite growth, growth cone behavior, cell death, 'fatores traficos' production and another processes are controlled by electric activity and neurotransmitters extracellular concentration. In response to the constraints imposed to morphogenesis and the requirements of functional efficiency, many biological structures are organized in irregular forms and we can model it like a laplacian growth, i.e., limited by extern mechanism. This fractal morphology is particularly important because the geometry of neurons has direct and fundamental effects on the connectivity pattern and electric activity of the nervous system. Here, we studied the neurite (axon and dendrites) outgrowth. In particular, we consider the fundamental influence of growth cones and their interactions with the extracellular environment, mainly with the neurotransmitters concentration field. The dynamics of neurite outgrowth is investigated on the basis of the dielectric breakdown model (DBM), modified to take into account the existence of growth cones at every branch tip (neurite). The extension, migration (random walk), splitting and retraction of neurites are controlled by parameters characteristic of each neuronal type. The squared model idea brings intuition and understood about complex growth phenomenon and physics rules that govern it. Nevertheless, for achieve a biological realism a off-lattice model becomes necessary. We show in this work a off-lattice neuronal outgrowth model that is able to reproduces, in a morphological sense, the neurons found *in vivo*.

Using an one-dimensional lattice applied to the thermodynamic study of DNA

N.F. Ribeiro, E. Drigo Filho
UNESP-São José do Rio Preto, São Paulo, Brazil

In this work, it is analyzed a one-dimensional lattice formed by mass-spring systems with an additional Rosen-Morse potential on site. This kind of lattice is used to study thermodynamic properties of DNA. The partition function was calculated by using the methodology of transfer integral operator [1]. This method relates the partition function with energy eigenfunctions and eigenvalues obtained by a pseudo-Schrödinger equation. In the context of this work, the Rosen-Morse potential simulates the hydrogen bounds between the double helix of the DNA. The graphic of the average streching in function of temperature gives information about the thermal denaturation of the macromolecule. It is shown that it is possible to obtain phase transition in models like the Peyrard-Bishop (PB) one [1] with an asymmetric potential, but it is not necessary the existence of an infinite barrier in the potential. This result complements the discussion in the literature about the no existence of phase transition to symmetric potentials [2] and the well know fact that an asymmetric potential, with an infinite barrier in one extremity, leaves to a phase transition [3]. The fact that there is an exact/analytical solution for the studied system allowed an alternative form to determine the temperature of rupture of the double helix. This can be done through direct inspection of the energy eigenfunction. The calculated value for this temperature is 347K. This value is in agreement with the values find in the literature. The temperature of denaturation for the DNA molecule varies between 318K and 372K [4] depending on the nucleotides involved in the chain. This result indicates that the used potential and the chosen parameters can be used to describe the thermal denaturation of DNA.

[1] Peyrard M. and Bishop A. R., Phys. Rev. Lett., 62 (1989) 2755; [2] Angelani L., Ruocco G. and Zamponi F., Phys. Rev. E, 72 (2005) 016122; [3] Qasmi H., Barr J. and Dauxois T., arXiv:cond-mat/0407662v1 (2004); [4] Saenger W., Principles of Nucleic Acid Structure, New York, Springer-Verlag Press (1984).

The Loewner equation for finger dynamics

M. A. D. Roa, G. L. Vasconcelos
Universidade Federal de Pernambuco, Brazil

The Loewner differential equation is an important result in the theory of univalent functions that has recently been shown to have profound implications for many areas of physics, ranging from statistical mechanics to conformal field theory. More specifically, the Loewner equation is a first-order differential equation for the time-evolution of the conformal mapping $w = g(z, t)$ from the physical domain in the z plane to the mathematical w plane consisting of the upper half-plane. In particular, if driven by a Brownian motion the Loewner equation generates random curves that are related to the critical state of equilibrium statistical mechanics models. Recently (T. Gubiek and P. Szymczac, P.R.E. **77**, 041602 (2008)), the deterministic Loewner equation was also used to describe the Laplacian growth of a family of finger-like protrusions of zero width (i.e., slits) both in the upper half-plane and in a channel. In the present work, the problem of the Laplacian growth of an extended finger (i.e., with nonzero width) is considered in the framework of the Loewner equation. The growth model is defined in such way that the maximum (minimum) growth occurs at the tip (endpoints) of the finger. It is shown that this process can be described by a novel generalized Loewner differential equation with logarithmic singularities. Some properties of this equation are studied and examples of finger evolution are shown for both symmetric and non-symmetric fingers. The situation with multiple extended fingers growing into the upper half-plane is also considered and the interation between such fingers is discussed. The case of a symmetric finger growing into the channel geometry is also studied.

Modeling growth with different classes of differential equations

W. Robazzi[1], J. Teleken[1], D. Stolf[2], G. Gomes[1]
[1]Udesc, Pinhalzinho, Brazil; [2]UFSC, Chapeco, Brazil

A variety of growth curves have been employed to model population dynamics and biological growth. Classical growth models include the logistic and Gompertz functions. The logistic function was first introduced by Verhulst which considered that a stable population would have a saturation level characteristic, called the carrying capacity. The logistic growth model has formed the basis for several extended models and has been used to describe many biological systems and other fields such as the market penetration of new products. The Gompertz model was introduced by the actuary Benjamim Gompertz and is one of the most employed growth models in biological and economic areas. The main difference between both models is related to the decrease of the specific growth rate, which decays linearly and logarithmically, respectively. Another important model is the Richards model. This model is an empirical construct which owes its generality to an additional parameter. The interesting point to be addressed is that appropriate values of this parameter result the Gompertz and the logistic equations. However, an important weakness of the Richards equation is that it was obtained empirically and its parameters have no biological meaning. In this paper we obtain a mechanistic derivation to Richards equation by imposing that the specific growth rate is a decreasing function of the variable studied. From a mathematical standpoint, this is equivalent to say that its derivative is negative and the chosen function to describe this feature was a power one. In addition, we introduced a new class of growth functions by employing a logarithmic function. Both classes of functions were used in three different sorts of phenomena: microorganisms growth in food, liver growth of children and tree growth in order to establish the universality of the models. Mathematical properties of the models are discussed and presented in detail.

Symplectic approach to calculation of magnetic field line transport in poloidal divertor tokamaks

M. Roberto[1], T. Kroetz[1], I.L. Caldas[2], R.L. Viana[3], P.J. Morrison[4], P. Abbamonte[5]
[1]Departamento de Fisica, Instituto Tecnológico de Aeronáutica, S. José dos Campos, São Paulo, 12228-900 Brazil; [2]Instituto de Fisica, Universidade de São Paulo, São Paulo, 05315-970; [3]Departamento de Fisica, Universidade Federal do Paraná, Curitiba, 81531-990; [4]Department of Physics, Institute for Fusion Studies, University of Texas, Austin, USA; [5]Department of Physics, Cornell University, Ithaca, USA

A symplectic mapping method to study magnetic field lines near the separatrix of poloidal divertor tokamaks, proposed by Morrison and Abbamonte, is applied to describe the magnetic field lines near the separatrix of a tokamak with a single-null divertor. For this application, the canonical time step required by the method is initially chosen to be uniform with a value adequated to roughly reproduce the equilibrium safety factor profile near the separatrix. To improve this fitting a nonuniform time step profile is numerically calculated to simulate the considered equilibrium safety factor profile near the separatrix. The map control parameters were varied to study the structure of field lines and the positions of the hyperbolic point and the divertor plate. The obtained integrable map is perturbed by helical resonances due to an ergodic limiter described by the Martin-Taylor map. This perturbed map is used to follow magnetic field lines initialized on the divertor plate until they again intersect the plate. Thus, the field line connection lengths are determined as a function of their initial position on the plate. Moreover, the field line structure is used to obtain their footprints, i. e.,the line deposition patterns on the plate.

The Fibonacci quantum walk
A. Romanelli
Fac. de Ingeniería, Montevideo, Uruguay

We study the quantum walk in momentum space using a coin arranged in quasi-periodic sequences following a Fibonacci prescription. We build for this system a classical map based on the trace of the evolution operator. The sub-ballistic behavior of this quantum walk is connected with the power-law decay of the time correlations of the trace map.

Immune response of tumor growth under power law behavior
Irving Rondon, J. A. Gonzalez
Instituto Venezolano de Investigaciones Cientificas, Centro de Fisica, Laboratorio de Dinamica No Lineal y Sistemas Complejos, Apartado Postal 21827, Caracas 1020-A, Venezuela

We propose a modification of a previous model by Stepanova, which describes the specific immunological response against cancer. The model assumes that normal cells and cancer cells coexist in an environment as two different species which compete for nutrients and space. The immune system and the tumor cells fight against each other. The modification consists of a substitution of a power law for the exponential rate used for tumoral growth. This modification is motivated by the numbers of recents works confirming that some tumour growth support power law behavior. We show different scenarios for tumor growth.

Experimental synchronism of four Chuas circuits P.H. Polegato[1], R.M. Rubinger[1], J.C. Sartorelli[2], M.S. Baptista[3], H.A. Albuquerque[4]
[1]UNIFEI, Itajubá, Brazil; [2]USP, São Paulo, Brazil; [3]UP, Porto, Portugal; [4]UDESC, Joinville, Brazil

Four Chaotic Chuas circuits [1] were built with bidirectional coupling composed by a operational amplifiers buffers and series resistors and connected in the form of a network in order to study synchronism and information transmission. Such networks can simulate at some extent the behavior of neural networks and be used to understand some mechanisms associated with information transmission. [2] The coupling strength is an inverse function of these coupling resistances. The four circuits were set with parameters of double-scroll attractors with parameters differing not more than 1 % . The coupling of circuits was carried out in a linear and circular form. The coupling resistances were precision resistive metal wire potentiometers with 10 turns and reaching up to 100kohm. The voltage across the capacitor close to the Chua's diode was measured from each circuit and assigned as Xi variable. Synchronization was identified by a plot of Xi versus Xj with j not equal to i. For a full synchronization the graph consists of a tipical Y=X line. The synchronization was investigated as a function of the coupling strength, i.e. the coupling resistance. The dependence is considered for all allowed combinations of i and j, considering both the linear and circular coupling.

[1] Holokx A. Albuquerque,, Rero M. Rubinger, Paulo C. Rech, Physica D 233 (2007) 66; [2] Elinei P. dos Santos, Murilo S. Baptista, Iber L. Caldas, Physica A 308 (2002) 101.

A stochastic population dynamics model for Aedes Aegypti
Victoria T. Romeo Aznar, Hernan G. Solari
Department of Physics, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, Buenos Aires, Argentina

Dengue is an emergent/re-emergent disease with global impact. Dengue is produced by an arbovirus of the family Flaviviridae and genre flavivirus, and is transmitted by the bitting of an infected mosquito, being the most common vector Aedes aegypti. Accurate knowledge of mosquito abundances ahead of time is needed if preventive measures are to be taken to avoid dengue epidemic outbreaks. This knowledge is also needed to asses the efficacy of control measures and monitoring eradication programs. While our earlier work did not consider the influence of the rains in egg hatching as rain and humidity are usually not limiting factors in the region then under study (Buenos Aires area) a general Aedes aegypti simulation requires the incorporation of the rain factor. As a first approach to the problem, we studied the emergence of larvae in a natural setting (larvae-trap) and its dependence with rain fall and temperature. We discuss an improved Aedes aegypti stochastic model that incorporates the lessons learned in the field studies.

Spin-glass attractor on finite-dimensional hierarchical lattices in the presence of an external magnetic field
Octavio R. Salmon and Fernando D. Nobre
CBPF, National Institute of Science and Technology for Complex Systems, Rio de Janeiro, Brazil

A nearest-neighbor-interaction Ising spin glass, in the presence of an external magnetic field, is studied on Migdal-Kadanoff hierarchical lattices that approach the Bravais lattices. A spin-glass attractor is found, in the plane magnetic field versus temperature, associated with a low-temperature phase, for fractal dimensions greater than two. The physical consequences of this attractor are discussed, in view of the present scenario of the spin-glass problem.

Simulation of antiretroviral therapy on HIV prevalence
N.L. Sanches, D.S. Ferreira and T.J.P. Penna
UFF, Niteroi, RJ, Brazil

In a previous work, Lopez et. al. (Math. Comput. Simul., 71, 131, 2006) shown a simple deterministic model for the effects of different antiretroviral treatment schedules on HIV incidence and prevalence of affected population. We will show the results from computer simulations of an age-structured model for population dynamics that can deal with several levels of sexual activity levels and the network structure of sexual relationships. Through computer simulations we are able to study some new effects that are of difficult implementation on the previous deterministic model such as how age affects the recovering of the treatment, the local effects of contamination by simulating the model in a network, and so on. We also have simulated our model on different topologies, where a connection means a sexual relationship. The effects of the treatment on different levels of sexual activities are also studied. We will also show how the finite size effects of a population change the efficiency of the treatment.

Exact mean interaction times in many-particle random walks on regular and complex networks

David P. Sanders
Departamento de Fisica, Facultad de Ciencias, Universidad Nacional Autonoma de Mexico, Mexico

We calculate analytically the mean time between encounters of many particles undergoing random walks on regular and complex networks. Results are obtained both for independent walkers, where any number of walkers can occupy the same site, and for walkers with an exclusion interaction, when no site can contain more than one walker. These analytical results are then compared with numerical simulations, showing very good agreement.

Self organized stability on predation networks dynamics

C. N. de Santana[1,2], A. F. Rozenfeld[1,2], C. Duarte[1,2]
[1]Instituto Mediterraneo de Estudios Avanzados, Esporles, España; [2]Laboratorio Internacional de Cambio Global, Esporles-Santiago, España-Chile

Predation networks' architecture and dynamics has become into a focus of attention and concern in ecology for many years. As a product of non-random evolutionary processes, a particular real network assemblage emerges. Furthermore, much effort has been invested to disentangle the complex relation between stability and resulting food-web structure. Here we show an alternative mechanism to achieve stability by introducing correlations between space parameters (birth, death, natural death and mobility) and species density. We model the dynamics of food-webs in a regular geographical landscape with fixed connectivity architecture. The modelled dynamics is governed by parameters that evolve leading the system into a stable self organized coexistence.

Can collective searches profit from Lévy flight strategies?

M. C. Santos[1], E. P. Raposo[2], G. M. Viswanathan[3,4] and M. G. E. da Luz[1]
[1]Departamento de Física, Universidade Federal do Paraná, CuritibaPR, 81531-990, Brazil; [2]Laboratrio de Física Terica e Computacional, Departamento de Física, Universidade Federal de Pernambuco, RecifePE, 50670-901, Brazil; [3]Instituto de Física, Universidade Federal de Alagoas, Maceió-AL, 57072-970, Brazil; [4]Consortium of the Americas for Interdisciplinary Science, University of New Mexico, 800 Yale Blvd. NE, Albuquerque, NM 87131, USA

In this work we address the problem of collective searching in which a group of walkers, guided by a leader, looks for randomly located target sites. In such process, the necessity to maintain the group aggregated imposes a constraint in the foraging dynamics. We discuss four different models for the system collective behavior, with the leader and followers performing Gaussian and/or truncated Lévy walks. In environments with low density of targets we show that Lévy foraging is advantageous for the whole group, when compared with Gaussian strategy. Furthermore, certain extra rules must be incorporated in the individuals dynamics, so that a compromise between the trend to keep the group together and the global efficiency of search is met. The exact character of these rules depend on specific details of the foraging process, such as regeneration of target sites and energy costs.

A periodic orbits based method for Nash equilibria analysis in quantum games

D. Schneider
Dpto. de Fisica, CNEA, Buenos Aires, Argentina

Nash Equilibria (NE) represent one of the central concepts in game theory, and are used to analyze the outcome of the interactions between decision-makers (players), when faced with a situation of conflict. Quantum realization of game theory started in 1999 with a seminal paper by D. Mayer [Phys. Rev. Lett. **82** 1052]. In that work, the author showed that the implementation of a quantum strategy can increase one of the players payoff, allowing him to deviate from the NE reached in mixed-strategies (classical) games. In addition, he sketched an extension of J. von Neumann equilibrium theorem for zero-sum games into the quantum domain. Shortly afterward, Eisert *et al.* published a quantum protocol for two-players non-zero-sum games [Phys. Rev. Lett. **83** 3077]. They studied the prisoner's dilemma, showing that the implementation of quantum strategies leads both players to an optimal solution which destroys the problematic feature of the classical setup. In the lapse of a few years, many contributions made the subject a vast field of theoretical research, having its experimental demonstration in 2002 on a NMR quantum computer. In this work, we come back to Eisert's protocol, and interpret the problem of NE in games in terms of non-linear map periodic orbits. Based on this interpretation, we develop a method for analyzing systematically symmetric games. We apply the method to the quantum prisoner's dilemma, recovering in a first step the main result reported in [2]. However, by exploring the symmetries of the space of results, we find that many new strategies should be included reasonably. The extended strategy space obtained in this way gives rise to a continuous set of NE which weren't identified at the present, and whose topological structure we discuss in detail.

Gel formation with dipolar colloidal particles

Pablo Serra[1], Verónica Marconi[1], Marcelo Carignano[2]
[1]FaMAF, Universidad Nacional de Córdoba, Argentina; [2]Department of Chemistry, Purdue University, Indiana, USA

Gels are of immense importance in many traditional industries like food and cosmetics and they are receiving considerable attention from new technological applications like rocket fuels, ion sensitive materials and display devices. In this work we investigate the gelling properties of dipolar colloidal particles in the low density regime using computer simulations. As gelation is not a thermodynamic phase, the conditions for gel formation differ depending on the computational treatment. In particular, we investigate the transitions fluid to string-fluid to gel using both, molecular and Brownian dynamics simulations. Starting from a high temperature homogeneous conformation, the time evolution of the system after a sudden quenching is monitored until the system reaches equilibrium or becomes kinetically arrested. In those cases where the final state is a gel, we calculate using oscillatory shear simulations the viscoelastic properties of the final material, such as the storage and loss moduli.

Synchronization and transition to chaos in two coupled circle maps

A. P. Silva, R. E. Carvalho, A. P. Mijolaro
Unesp, Rio Claro, Brasil

In this work, we studied the dynamics of the circle map. The Arnold tongues corresponding to areas in which the map is synchronized with the rotation number were determined in the parameters space, when the theses numbers are rational.

It was observed that the transition from almost-periodicity to chaos is caused by the interaction and overlap of these tongues. This phenomenon occurs above the critical line where the map is not invertible and Arnold tongues begin overlap, transforming periodic orbits in chaotic. Local universality of transition to chaos was investigated for the golden mean winding number. At critical line these areas form a complete Devil staircase, whose complementarity is a Cantor set that characterizes the global universality of the transition to chaos, which we estimated its fractal dimension. Below critical line, only synchronization and almost-periodicity movements occur. Then, we studied the effects of perfect and imperfect phase synchronization of two coupled circle maps in regular and chaotic regimes. Statistics of the synchronization plateau were estimated, and the effects of the synchronization region to non-synchronization region transition in the space of the parameters were analyzed. Through the use of Lyapunov exponents we characterized the local and global stability of complete synchronization states of these coupled maps.

Nonlinear effects in the dynamics governed by non-Markovian stochastic Langevin-like equations

R. L. S. Farias, Rudnei O. Ramos, L. A. da Silva
UERJ, Rio de Janeiro, Brazil

Explicit derivations of effective equations of motion of a system (or order parameter), in interaction with some bath degrees of freedom, are known to lead in general to quite complicated equations of motion. These equations are of the form of non-Markovian stochastic Langevin-like equations of motion. Typically, it is difficult to approximate these equations to a local (Ohmic) form, whose approximation may depend on the various parameters characterizing both the system and the thermal bath. Though studies about how well non-Markovian stochastic equations of motion can be approximated by Markovian ones have been recently performed, these studies only analyzed the cases of variations of the characteristics of the thermal bath through which the system is coupled to. An explicit analysis of how the parameters characterizing the system may affect the dynamics, in special the role of the nonlinearity of the system, is here performed. Results for the different time scales, where the non-Markovian dynamics becomes equivalent to its Markovian approximation, as well the study of the variations of the system's thermalization time as a function of the nonlinearity of the system (with a quartic potential), are here given and analyzed.

Can minimal models based on game theory to describe the dynamics of live-streaming applications in P2P networks?

Roberto da Silva, Sandra Satyko Guimarães Watanabe, Ingrid Eleonora Schreiber Jansch Porto
Informatics Institute UFRGS Porto Alegre, Rio Grande do Sul, Brazil

Our main aim in this contribution is to model the dynamics of Live Streaming applications using a minimal model based on Game theory. In such applications, users distributed according a specific P2P network desire watching a video, or something like that. Thus, packages are interchangeable and downloading/uploading levels are established. In this scenario evolutionary game theory appears as an interesting alternative for the modeling of this cooperative/collaborative dynamics. From that, statistics properties of the utility function and also of downloading and uploading levels were analyzed and a new model was proposed using aspects from a simulator based on physical aspects of such applications in P2P networks.

Analysis of the package dependency on Debian GNU/Linux

O. F. Sousa, M. A. F. Menezes, T. J. P. Penna
IF-UFF, Niterói, Brazil

We build the directed network of more than 18,000 software packages of Debian GNU/Linux operating system and their interdependencies. We measure the in- and out-degree distribution, as well as the degree evolution over different releases and find scale-free degree distributions and preferential addition and deletion of nodes. The betweeness centrality distribution and damage spreading simulations indicate that the system is resilient to bugs (wrong pieces of code) that might render unusable a package and, consequently, all the packages that depend on it. We use simulated annealing and exact diagonalization of Potts model community detection algorithms to find groups that have more interdependencies and should be maintained by developer teams, as we further discuss.

A cellular automata-based mathematical model for thymocyte development

Hallan Souza-e-Silva[1,*], Wilson Savino[2], Raúl A. Feijó[3,4], Ana Tereza Ribeiro Vasconcelos[5]
[1]Bioinformatics Laboratory and [3]Computer Science Coordination, LNCC/MCT, Petrópolis, Brazil; [2]Laboratory of Thymus Research, Oswaldo Cruz Institute, Fiocruz, Rio de Janeiro, Brazil; [4]National Institute of Science and Technology for Medicine Assisted by Scientific Computing, INCT-MACC, Petrópolis, Brazil; [*]present address: Physics Department, Federal University of Viçosa, Viçosa, MG, Brazil

Intrathymic T cell development is an important process necessary for the normal formation of cell-mediated immune responses. Importantly, such a process depends on interactions of developing thymocytes with cellular and extracellular elements of the thymic microenvironment. Additionally, it includes a series of oriented and tunely regulated migration events, ultimately allowing mature cells to cross endothelial barriers and leave the organ. Herein we built a cellular automata-based mathematical model for thymocyte migration and development. The rules comprised in this model take into account the main stages of thymocyte development, as well as the chemokines involved in intrathymic cell migration. We further compared our computer simulations with results derived from previous experimental data using sub-lethally irradiated mice, in which thymus recovery can be evaluated. The model fits with the increasing numbers of each CD4/CD8-defined thymocyte subset. Furthermore, simulations made with a human thymic epithelial network using the same mathematical model generated similar profiles for temporal evolution of thymocyte developmental stages. Lastly, we provided in silico evidence that the thymus architecture is important in the thymocyte development, since changes in the epithelial network result in different theoretical profiles for T cell development/migration. This model likely can be used to predict thymocyte evolution following therapeutic strategies designed for recovery of the thymus in diseases coursing with thymus involution, such as some primary immunodeficiencies, acute infections, and malnutrition.

Bubbling transition and onset of spatio temporal chaos in a extended dynamical system

J.D. Szezech Jr[1], S.R. Lopes[2], R.L. Viana[2], I.L. Caldas[1]
[1]Instituto de Fisica, Universidade de São Paulo, São Paulo, São Paulo, Brazil; [2]Departamento de Fisica, Universidade Federal do Paraná, Curitiba, Paraná, Brazil

One of the stumbling blocks on investigating turbulence in fluids and plasmas is the large number of degrees of freedom necessary to describe the energy flow from large to small-scale structures. In this work we interpret the onset of spatio-temporal chaos in terms of the excitation of spatial modes drawing energy from a purely chaotic temporal mode. More specifically, we investigate the transition to spatio-temporal chaos in spatially extended nonlinear dynamical systems possessing an invariant subspace with a low-dimensional attractor. When the latter is chaotic and the subspace is transversely stable we have a spatially homogeneous state only. The onset of spatio-temporal chaos, i.e. the excitation of spatially inhomogeneous modes, occurs through the loss of transversal stability of some periodic orbit embedded in the chaotic attractor lying in the invariant subspace. This is a bubbling transition, since there is a switching between spatially homogeneous and nonhomogeneous states with statistical properties of on-off intermittency. Hence the onset of spatiotemporal chaos depends critically both on the existence of a chaotic attractor in the invariant subspace and its being transversely stable or unstable.

Synchronization in a coupled maps lattice with scaling form of connectivity

R. M. Szmoski[1], R. F. Pereira[1], A. M. Batista[2], S. E. de S. Pinto[1]
[1]DEFIS, UEPG, Ponta Grossa, Brazil; [2]DEMAT, UEPG, Ponta Grossa, Brazil

The coupled map lattices have been intensively investigated as models to study many spatiotemporal phenomenons such as phase transitions, intermittency and chaos synchronization. Specifically the synchronization phenomenon, that is the process where all variables state assume even values, has been one of the collective phenomenon most studied, since that it can be observed in several natural contexts and technological applications, such as semiconductor lasers to secure communications. In this work we analyze the complete synchronization in a coupled chaotic maps lattice with connection probability depending on the interstice distance. We consider bidirectional and time-varying couplings where the chaotic locally dynamics is governed by logistic maps. We also assume periodic boundary conditions and random initial conditions. Using the locally linear analysis and the transversal distance to the synchronization manifold, we investigate the conditions for the synchronization may be attained. We obtain the parameters values that the lattice synchronizes and in this analysis we observe that in a lattice whose topology varying in the time the decay of the Jacobian eigenvalues provide a more efficient method to estimate the Lyapunov exponents. We also show that the Lyapunov spectrum of the lattice approaches to a spectrum of a lattice with fixed couplings where the intensity decay with the distance following a power-law. The results obtained show that in the thermodynamics limits the Lyapunov exponents of the lattices are equivalent and, in this case, can be analytically obtained.

Synchronization in lattice-embedded scale-free networks

C. Tauro[1], F. Tamarit[1], P. Gleiser[2,3]
[1]Famaf, Universidad Nacional de Córdoba, Argentina; [2]Instituto Balseiro, Bustillo 9500, 8400 Bariloche, Argentina; [3]Centro Atómico Bariloche, Bustillo 9500, 8400 Bariloche, Argentina

In this work we study the effects of embedding a system of non-linear phase oscillators in a scale-free network on a two dimensional lattice. In order to analyze the effects of the embedding we consider two different networks. On the one hand we consider a scale-free complex network where no constrain on the length of the links is taken into account. On the other hand we use the method suggested by Rozenfeld *et al.* (Phy. Rev. Lett. **89** (2002) 218701) for embedding scale-free networks in regular Euclidean lattices. In this case the embedding is driven by a natural constraint of minimization of the total length of the links in the system. We analyze and compare the synchronization properties of a system of non-linear Kuramoto phase oscillators, when the interactions between the oscillators take place in these networks. First we analyze the behavior of the Kuramoto order parameter, and show that the onset of synchronization is lower for the non-constrained lattices. Then we analyze the behavior of the mean frequency of the oscillators as a function of the natural frequency for the two different networks and also for different values of the scale-free exponent. We show that the constrained lattices present a larger dispersion around the synchronization frequency. Finally we analyze and compare the role of hubs in the synchronization properties of the system, by considering the behavior of the mean frequency as a function of the degree.

Dynamical properties of the weak stability boundary and associated sets

P.A.S. Silva, M.O. Terra
ITA, São José dos Campos, Brazil

The Weak Stability Boundary (WSB) concept was proposed by E. Belbruno (1987 and beyond) in the context of ballistic lunar capture transfer development. This approach was successfully employed in the Japans Hiten spacecraft rescue (1990). In this contribution the WSB algorithmic definition, recently refined by F. Garcia and G. Gomez (2007), was reconstructed and analyzed. The obtained stable (S) and unstable (U) sets are defined as a function of the osculating ellipse eccentricity for prograde and retrogade initial conditions. Given that, the S sets, candidates to low energy transfers, are sub-classified according to chosen specific criteria, such as, the related exit basin, the Jacobi constant intervals defined by distinct classes of Hill regions, transfer times, and Δv necessary to the stabilization of the final lunar orbit. Finally, the real applicability of these sets is investigated in the light of the preliminary design of a complete mission based on a two patched three-body problem approximation, exploiting the Sun gravitational assist.

Low energy earth-moon transfer orbit design

P.A.S. Silva, M.O. Terra
ITA, São José dos Campos, Brazil

Recently, alternative techniques have been proposed to build modern low energy interplanetary transfer orbits [1,2] based on models of three or four bodies. Specifically, in the Earth-Moon transfer, a two patched three-body approach is applied in order to take advantage of the natural nonlinear interaction among the four-bodies involved in this transfer, when the Sun gravitational assist is considered. The invariant manifolds associated to periodic orbits around equilibrium points (Lagrangian Points) of the circular planar restricted three-body problem are the fundamental dynamical structures which determine the existence of possible dynamical transport channels between the lower primaries of each one of the three-body systems. These bidimensional invariant tubes, formed by asymptotic trajectories to the Lyapunov orbits, separate the transit and non-transit orbits in the neck region around the Lagrangian point. Transit orbits in a energy shell associated to an stable invariant Earth-Moon L2 tube and non-transit orbits associated to the unstable invariant Sun-Earth L1 or L2 tubes define the set of applicable trajectories. By the first time, a systematic investigation of these potential applicable candidate sets is performed. In this contribution, the transfer orbit design procedure is analyzed in detail in order to establish a method of building an optimized ballistic transfer to the Moon departing from a geostationary orbit.

[1] W.S. Koon, M.W. Lo, J.E. Marsden and S.D. Ross, Chaos 10 (2000) 427-469; [2] W.S. Koon, M.W. Lo, J.E. Marsden and S.D. Ross, Celestial Mechanics and Dynamical Astronomy 81 (2001) 63-73.

Scalings and internal structure of Mandelbrot-like sets

Abraham Torrico-Chavez[1,2], A. Endler[2], J.A.C. Gallas[2]
[1]Carrera de Fisica-UMSS, Cochabamba, Bolivia; [2]Instituto de Fsica-UFRGS, Porto Alegre, Brazil

We report a unitary scaling in period-adding sequences inmersed in the chaotic sea on the parameter space of Mandelbrot-like sets, using the complex cubic map and the Henon complex map as examples, and we conjecture this unitary scaling to be general in period adding sequences toward saddle-node curves. To complement our study we uncover the internal structure of Mandelbrot-like sets by using the well known multipliers of periodic orbits, and we find differences with the corresponding internal structure of the Mandelbrot set, we think this difference is due to the fact that Mandelbrot-set are disconnected.

Chaotic synchronization induced by asymmetry in coupled maps on random networks

J. DeCastro, K. Tucci
ULA, Merida, Venezuela

The phenomenon of synchronization occurring in asymmetrically coupled chaotic maps on a random network is studied. The degree of network asymmetry is characterized by the fraction of directed links. It is found that asymmetry induces chaotic synchronization in the system. In addition,the system undergoes a transition from an asynchronous phase to a synchronous one at some critical values of its parameters. The critical boundary separating the synchronous from the asynchronous regime is calculated on the parameter space of the system, given by the coupling strength and the degree of asymmetry of the network. The phase transition between the two regimes is of second order, and the critical exponent depends of the degree asymmetry.

Mixing foams and grains in Hele-Shaw cells

A. Tufaile, A. P. B. Tufaile,T. A. S. Haddad
EACH-USP, São Paulo, Brazil

We have observed some features of the coexistence of foams and granular materials in Hele-Shaw cells. The most part of the liquid and granular material stays at the bottom of the cell, with only a small quantity of the mixture resting on the froth. The fractal dimensions of the final states of the foams are close to the values obtained from the Random Apollonian Packing model. The disperse structure of the granular material affects the probability distribution of number of sides of the foam bubbles. The nearest neighbor distances between the peaks of the sand piles at the bottom of the cell are close to a lognormal distribution.

Chaotic scattering in curved kaleidoscopes and plateau borders

A. Tufaile, A. P. B. Tufaile
EACH-USP, São Paulo, Brazil

Liquid foams have fascinating optical properties, which are caused by the large number of light refractions and reflections by films and Plateau borders. Due to refraction and total reflection at the interfaces, the direction of the rays leaving the Plateau border can vary greatly for the same incident angle and a small positional offset. Provided the optical properties of the surfaces are chosen appropriately, fractals and Wada basins are natural consequences of multiple scattering of light rays in some cavities. The cavity acts as a kaleidoscope multiplying the scattering of light rays generating patterns related to Poincare disks and Sierpinsk gaskets. Given the mathematical space S representing these patterns, we identify some important aspects of the structure of S, and define a set of motions M to be automorphisms of S that preserve the structure. Using the Poincare model, the points are in the interior of the Euclidean unit disk, and the lines are circular arcs that cut the boundary of the disk at right angles. The Poincare model is conformal: the angle between any two hyperbolic lines is accurately reflected by the Euclidean angle between the two circular arcs that represent them. The Poincare model is therefore a good choice for drawing Euclidean representations of hyperbolic patterns, because in some sense it does the best job of preserving the shapes of hyperbolic figures. We present some experimental results and simulations of these patterns explained by the light of the hyperbolic geometry and chaotic scattering.

Scaling laws in the recurrence quantitative analysis of a stock market

D. B. Vasconcelos[1], Sandro E. de S. Pinto[2], A. P. Guilherme[2]
[1]Departamento Academico de Fisica, Universidade Tecnologica Federal do Parana, Curitiba, Parana, Brazil; [2]Departamento de Fisica, Universidade Estadual de Ponta Grossa, Ponta Grossa, Parana, Brazil

When the trajectory of a dynamical system in the phase space approachs, neighbours or repeats itself after some time, we say that the system displays recurrence. Recurrence plots (RP) and the Recurrence Quantitave Analysis (RQA) were introduced as tools to investigate this property. Recently, many economic and financial time series are being investigated under the perspective of a dynamical system. In this work we employ the RPs and RQA to analyse the recurrence behaviour of a long time series of the returns of the Bovespa Index (Ibovespa), we carefully studied the obtention of the parameters for the phase space reconstruction of the supposed dynamical system which created the time series, we analyze the patterns formed in RP as well as the values of the quantities of RQA, comparing the results obtained for the original and randomized series. We search, from these results, to establish whether there is some sort of deterministic component in the studied system, and what its intensity.

Experimental period-adding bifurcation in a modified Chua's circuit

E.R. Viana[1], R.M. Rubinger[2], H.A. Albuquerque[3], F.O. Dias[1], A.G. de Oliveira[1], G.M. Ribeiro[1]
[1]Universidade Federal de Minas Gerais, UFMG, Brazil; [2]Universidade Federal de Itajubá, UNIFEI, Brazil; [3]Universidade do Estado de Santa Catarina, UDESC, Brazil

In this work we carried out an experimental study of Chaos in the Chuas Circuit. The Chuas Circuit is basically formed by one inductor, two capacitors, one variable resistance and one element with negative resistance called Chuas diode. As Inductors have the tendency to be of low precision, we used in this work the circuit without the inductor as proposed by Trres and Aguirre[1], the "Inductorless Chuas Circuit", where the inductor is simulated by a combination of capacitors and operational amplifiers. In the arrangement with the inductor it is difficult to obtain experimental hetero-(homo-) cyclic loops. In our study, the Inductorless Chuas Circuit was modified in order to add a voltage source in series with the Chuas diode. Thus, we studied bifurcation routes to chaos where we fixed the parameter rL and varied the external voltage source from -0.75V to +0.75V, with step 0.5mV, and used the R resistance as the other parameter, in a range from 1600 Ω; to 1720 Ω. Some bifurcation diagrams obtained show period-adding cascades with alternation of chaos and periodicity. The number of periodicity was increased by a fixed amount, in our case one-by-one: (period-2)-chaos-(period-3)-chaos-(period-4)-chaos- and so on. In our study we obtained stable periodic attractors up to cycle-10, odd periodic attractors embedded in a sea of chaos, double-scroll chaotic attractors and also Rsller-like chaotic attractors. The experimental data were registered by programs built in LabView. Our programs were used to control the data acquisition card DAQ and the voltage source. With both V and R parameters we obtained periodic structures embedded in chaotic regions, and we analyzed them with respect to the periodicity and to the higher Lyapunov exponent to build color parameter spaces.

[1] L.A. Tôrres and L.A. Aguirre, Electron. Lett. 36 (2000), p. 1915.

Investigating Fermi acceleration in the 4-dimensional phase space

C. Vieira Abud, R. Egydio de Carvalho
UNESP - Rio Claro, Brazil

In this work we studied the Fermi acceleration phenomenon through statistical transport properties. We consider the time-dependent annular billiard, which consists of a classical particle moving freely in an annular region limited by two circumscribed circles playing the role of infinity potential barriers with time-periodic perturbation. Since the unlimited energy growth (Fermi Acceleration) for the annular billiard is observed only when the circles are arranged eccentrically, we decided to investigate this phenomenon in the context of anomalous transport, where we found, after many simulations, sub-diffusion, super-diffusion and even ballistic process. It means that the annular billiard transport properties are parameter dependent and Fermi acceleration is a non-trivial controlled process. In order to explain this observation we scanned the 4-d phase space and the results that we have obtained support that, for two-dimensional billiards with time-dependent perturbations on its boundaries, the source of the energy growth is simultaneously connected with the dynamical properties and structures (regular islands, ergodicity, non-ergodicity and stickiness) of both phase spaces.

Investigation of quasi-doublets inside the beach region in the annular billiard system

A. P. Mijolaro, C. Vieira Abud, R. Egydio de Carvalho
UNESP - Rio Claro, Brazil

We study the quantum energy level splittings in the beach region of the phase space in the billiard annular system. When the circles are concentric, the classical system is completely integrable and the phase space is composed by straight lines. When we introduce an eccentricity, chaos appears between integrable regions. Differently to other systems, classical chaos in the annular billiard does not firstly appear close to fixed point. Chaos initially starts in a region close to the Whispering Gallery Orbits (WGO), usually denominated beach region. Recently, studies involving marginally unstable periodic orbits (MUPO) brought a new scenario where infinity set of zero measures are inside this beach region. In R. Egydio de Carvalho and A. P. Mijolaro (2004), the authors studied the statistical distribution of the quantum energy splittings located in integrable region of annular billiard phase space (WGO's region). We are extending this work, in order to identify quasi-doublets in the beach region associated with the MUPO's and verify the influence of classical chaos in the quasi-doublets behavior.

A comparative study of different integrate-and-fire neurons: spontaneous activity, dynamical response, and stimulus-induced correlation

R.D. Vilela[1], B. Lindner[2]
[1]Universidade Federal do ABC, Santo Andre, Brazil; [2]Max Planck Institute for the Physics of Complex Systems, Dresden, Germany

Stochastic integrate-and-fire (IF) neurons have found widespread applications in computational neuroscience. I will present results on three different white-noise-driven neurons, namely, the perfect, leaky, and quadratic IF models. We focus on the spectral statistics (power spectra, cross spectra, and coherence functions) in different dynamical regimes (noise-induced and tonic firing regimes with low or moderate noise). We make the models comparable by tuning parameters such that the mean value and the coefficient of variation of the interspike interval match for all of them [1]. We find that, under these conditions, the power spectrum under white-noise stimulation is often very similar while the response characteristics, described by the cross spectrum between a fraction of the input noise and the output spike train, can differ drastically. We also investigate how the spike trains of two neurons of the same kind (e.g. two leaky IF neurons) correlate if they share a common noise input. We show that, depending on the dynamical regime, either two quadratic IF models or two leaky IFs are more strongly correlated. Our results suggest that, when choosing among simple IF models for network simulations, the details of the model have a strong effect on the correlation and regularity of the output.

[1] RD Vilela and B Lindner, J. Theor. Biol. 257, 90 (2009); [2] RD Vilela and B Lindner, 2009 (in preparation).

Trapping heavy particles in open flows

R.D. Vilela[1], A.E. Motter[2]
[1]Universidade Federal do ABC, Santo Andre, Brazil; [2]Northwestern University, Evanston, US

The advection of heavy particles is relevant in a variety of physical contexts, including astrophysical, atmospheric and environmental research. Previous studies are consistent with the assumption that such particles always escape in open chaotic advection. In this talk I will show that a different behavior is possible and that permanent trapping and clustering of heavy particles can occur for a wide range of conditions in periodic flows [1]. In a rather counterintuitive manner, we observe that this phenomenon is determined by a process in which the particles are continuously scattered by vortices of the advecting flow. I will also show the occurrence of the phenomenon in more general, non-periodic flows [2].

[1] RD Vilela and AE Motter, Phys Rev Lett 99, 264101 (2007); [2] RD Vilela and AE Motter, 2009 (in preparation).

Discrete lattices of vanishing correlations for triplets of coherent states

E. Zambrano, A M Ozorio de Almeida
Centro Brasileiro de Pesquisas Fsicas - CBPF, Rio de Janeiro, Brazil

The overlap of a large quantum state with its image, under tiny translations, oscillates swiftly. Complete orthogonality occurs generically at isolated points. We here show that these blind spots depend strongly on positions and amplitudes in the case of a superposition of coherent states. In contrast, they are only weakly affected by relative phases and the various degrees and directions of squeezing. Decoherence, in the Markovian approximation, lifts the correlation minima from zero. The blind spots for coherent state triplets lie close to an hexagonal lattice: Further superpositions of translated triplets, specified by nodes of one of the sublattices, are quasi-orthogonal to the original triplet and to any state, likewise constructed on the other sublattice.

Reflection chromaticity of a cholesteric liquid crystal multilayered structure with anisotropic defect layer

F. M. Zanetti, E. M. Nascimento, I. N. de Oliveira, M. L. Lyra
UFAL - Maceio, Alagoas, Brazil

In this work, we investigate the spectral characteristics of normal incident light reflected by a multilayered structure composed of an alternated sequence of single pitch cholesteric liquid crystal (ChLC) and anisotropic material layers. Using the Berreman 4×4 matrix formalism, we numerically obtain the reflection spectrum and the chromaticity diagram as function of the anisotropic layer thickness d. For $d \to 0$, the structure behaves like a single ChLC layer, showing a single reflection band. As the anisotropic layer thickness increases, the reflection band shifts toward high wavelength spectral regions, while new reflection bands appears. As a consequence of the spectral variation, the associated reflection chromaticity shows great dependence with d. It is observed that a suitable choice of anisotropic layer thickness can produce a three-fold reflection band with an almost red-green-blue associated color, both for polarized and incoherent incident light.

Causal random geometry from stochastic quantization

J. Ambjorn[1,2], R. Loll[2], W. Westra[3], S. Zohren[4,5]
[1]Niels Bohr Institute, Denmark; [2]Utrecht University, The Netherlands; [3]Iceland University, Iceland; [4]Leiden University, The Netherlands; [5]São Paulo University, Brazil

Models of random geometry are important for the study of two-dimensional quantum gravity, but have also applications in many other fields of theoretical physics and mathematical biology. In this work we show how a particular model describing a string field theory for two-dimensional causal quantum gravity can be derived from stochastic quantization. One observes that the proper time used in the string field theory can be identified with the stochastic time used in stochastic quantization. Further, the stochastic quantization allows one to sum over all genera in the string field theory.

Semi-classical conductance of a periodic chaotic waveguide

F. Barra[1], A. Maurel[2], V. Pagneux[3], J. Zuñiga[1]
[1]Departamento de Física, Facultad de Ciencias Físicas y Matemáticas, Universidad de Chile, Santiago, Chile; [2]Laboratoire Ondes et Acoustique, Ecole Superieure de Physique et de Chimie Industrielles, Paris, France; [3]Laboratoire dAcoustique de lUniversite du Maine, Le Mans, France

The Landauer's conductance $G = \frac{2e}{h}\mathrm{Tr}(tt^\dagger)$ of a periodic waveguide can be linked to the number of Bloch modes N_B propagating in it. We study this later quantity in an infinite quasi-one-dimensional chain of chaotic cells in the semiclassical limit following a result from Faure (J. Phys. A: Math. Gen (2002) vol. 35 pp. 1339-1356) and the generalization to waveguides with anomalous diffusion. We also consider the conductance through a localized scatterer of N identical cells and investigate the possible Ohmic behaviour of $G(N)$. Finally, we show that our results are consistent with Random Matrix Theory predictions.

POSTER SESSION I: Monday

1. Altmann, Eduardo; *From closed to open chaotic systems: the case of optical cavities*
2. Alves, Sidiney; *Scaling laws for aggregation process of wandering particles with correlated walks*
3. Andrade, Roberto; *A model of partial differential equations for the propagation of HIV in TCD4+ cells*
4. Andreguetto Maciel, Gabriel; *Discrete-time predator-prey model for blowfly populations*
5. Argollo de Menezes, Marcio; *Network analysis of Folksonomies: creating a recommendation engine*
6. Argollo de Menezes, Marcio; *Finding alternative representations of formal languages: theorem proving with random walks*
7. Arneodo, Ezequiel; *Frequency jumps and source-tract coupling in birdsong*
8. Assaneo, Maria Florencia; *Evidence of dynamic in the vocal tract of suboscines birds*
9. Azevedo, Franciane; *Lotka-Volterra model of finite domains*
10. Bacelar, Flora Souza; *The evolution of male-biased parasitism*
11. Baram, Reza Mahmoodi; *Superdiffusion of massive particles induced by multi-scale flows*
12. Brigatti, Edgardo; *Continuous and discrete models for pattern formation in a predator-prey system with a finite-range interaction*
13. Cachile, Mario; *Study of flow through porous media using lattice-Boltzmann method*
14. Canabarro Askery, Alexandre; *A molecular dynamics simulation of a suspension of ferroelectric nanoparticles in a nematic liquid crystal*
15. Cortines, Anderson; *Exact corrections to finite-time drift and diffusion coefficients*
16. Costa, Felipe; *A multi-layer model for the global intermittency in the nocturnal atmospheric boundary layer*
17. Dickman, Adriana; *Model for the transmission of malaria: mean-field approximation*
18. Dickman, Adriana; *Phase diagram and critical exponents for the pair annihilation model in one and two dimensions*
19. Falcon, Claudio; *Capillary wave turbulence*
20. Ferreira, Nuno; *Nonlinearity analysis in international stock markets*
21. Ferreira, Ronan Silva; *Thresholds, critical exponents, and spreading patterns of the contact process on Watts-Strogatz and Barabási-Albert networks*
22. Galhardo, Carlos Eduardo; *Detrended fluctuation analysis of systolic blood pressure control loop*
23. Galvao, Viviane; *A framework for complex systems by using multi-agent and complex networks: application to the evolution of Chagas disease*
24. Heckler, Marla; *Transport properties in a open square billiard*
25. Hiraiwa, Tetsuya; *Linear viscoelasticity of a single semiflexible polymer chain*
26. Kalmar-Nagy, Tamas; *Delay tuned phase-locking in a pair of coupled limit cycle oscillators*
27. Kroetz, Tiago; *Investigation of multistability and transport on the bouncing ball problem*
28. Ladeira, Denis Gouvêa; *Competition between suppression and production of Fermi acceleration*
29. Livorati, Andre Luis Prando; *Scaling investigation of Fermi acceleration on a dissipative bouncer model*
30. Mata, Angelica S. da; *Epidemic processes in complex networks*
31. Melo, Anderson; *Multiple difference-frequency generation in nonlinear acoustics*
32. Menezes, Rui; *Nonlinear asymmetric co-movements in globalised stock markets: evidence from the U.S. and the E.U.*
33. Miramontes, Octavio; *Walking patterns in termites*
34. Oliveira, Hercules Alves de; *Dynamics of two interacting particles in a 1D soft billiard*
35. Passos, Frederico; *A simple heterogeneous agent-based model for traders systems*
36. Roa, Miguel Angel Duran; *The Loewner equation for finger dynamics*
37. Romanelli, Alejandro; *The Fibonacci quantum walk*
38. Romeo Aznar, Victoria; *A stochastic population dynamics model for Aedes Aegypti*
39. Sanders, David P.; *Exact mean interaction times in many-particle random walks on regular and complex networks*
40. Santos, Marcos Cesar; *Can collective searches profit from Levy flight strategies?*
41. Serra, Pablo; *Gel formation with dipolar colloidal particles*
42. Vasconcelos, Diogenes; *Scaling laws in the recurrence quantitative analysis of a stock market*
43. Vieira Abud, Celso; *Investigating Fermi acceleration in the 4-dimensional phase space*
44. Vieira Abud, Celso; *Investigation of quasi-doublets inside the beach region in the annular billiard system*
45. Vilela, Rafael; *Trapping heavy particles in open flows*
46. Zanetti, Fabio Marcel; *Reflection chromaticity of a cholesteric liquid crystal multilayered structure with anisotropic defect layer*
47. Zuñiga, Jaime; *Semi-classical conductance of a periodic chaotic waveguide*

POSTER SESSION II: Tuesday

1. Assis, Vladimir; *Nonlinearly pulse-coupled stochastic excitable elements: collective excitability and discontinuous phase transitions*
2. Belardinelli, Rolando; *The 1/t algorithm: Fast method to calculate the joint density state function for the adsorbed phase with multisite occupancy*
3. Coutinho dos Santos, Bernardo; *Unification of Ito and Stratonovich procedures and its consequences in the power-law-decaying probability densities*
4. Coutinho, Renato; *Resonance analysis of Hutchinson's delay differential equation*
5. Dias, Sandra P.; *Influence of the finite precision on calculations*
6. Ferreira, Anderson Augusto; *Boundary induced phase transitions in automata reaction diffusion model*
7. Florez, Jefferson; *Excitonic effects on the nonlinear optical rectification in one-dimensional quantum dots*
8. Freitas, Mario; *Do Arnold tongues really constitute a fractal set?*
9. Frigori, Rafael; *Extended Gaussian ensemble for the mean-field Blume-Capel model*
10. Gama, Anderson Luis; *Fractal formation process in the Mandelbrot set*
11. Hernandez, Kevin; *Specific heat and compactivity of the parking lot model*
12. Kramer, Klaus; *Cellular automata with inertia*
13. Loureiro, Marcos P. de Oliveira; *Curvature-driven coarsening in the two dimensional Potts model*
14. Macias, Lucas; *Instabilities in reaction-diffusion systems modify by porosity changes*
15. Magalhães, Felipe; *Dynamics of defects in the Swift-Hohenberg equation*
16. Maia, Leonardo; *Evolution and drug resistance: a computational study*
17. Manchein, Cesar; *Instability statistics and mixing rates*
18. Mansilla, Ricardo; *The morphogenesis of color patterns in reptiles as a variational problem*
19. Manzi, Sergio; *One-dimensional diffusion: range of validity of the kinetic jump*
20. Mendes, Renio; *Terrorism, power laws and long-range correlations*
21. Morgado, Welles; *Arch generated shear bands in granular systems*
22. Nascimento, Cesar; *Multifractal properties of time series and the Levy sections theorem*
23. Nicolao, Lucas; *Orientational order of modulated phases in Langevin simulations of a scalar model with competing interactions*
24. Ohkuma, Takahiro; *Dynamics of deformable self-propelled particles*
25. Paiva, Leticia; *Multiscale modelling for the virotherapy of avascular papillary tumors*
26. Pallavicini, Carla; *Analysis of persistance during intracellular actin-based transport mediated by molecular motors*
27. Pedron, Isabel; *Correlation and multifractality in climatological time series*
28. Pedrosa, Juan Manuel; *Quantum chaotic resonances from short periodic orbits*
29. Pennini, Flavia; *Non-extensivity index as an indicator of non-classicality*
30. Pereira, Tiago; *Bifurcations in normal random matrix ensemble*
31. Picoli Junior, Sergio de; *Height fluctuations in plant monoculture: non-Gaussian behavior and anti-correlations*
32. Polotto, Franciele; *Solutions of the Fokker-Planck equation for Morse isospectral potential*
33. Portela, Sofia; *Duration models of independent competing risks: an application to the customer churn*
34. Ramos, Jorge; *Nonlinear response and dynamical transitions in a phase field crystal model for adsorbed overlayers*
35. Ribeiro, Alexandre; *Semiclassical many-body density of states of a Bose gas*
36. Ribeiro, Haroldo; *Anomalous diffusion and symbolic sequences*
37. Robazzi, Weber; *Modeling growth with different classes of differential equations*
38. Rondon, Irving; *Immune response of tumor growth under power law behavior*
39. Salmon, Octavio Rodriguez; *Spin-Glass attractor on finite-dimensional hierarchical lattices in the presence of an external magnetic field*
40. Sanches, Newton Lima; *Simulation of antiretroviral therapy on HIV prevalence*
41. Schneider, David; *A periodic orbits based method for Nash equilibria analysis in quantum games*
42. Souza e Silva, Hallan; *A Cellular automata-based mathematical model for thymocyte development*
43. Szezech, Jose Danilo; *Bubbling transition and onset of spatio temporal chaos in a extended dynamical system*
44. Torrico C., Cesar Abraham; *Scalings and internal structure of Mandelbrot-like sets*
45. Tufaile, Adriana; *Chaotic scattering in curved kaleidoscopes and plateau borders*
46. Tufaile, Alberto; *Mixing foams and grains in Hele-Shaw cells*
47. Zohren, Stefan; *Causal random geometry from stochastic quantization*

POSTER SESSION III: Thursday

1. Abdulack, Samyr; *Unstable periodic orbits and chaos in standard map*
2. Agnaldo, J.S.; *Fill factor and efficiency characteristics of dye sensitized nanocrystalline TiO2 photoelectrochemical cell*
3. Batista, Adriano; *A parametrically-driven magnetic pendulum*
4. Benito, Rosa M.; *On the topology of optical transport networks*
5. Bologna, Clelia; *Dynamic behavior of a social model for opinion formation*
6. Bolzan, Mauricio Jos Alves; *Multifractal analysis from vertical total electron content obtained in two different locations in Brazil*
7. Cajueiro, Daniel Oliveira; *Learning paths in complex networks*
8. Camargo, Sabrina; *Riddled basins of attraction in a mechanical system*
9. Carpi, Laura Corina; *Missing ordinal patterns and stochastic processes*
10. Carusela, Maria Florência; *Noisy and damped quantum ratchets*
11. Carvalho Josue Xavier de; *Deformed Gaussian-orthogonal-ensemble description of small-world networks*
12. Crokidakis, Nuno; *Geometrical phase transitions in growing networks: competition between aging and preferential attachment*
13. Dias, Sandra; *Solitary waves on carbon nanotubes*
14. Escaff, Daniel; *Noise induces partial annihilation of colliding dissipative solitons*
15. Faustino, Caio; *Statistical aspects of search dynamics in scarce environments*
16. Felisberto, Marcelo; *Correlated Lévy walk*
17. Fiore, Carlos Eduardo; *Liquid polymorphism, order-disorder transitions and anomalous behavior: a Monte Carlo study of the Bell-Lavis model for water networks*
18. Fonseca, Josue; *Symmetry and dissipation in coupled Huygens pendula*
19. Fumiã, Herman Fialho; *Cell differentiation on scale-free networks*
20. Gameiro L. Martins, Caroline; *Building robust barriers to control chaotic magnetic field lines in tokamaks*
21. Gleiser, Pablo M.; *Complex network analysis of a semantic memory system*
22. Gleiser, Pablo M.; *Emergent hierarchical structure in a dynamical network with chaotic units*
23. Gouveia Slade, Gabriel; *Stability of breathers in simple mechanical models for DNA*
24. Leoncio, Filipe; *Tokamak equilibria with toroidal-current reversal*
25. Mendes, Diana Aldea; *Hausdorff dimension of the attractors of Baker's transformations with holes*
26. Mulansky, Mario; *Dynamical thermalization of disordered nonlinear lattices*
27. Oliveira, Marcelo M. de; *Universality of the contact process with random dilution*
28. Pereira, Rodrigo; *Topological approach to synchronization times in coupled chaotic maps lattices*
29. Petit Lobao, Thierry; *Classifying graphs by spectra of neighborhood matrix and higher order adjacency matrices*
30. Ramirez, Cohen Marie Francis; *Propagation of optical solitons in semiconductor quantum dot ensembles*
31. Ribeiro, Mauricio; *Off-lattice model for neuron outgrowth*
32. Ribeiro, Natalia; *Using an one-dimensional lattice applied to the thermodynamic study of DNA*
33. Roberto, Marisa; *Symplectic approach to calculation of magnetic field line transport in poloidal divertor tokamaks*
34. Rubinger, Rero; *Experimental synchronism of four Chuas circuits*
35. Santana, Charles N. de; *Self organized stability on predation networks dynamics*
36. Silva, Aline Pereira da; *Synchronization and transition to chaos in two coupled circle maps*
37. Silva, Leandro A. da; *Nonlinear effects in the dynamics governed by non-Markovian stochastic Langevin-like equations*
38. Silva, Roberto da; *Can minimal models based on game theory to describe the dynamics of live-streaming applications in P2P networks?*
39. Sousa, Orahcio; *Analysis of the package dependency on Debian GNU/Linux*
40. Szmoski, Romeu; *Synchronization in a coupled maps lattice with scaling form of connectivity*
41. Tamarit, Francisco; *Synchronization in lattice-embedded scale-free networks*
42. Terra, Maisa de Oliveira; *Dynamical properties of the weak stability boundary and associated sets*
43. Terra, Maisa de Oliveira; *Low energy earth-moon transfer orbit design*
44. Tucci, Kay; *Chaotic synchronization induced by asymmetry in coupled maps on random networks*
45. Viana, Emilson Ribeiro; *Experimental period-adding bifurcation in a modified Chua's circuit*
46. Vilela, Rafael; *A comparative study of different integrate-and-fire neurons: spontaneous activity, dynamical response, and stimulus-induced correlation*
47. Zambrano, Eduardo; *Discrete lattices of vanishing correlations for triplets of coherent states*